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VISUAL MEMORY IN AUSTRALIAN
ABORIGINAL CHILDREN AND CHILDREN OF
EUROPEAN DESCENT

EXPERIMENTAL REPORT

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Abstract

The aim of this research was to carry out using Aboriginal children from Alice Springs a replication with variations of a study by Kearins (1974; 1977), which reported superior visual memory skills among Aboriginal children from the Western Desert; and to explore further the implications of Kearins' results. The experimental task used by Kearins was a spatial version of Kim's game.

Three working hypotheses were stated based on a genetic-ecological demand theory proposed by Kearins. The third hypothesis related Kearins' theory to the Aborigines' superior 'cognitive mapping' ability as described by Lewis (1976).

Hypothesis 1: As a result of ecological demand Aboriginal children from Alice Springs (a desert habitat) will be superior to a matched sample of European children from Canberra on a visual memory task; and Aboriginal children will use different coding strategies in memorizing arrayed objects than will European children.

Hypothesis 2: If Aboriginal children are superior to European children on a visual memory task where objects are arrayed on a matrix, this ability should be enhanced if the objects are arrayed on the ground.

Hypothesis 3: Aborigines will also demonstrate superior performance if the visual memory task involves a mental rotation.

Europeans were found to make significantly more correct replacements than Aborigines in experiment 1; otherwise, no significant difference of race were found in either experiments 1 or 2. On the basis of these results, an 'environmental experience' hypothesis (Drinkwater, 1976) was accepted in preference to Kearins' genetic-ecological demand hypothesis.

In experiment 3, Europeans performed significantly better than the Aborigines. It was suggested that the experimental task did not adequately reflect the Aborigines' 'cognitive mapping' ability.

In conclusion, these data support an explanation that any differences found between Europeans and Aborigines in visual memory skill will likely result from a complex interaction of factors largely of an environmental nature.

The Aborigines of Central Australia were traditionally nomadic hunters and food gatherers, living successfully in a harsh, uncompromising, desert environment. The reader is referred to Kaberry (1939); Meggitt (1962); Berndt and Berndt (1968); and Elkin (1974) for detailed accounts of their traditional life patterns.

It has been suggested (e.g. see the review article presented in conjunction with this paper) that the survival skills demanded by a hunting-gathering people must have included:

1. a highly developed, practical orientation ability, an ability for example that would be required in pursuing fast moving game and in returning directly to the home camp after the chase. (According to Lewis (1976), the Aborigines while hunting formulate "some kind of dynamic image or mental 'map' " of the area p. 262);
2. an acute visual perceptiveness, as needed in scanning the countryside for signs indicative of a food or water source (see e.g. Kaberry, 1939 p.1; Berry, 1971 p.328);
3. and a well developed visuo-spatial memory, as demanded, particularly by a pre-literate society, in memorizing the details of animal and bird tracks, the appearance of edible foods, the geography of the landscape, etc.

Several authors (e.g. Berndt & Berndt, 1968; Brokensha, 1975; Berry, 1976) have proposed that traditional Aboriginal skills, developed as a result of ecological demand and a hunting-gathering life style, will probably persist in some measure even in detribalized conditions.

A recent cross-cultural study by Kearins (1974; 1977; 1978 a) has presented an argument which relates the traditional life style of the Aborigines and the implied cognitive skills demanded by that life style to a hypothesis predicting that Aboriginal children will be superior to children of European descent on visual memory tasks.

Kearins' thesis stemmed from an "environmental pressures hypothesis", extended to human groups from Lockard's (1971) suggestions for research in comparative psychology. In her hypothesis, Kearins postulated the genetic inheritance of cognitive skill:

environmental pressures lead to selection of cognitive characteristics most likely to ensure survival in a particular environment (Kearins, 1977 p. 13).

To test this hypothesis, Kearins chose Aboriginal people from the Western Desert region of Australia; and inferred that the following survival skills were required by these hunter/gatherers in a desert habitat:

superior acuity for low contrast material; and
the capacity to remember relationships of objects
in visual space (Kearins, 1977 p. 22).

The task Kearins devised to reflect these assumed survival skills was a spatial version of Kim's game and her experimental design compared the performance of a group of Aboriginal children (aged 7-16 years) on this task with the performance of a matched group of European children. Children were presented with an array of objects which were displayed on a grid marked card and required to memorize the positions of the objects. The objects were then jumbled and the task was to replace each in its original position. Four different arrays were presented in this manner. Two classes of objects were used to allow for differences in experience between the two groups of children - man-made objects familiar to Europeans; and natural objects familiar to Aborigines. Both these classes of objects were used in each of two types of arrays, classified as "different-name" objects and "same-name" objects. The latter was intended to make verbal labelling difficult and thus to identify children attempting such a strategy.

Kearins' results indicated that the performance of Aboriginal children, whether from a traditional or a non-traditional background,

"was consistently and significantly superior to that of the non-Aboriginal groups" (Kearins, 1978 a p.9). Object familiarity was found to make no difference to the Aboriginal groups, but the European groups performed better on items which were familiar and, according to Kearins, potentially nameable (i.e. "different-name" type objects). From the fact that European children tended to mouth the names of the objects, were effected by object type; and because their overall performance was inferior, Kearins inferred that these children were employing verbal strategies to code the information in memory. The Aboriginal children's silence, on the other hand, together with their superior performance under all array conditions was given as evidence for the use of visual, gestaltic strategies.

No significant sex differences were found in either the European or the Aboriginal groups, although Kearins (1977) has commented that "in the European descent group boys aged 7-12 years tended to score higher than girls, but differences were slight" (p. ii).

Kearins concluded from her results that the genetic question of the inheritance of a cognitive skill of adaptive significance within a particular environment might therefore be said to have been fairly clearly answered by the present study (Kearins, 1977 p. 152).

There is some evidence which lends support to Kearins' assumption that Aboriginal people may prefer to employ visual strategies in processing information from a patterned array. Davidson (1977) found that in the card game Baccarat Aboriginal players have developed a visual, pattern recognition system to identify the face value of the cards in their hand. European players, in contrast, use the verbal strategy of reading the numbers on the cards and summing them. More recently, Davidson and Klich (1979) demonstrated that on a free recall task,

involving the serial presentation of three mounted pictures, Aboriginal subjects retrieved the remembered information as a visuo-spatial unit. On the same task, European subjects employed a serial strategy. This evidence, however, is minimal and the strategies used by the Aborigines may be task-specific and unrelated to the strategies required for survival in the 'bush'.

Other cross-cultural studies have indicated that Aborigines may be superior to Europeans on visuo-spatial tasks. Berry (1971; 1976), using a battery of tests (Witkin Embedded Figures Test; Koh's Blocks, Raven's Matrices; Morrisby Shapes; and a discrimination task) purported to measure visuo-spatial skill, concluded that there is a significant relationship between a hunter-gatherer life style and superior ability in visual discrimination and spatial skill. Similarly, Dasen (1974) demonstrated in a Piagetian framework that Aborigines perform better on spatial than on logico-mathematical tests. The reverse was found to be true for Europeans.

Again the evidence is sparse and not unequivocal. Tests of spatial ability, such as those used in the studies mentioned above, have been variously criticized (e.g. Kearins, 1977; LCHC, 1979) as being culturally unfair and as measuring performance, not competence. The main criticism to be levelled, however, in relation to an ecological demand hypothesis is that the cognitive skills measured by these tests will be test-specific and do not reflect the strategies that Aborigines employ in moving around in their natural habitat. As the review article related to this paper has outlined, the 'cognitive mapping' strategies used by Aborigines in the 'bush' are complex and variable.

Kearins' findings, furthermore, could not be replicated by either Harris (1977) or by Drinkwater (1976; 1978). Harris followed Kearins' original design using a sample of children (aged 9-17 years) from three groups: traditional Aborigines from Milingimbi, an island off the coast

of the Northern Territory; urban Aborigines from Darwin; and Europeans from Darwin. On overall mean error score, Harris found that the European children performed better than either of the Aboriginal groups. Drinkwater (1976; 1978) varied Kearins' design and used two arrays of objects, one consisting of 10 artefactual and 10 natural objects; and the other made up of different, plastic letters of the alphabet. The children in Drinkwater's sample were a group of medium-contact, adolescent Aborigines from Palm Island; and a matched group of European children from a coastal city in Queensland. Drinkwater found no significant differences in performance between the two racial groups on the number of objects correctly replaced or on a score reflecting the magnitude of replacement error. For both the racial groups, the letters proved significantly more difficult than the objects; the natural objects were significantly more difficult than the artefactual objects; and the girls made significantly less replacement errors than the boys.

On the basis of her results, Drinkwater (1976) rejected Kearins' genetic inheritance hypothesis. She argued that if Aboriginal people had evolved superior visual memory ability as a result of long-term survival as hunter-gatherers, then this ability should also be evident in Aborigines from Queensland. Since this was not found to be the case, Drinkwater proposed an alternative explanation for Kearins' results, namely that "the specific environmental experience of the desert children had facilitated the acquisition of perceptual and visual memory skills" (Drinkwater, 1976 p. 38). In a more recent article, Drinkwater (1978) has further suggested that the superior performance of the Aboriginal children in Kearins' study may be the result of a memory training game (see Harney, 1952, pp. 378-379) which is played by Aboriginal children from the desert. This game is remarkably similar to Kim's game.

Kearins (1978 b) has since replied to Drinkwater (1976) and proposed that Drinkwater's failure to reproduce her results could be

attributed to the following deficiencies in Drinkwater's experimental design.

1. Drinkwater used coastal Aborigines as subjects and not Aborigines from a "desert habitat" as specified in Kearins' hypothesis.
2. The letters task, according to Kearins, had "no place in work based on an ecological rationale directed towards a pre-literate people" (p. 3).
3. Kearins complained that the inside setting used by Drinkwater detracted from the 'aboriginality' of the situation; and created an obvious European, schoolroom situation which may have been associated with past failure by the Aborigines.

Kearins' criticisms are trivial. As Drinkwater (1978) has pointed out, if a selective genetic development of perceptual/cognitive skill has occurred, it should be manifest in all Aboriginal people. The letters task was an extra experimental condition which was separate from the objects task. Furthermore, Drinkwater (1978) has emphasized that her setting was "in a small school store room"; the atmosphere was "relaxed and low key"; and the Aboriginal children were attentive and appeared to enjoy performing the tasks.

The three experiments described in this paper were designed to shed some light on this controversy.

Experimental Hypotheses

1. The aim of the first experiment was to replicate Kearins' experiment (1974; 1977) using Aboriginal children from Alice Springs. Kearins' genetic-ecological demand hypothesis states that

Australian Aboriginal children of (long-term) desert origin, whether living traditionally or not, are more likely than others to excel in visual spatial memory (Kearins, 1978 b, p. 2).

If this hypothesis is correct, then one would predict that the superior

visual memory found in Aboriginal children from the Western Desert would also be found in Aboriginal children from Alice Springs (a desert area).

Kearins inferred that the Aboriginal and the European children were employing different coding strategies in performing her tasks. In order to verify this implication experimentally, the objects in each array were randomly assigned to the locations, such that each child within one cell of the experimental design was presented with a different array. This paradigm was used so that the saliency of given objects and locations could be analyzed separately. If Aboriginal children are using different coding strategies to those being used by European children, then it is to be expected that they will select different aspects of the experimental arrays to commit to memory.

Hypothesis 1: As a result of ecological demand Aboriginal children from Alice Springs (a desert habitat) will be superior to a matched sample of European children from Canberra on a visual memory task; and Aboriginal children will use different coding strategies in memorizing arrayed objects than will European children.

2. It is suggested that the presentation of the arrayed objects on a grid-marked card detracts from the aim of providing a 'natural' setting for the Aborigines and imposes a row/column coding strategy on the task, particularly for the European children. In order to control for this possibility, in experiment 2 the objects were presented at random locations on the ground. Experiment 2 was otherwise the same as experiment 1.

Hypothesis 2: If Aboriginal children are superior to European children on a visual memory task where objects are arrayed on a matrix, this ability should be enhanced if the objects are arrayed randomly on the ground, a presentation which is closer to the situation they would find in the 'bush'.

3. Basic to Aboriginal survival skill in the 'bush' must be the ability not only to remember the visuo-spatial pattern of environmental features but to be able to recognise these features when approaching them from any direction. Lewis (1976) has suggested that Aborigines have superior ability in 'dynamic mental mapping'. Thus experiment 3 was designed to incorporate a mental rotation into a Kearins-like task.

Hypothesis 3: If Aborigines are superior to Europeans on visual memory tasks as a result of their hunting-gathering tradition, they will also demonstrate superior performance if the visual memory task involves a mental rotation.

Method

Experiment 1: Replication of a Study Conducted by Kearins (1974, 1977)

Three groups of children (classified as 1. Europeans; 2. urban Aborigines; and 3. traditional Aborigines) from a total of 100 children were tested. Each group was divided by age into juniors and seniors and by sex. Table 1 summarizes the allocation of children to groups.

Table 1

Distributions of Subjects Taking Part in Experiment 1,
with Age Range, Mean Ages and Standard Deviations.

Group	Age Group	Sex	No. of Subjects n	Age Range	(Years) - (Months)	(Years) (Months) Mean Age	S.D. (Months)
1. European	Juniors	M	10	6.10 -	8.4	7.7	5.9
		F	10	7.3 -	8.4	7.8	4.7
	Seniors	M	10	10.6 -	12.5	11.8	6.3
		F	10	9.9 -	11.10	11.1	7.5
2. Urban Aborigines	Juniors	M	10	6.8 -	8.3	7.6	6.4
		F	10	7.4 -	8.2	7.9	3.7
	Seniors	M	10	10.11 -	12.8	11.8	6.2
		F	10	10.6 -	11.10	11.4	5.6
3. Trad- itional Aborigines	Juniors	M	10	In most cases ages unknown. Classified			?
		F	4				
	Seniors	M	2	junior-senior by class-teacher.			?
		F	4				

The Aboriginal Subjects

All the Aboriginal children tested attended Traeger Park Primary School in Alice Springs, N.T. The total enrolment at the school was 460. Approximately 76% of the children were of Aboriginal descent and 24% of European descent.

The information on this sample came from current school records; a submission from the school to the Neil/Hird Committee (1976); interviews with the teachers, including two Aboriginal aids; the school counsellor; and a social worker.

The urban Aboriginal group: Of the sample of 40 children, the 20 juniors were selected randomly from grade 2 and the 20 seniors from grades 5 and 6. Most of the children in this group were of mixed ancestry and came from three sub-groups: 1. a stable, permanently employed group living in town; 2. a largely unemployed group living in town, often with more than one family per house; and 3. a group of children from hostels or cottages run by surrogate white parents, but whose own families were considered to be town dwellers.

Most of these children were conversant with tribal customs (see Table 2 for tribal distributions) and had some experience in 'bushcraft'.

The traditional Aboriginal group: The traditional Aborigines were taught in one classroom for specialized instruction and although 56 children were listed on the roll, because of variable attendance it was only possible to test 20 of them. The traditional children were from two sub-groups: 1. hostel or cottage children from traditional families; and 2. fringe-dwellers from the make-shift settlements on the outskirts of town.

The majority of the traditional children came from a transient Aboriginal population who frequently went on journeys lasting for weeks and months. As a result, the children attended school sporadically. Their families lived a tribal life (see Table 2 for tribal distributions) and still preserved to some extent the hunting-gathering tradition.

Table 2

Distribution of Tribal Groups in the Urban
Aboriginal and Traditional Aboriginal Groups

Experiment 1							
Urban Aborigines	Tribal Origin	No. of Subjects		Traditional Aborigines	Tribal Origin	No. of Subjects	
		Male	Female			Male	Female
Juniors	Aranda	3	6		Aranda	4	1
	Loritja	2	1		Loritja	1	1
	Pitjant- jatjara	1	1	Juniors	Walbiri	1	1
	Unknown	4	2		Unknown	4	1
Seniors	Aranda	3	5		Aranda	-	1
	Loritja	3	1	Seniors	Loritja	2	1
	Pitjant- jatjara	2	-		Walbiri	-	2
	Walbiri	1	-				
	Unknown	1	4				

The School: Lessons at Traeger Park were conducted by a predominantly European teaching staff. All the Aboriginal children used in the study could speak English; and the majority were bi- or trilingual. Most children at the school, but the fringe-dwellers in particular, performed well below European norms in literacy and numeracy. The school building, the classrooms and the educational equipment at Traeger Park compared favourably with those of any European school. It can be assumed, therefore, that the Aboriginal children would have been familiar with many of the artefactual objects found in a European school and would have some knowledge of the objects likely to be found in a European home.

Health was generally good. There were cases of trachoma, and middle ear infections were common. However, a full-time nursing sister permanently stationed at the school paid immediate attention to any medical problems.

Games: Observation of the games played by the Aboriginal children in the playground; and interviews with the children, their teachers and the staff at the hostels, revealed no instances of memory games.

The European Subjects

The European children tested came from Duffy Primary School, an open-plan school in a middle-class suburb of Canberra. The total enrolment at Duffy was 560 children. The children in the sample consisted of 20 juniors from a 2nd/3rd grade unit and 20 seniors from a 5/6th grade unit. The criterion for selection was to match the urban Aboriginal sample for sex and for age.

Canberra has many open areas of parkland or bush and the city limits are easily accessible by car. Thus, although the European group consisted of city children, the Canberra children would have had reasonable experience with the natural objects presented in the experiment.

Games: Five children from Duffy (four seniors and one junior), when questioned admitted to having played on isolated occasions a party game in which a number of objects had to be memorized and later recalled.

Materials

Two arrays of objects were used, one of 20 different-name, artefactual objects (A/D) and the other of 20 different-name, natural objects (N/D). The A/D objects were found at school and in the European home and were considered to be easily recognizable, European objects. The N/D objects, collected around Alice Springs were considered to be more familiar to the Aboriginal children. The objects were displayed on two sheets of white card (40cm. × 32cm.), each divided into a matrix of 20 (8cm. × 8cm.) locations (see Appendix 1a for photographs of example arrays).

For the practice trial, a third identical display card was constructed on which four objects (two A/D and two N/D), different from those used in the experiment, were presented at four dispersed locations.

The other materials were: two lengths of cloth to cover the arrays; one record sheet per subject (see Appendix 2a); and a stop watch.

Design

Kearins' experimental design was replicated with the following variations:

1. Whereas Kearins presented the same two arrays to every child, in this experiment the 20 objects in each array were randomly assigned to the 20 locations in the matrix, such that each object appeared in each location once over 20 trials. The two arrays thus varied for each child within a given age group, but the set of 20 arrays remained the same for juniors and seniors across the three racial groups.
2. Four arrays were used in the Kearins experiment. The two not included in this replication consisted of one array of 12 same-name, artefactual objects displayed on a matrix of 12 locations; and a similar array of 12 same-name, natural objects. The same-name task was not replicated as it was considered to be altogether different to the different-name task. The added difficulty of discriminating between the objects in memorizing the array probably requires different coding strategies to those required on the other task.
3. In the Kearins design, the experimenter and the subject sat on camp stools before an array positioned at the same height. A more natural setting and one considered more appropriate for the Aboriginal children was used in this experiment. The child and the experimenter sat on the ground before the array which was also on the ground.
4. A practice trial was included for the Aboriginal children to ensure that they understood the experimental instructions. A practice trial was considered unnecessary for the European children.

Procedure

Familiarization: Before and during the experimental period, time was spent getting to know the children. At both schools, the experimenter taught on

relief; observed and assisted teachers in all the classes from which subjects were selected; and became generally involved in school activities, such as sport and excursions.

Experimental Procedure: Children were tested individually in an outdoor setting during school hours. The Aboriginal children were first given a practice session. Children who appeared not to have understood the task or who were considered too shy to participate were eliminated from experimental sample. Only one junior girl was eliminated.

Before an experimental trial, the two arrays were covered with cloths. Each child was given the same instructions (Appendix 3a). Arrays were presented one at a time and after each trial the order of array presentation was reversed to control for 'order effect'. Timing commenced as soon as the cover was removed. Each child was given 30 seconds to view the array. After 30 seconds, the objects were disarrayed by lifting the card and tipping the objects into a pile near the child. The task was to reconstruct the array as accurately as possible. No time limit was imposed during the reconstruction and objects could be relocated at will.

When the child had completed the task to his satisfaction, the object replacement positions were recorded (see Appendix 2a for a sample record sheet) and the child was told his number of correct replacements. The child then moved to the next array and the same procedure was followed (see Appendix 3a for instructions). Before the following trial, the next two arrays were set up by consulting the recording sheet for the next child.

For each child, the number of correct placements and an error score were calculated. The error score was calculated by summing, over all objects, the number of location squares by which each object was misplaced.

Experiment 2: A Random Variation on Kearins' (1974, 1977) Design

Subjects

A sample of 100 children from Traeger Park and Duffy Primary Schools were tested. Where possible the same children were used in experiments 1 and 2. Table 3 summarizes the allocation of children to groups and shows the number of children, per cell of the design, who were tested under both experimental conditions.

Table 3

Distributions of Subjects Taking Part in Experiment 2,
with Age Range, Mean Ages and Standard Deviations.

Group	Age Group	Sex	No. of Subjects n ^a	Age Range	(Years) (Months)	(Years) (Months) Mean Age	S.D. (Months)
1. European	Juniors	M	10 (10)	7. 0 -	8.3	7.7	5.9
		F	10 (10)	7. 0 -	8.3	7.8	4.7
	Seniors	M	10 (10)	10.11 -	12.7	11.8	6.3
		F	10 (10)	10. 1 -	12.3	11.1	7.5
	Juniors	M	10 (10)	6. 8 -	8.3	7.6	6.4
		F	10 (9)	7. 4 -	8.2	7.9	3.6
2. Urban Aborigines	Seniors	M	10 (10)	10.11 -	12.8	11.8	6.2
		F	10 (8)	10. 6 -	12.0	11.5	5.0
	Juniors	M	8 (7)	In most cases ages unknown. Classified junior-senior by class teacher.			
		F	5 (2)				
3. Trad- itional Aborigines	Seniors	M	2 (1)				
		F	5 (3)				

^a Numbers in parentheses indicate the number of children included in both experiments 1 and 2.

Table 4

Distribution of Tribal Groups in the Urban
Aboriginal and Traditional Aboriginal Groups

Experiment 2

Urban Aborigines	Tribal Origin	No. of Subjects		Traditional Aborigines	Tribal Origin	No. of Subjects	
		Male n ^a	Female n ^a			Male n ^a	Female n ^a
Juniors	Aranda	3 (3)	6 (5)		Aranda	3 (3)	3 (2)
	Loritja	2 (2)	1 (1)		Loritja	1 (1)	- -
	Pitjant- jatjara	1 (1)	1 (1)	Juniors	Walbiri	1 (1)	2 (1)
	Unknown	4 (4)	2 (2)		Unknown	3 (1)	- -
Seniors	Aranda	3 (3)	6 (5)		Aranda	1 (0)	2 (1)
	Loritja	3 (3)	1 (1)		Loritja	1 (1)	1 (1)
	Pitjant- jatjara	2 (2)	1 (0)	Seniors	Pitjant- jatjara	- -	1 (0)
	Walbiri	1 (1)	- -		Walbiri	- -	1 (1)
	Unknown	1 (1)	2 (2)		Unknown	- -	- -

^a Numbers in parentheses indicate the number of children included in both experiments 1 and 2.

Materials

Two arrays of 20 objects each were used. One consisted of 20 different-name, artefactual objects (A/D); the other of 20 different name natural objects (N/D). The objects were collected around the school and the home; and around Alice Springs, respectively. All 40 objects were different to those used in experiment 1 (see Appendix 1b).

Two sheets of clear plastic (60cm. × 70cm.), labelled A/D and N/D, respectively, were used to preserve the two sets of random locations. Out of each sheet were cut 20 × 3cm. square, predetermined location-markers through which thumb tacks could be pressed into the ground in order to mark the locations. On each sheet, each hole was numbered from 1 to 20 to correspond to the numbered arrays (A/D, N/D) on the individual subject's record form (see Appendix 2b).

For the practice trial, four objects (two A/D and two N/D) different from those previously used in either experiment were presented on four randomly dispersed thumb tacks in the ground.

The other materials corresponded to those used in experiment 1.

Design

The experimental design was identical to that used in experiment 1 with the following exception. The 20 locations per array in experiment 2 were 20 easily detectable thumb tacks, pressed into the ground through holes in a master sheet.

Each master sheet consisted of a (60cm. $\times$ 70cm.) rectangle, which was subdivided into a matrix of 12 rows $\times$ 14 columns or 168 locations. From this set of locations, 20 were randomly selected with the restriction that five locations occurred in each quadrant of the matrix and that no more than four locations could occur in any given row or column. The restrictions were imposed so that the objects were equally dispersed over the area and no obvious rows or columns of objects occurred in either array. The effect of objects randomly displayed on the ground was thus achieved (see Appendix 1b).

Procedure

The procedure was the same as for experiment 1 (see Appendices 2b record sheet; and 3b instructions). No subject was eliminated after the practice session. After the thumb tacks were put into position, the master sheets were removed and the tacks stayed in position throughout an experimental session.

Experiments 1 and 2 were conducted on alternative days to avoid a 'practice effect' in subjects taking part in both experiments.

Error scores for each array were calculated using a table. Each score in the table represented a distance in decimetres between each possible location an object could be placed and its correct location.

Experiment 3: Spatial Memory and Mental Rotation

Subjects

148 children were tested in experiment 3. They attended Traeger Park and Duffy Primary Schools. All the traditional Aborigines available were tested. Of the urban Aborigines, juniors were selected randomly from grades 2 and 3; and seniors from grades 6 and 7. The European sample, matched to the urban Aborigines for age and sex, was selected from a 2/3 grade unit and two 5/6 grade units. Some children from both the Aboriginal and European samples had taken part in either experiment 1 or experiment 2. For the allocation of subjects to groups and the tribal origin of the Aboriginal samples see Tables 5 and 6.

Table 5

Distributions of Subjects Taking Part in Experiment 3,
with Age Ranges, Mean Ages and Standard Deviations.

Group	Age Group	Sex	No. of Subjects	Age Range	(Years) (Months)	(Years) (Months) Mean Age	S.D. (Months)	
1. European	Juniors	M	16	7. 2 -	9.3	8.3	7.9	
		F	16	7. 2 -	8.9	8.0	6.8	
	Seniors	M	16	9.11 -	12.8	11.4	9.2	
		F	16	11. 2 -	12.3	11.7	4.1	
2. Urban Aborigines	Juniors	M	16	7. 0 -	9.2	8.3	8.1	
		F	16	7. 0 -	8.9	8.0	5.9	
	Seniors	M	16	9.11 -	13.5	11.8	11.2	
		F	16	11. 2 -	13.8	12.3	10.2	
3. Trad- itional Aborigines	Juniors	M	9	In most cases ages unknown. Classified junior-senior by class teacher.				
		F	3					
	Seniors	M	3				?	?
		F	5					

Table 6

Distribution of Tribal Groups in the Urban
Aboriginal and Traditional Aboriginal Groups

Experiment 3

Urban Aborigines	Tribal Origin	No. of Subjects		Traditional Aborigines	Tribal Origins	No. of Subjects	
		Male	Female			Male	Female
Juniors	Aranda	8	5		Aranda	3	1
	Loritja	1	4		Loritja	1	-
	Pitjant- jatjara	1	1	Juniors	Walbiri	1	1
	Unknown	6	6		Unknown	4	1
Seniors	Aranda	5	7		Aranda	1	2
	Loritja	3	1	Seniors	Loritja	2	2
	Pitjant- jatjara	3	1		Walbiri	-	1
	Unknown	5	7				

Materials

The array consisted of 16 artefactual objects, different from those used in either experiments 1 and 2, arranged on the ground in a circle of radius 30cm. (see Appendix 1c for photograph). A plastic, circular master-sheet was used to preserve the 16 locations. The master-sheet was divided into 16 equal sectors. Holes, big enough for the experimental objects to pass through were cut in the middle of each sector, 30cms. from the centre of the circle. Each hole was labelled with the name of one object.

Other materials used were a cloth to cover the array; a duplicate set of 16 objects; 16 identical, covering pots (5.5cm. radius); five different objects plus duplicates of three for practice; one record sheet per subject (see Appendix 2c); and a stop watch.

Design

A circular array was used to create a continuous border (i.e. no corners or edges) so that in performing the task, which required a mental rotation of the remembered array, the child had to code cues within the array in relation to reference points found in the larger space of the setting.

A circle is a shape familiar to both European and Aboriginal children (see Strehlow, 1947; Munn, 1973 for evidence of the importance of the circular design in Aboriginal culture).

The 16 objects were positioned in the same locations for every child. Objects were not rotated as the saliency of object and location had been considered in experiments 1 and 2. All objects were artefactual because:

1. The natural/artefactual distinction had been previously considered; and
2. Kearins' (1974, 1977) results indicated that Aborigines showed no preference for natural over artefactual objects, while Europeans showed a decided preference for artefactual objects.

Children were required to recall only eight of the 16 objects. No pre-warning was given as to which eight were to be recalled. The eight objects were selected randomly such that each object appeared eight times over a block of 16 trials to control for object/location saliency.

The design of selecting only half of the objects from the array for recall was chosen because:

1. It reduced the likelihood of a chance correct placement, since the number of possible locations to choose from remained high even for the last placement; and
2. It encouraged the child to code the array as a gestalt, i.e. the child knew he would have to recall eight objects, but not which eight. This was intended to control the method of coding so that difficulty with the task could be related to an inability to perform the necessary mental rotation.

The duplicate set of 16 objects allowed the experimenter to present the child with the objects to be recalled and thus avoided any ambiguity.

Procedure

Children were tested individually during school hours in an outside setting. Before each trial, the array was set up using the master sheet, which was subsequently removed, and covered with a cloth. A brief practice trial was given to the Aboriginal children. No child had to be eliminated after the practice trial. The practice array consisted of five objects arranged in a circle and the child was asked to recall three.

The children were positioned at point A before the array (see Appendix 1c) and given the same instructions (Appendix 3c). The cover was lifted and a 30 seconds viewing period immediately commenced. After 30 seconds, the child was requested to turn his back on the array. The experimenter then covered each object in the array with an identical, upturned pot, being careful not to change the position of any object. The child was then led to point B (Appendix 1c), a reorientation of 180° from point A. An assurance was given that the objects had not been moved but were individually concealed beneath the covering pots (see Appendix 3c for wording). The eight objects to be recalled (as pre-recorded on the child's recording sheet, Appendix 2c) were given to the child. The task was to place each object on the pot that concealed its duplicate (Appendix 3c). No time limit was imposed on the child during this task and objects could be moved around after they had been positioned.

When the child had completed the task, the pots were removed, in view of the child, and the objects both on and under each pot were noted.

The number correct and an error score were recorded for each child. The error score was calculated by summing the number of locations, by the shorter distance, each object was from its correct location.

Results

Experiments 1 and 2

Graphs of the mean number of correct replacements and standard deviations on each array for the total sample of children tested are shown in figures 1, 2 and 3 (experiment 1) and 5, 6 and 7 (experiment 2). The mean error scores and standard deviations for the total sample are graphed in figures 4 and 8, for experiments 1 and 2 respectively.

A four-way analysis of variance (race $\times$ age $\times$ group $\times$ sex $\times$ object type) with repeated measures on object type and 10 children per cell was carried out on the number of correct replacements and on the error scores for both experiments 1 and 2. Each variable had two levels: European $\times$ Aborigine; seniors $\times$ juniors; male $\times$ female; and artefactual $\times$ natural objects. The Aborigines were a random selection of children from the urban and traditional groups who had taken part in both experiments 1 and 2. This selection was performed to equate cell size in the statistical design since the traditional Aborigines were under-represented.

The following variables were found to be significant in experiments 1 and 2 (see Appendix 4, Tables 7, 8, 9 and 10 for complete ANOVAS).

Experiment 1: Correct Replacement Scores

<u>Variable</u>	<u>F(1, 72)</u>	<u>P</u>	<u>Favouring</u>
Race	4.04	< .05	Europeans
Age group	20.18	< .001	seniors
Object type	41.77	< .001	artefactual

Experiment 1: Error Scores

<u>Variable</u>	<u>F(1, 72)</u>	<u>P</u>	<u>Favouring</u>
Age group	26.51	< .001	seniors
Object type	53.67	< .001	artefactual
Sex	5.05	< .05	girls
Age group $\times$ sex	4.25	< .05	See figure 4.
Race $\times$ age group $\times$ sex	5.71	< .05	

In relation to the interaction effects, figure 4. indicates that both the European and the Aboriginal junior girls, but the European junior girls in particular, made markedly less errors than the junior boys. Sex differences in the senior age group were less pronounced, but the European boys performed better than the other groups on artefactual objects.

Experiment 2: Correct Replacement Scores

<u>Variable</u>	<u>F(1, 72)</u>	<u>P</u>	<u>Favouring</u>
Age group	28.38	< .001	seniors
Object type	48.67	< .001	artefactual

Experiment 2: Error Scores

<u>Variable</u>	<u>F(1, 72)</u>	<u>P</u>	<u>Favouring</u>
Age group	21. 27	< .001	seniors
Sex	4. 82	< . 05	girls
Object type	43. 93	< .001	artefactual
Object type x age group	6.083	< . 05	See figure 8.

Figure 8 shows that the difference between the mean error scores for the artefactual and the natural arrays within each group was not as large for the seniors as for the juniors.

To determine whether the different array presentations of experiments 1 and 2 had an effect on the number of correct replacements scored by Europeans and by Aborigines (urban and traditional), two (1×2) analyses of variance (subjects x experimental conditions) with repeated measures on experimental conditions were carried out for each racial group: one ANOVA on the number correct for the artefactual arrays across experimental conditions 1 and 2, and another on the number correct on the natural arrays across experimental conditions. All children who took part in both experiments 1 and 2 were included in the analyses. No significant effects were found for the Aboriginal group. A significant effect of

experimental condition was found for the European group on both the artefactual, $F(1, 39) = 11.09$, $p < .01$; and the natural, $F = (1, 39) = 5.61$, $p < .05$ object arrays (see Appendix 4, Tables 11 and 12). The Aborigines' overall performance remained the same under both experimental conditions, whereas the Europeans found the array presentations of each object type more difficult in experiment 2.

In experiments 1 and 2, the number of correct replacements made by all subjects for each object and each location were summed separately for Europeans and for Aborigines (urban and traditional). As the locations remained the same for both arrays on the matrix design of experiment 1, the number of correct replacements for each location were summed across both arrays. Within each racial group, objects and locations were then ranked. A Spearman's rank-order correlation was performed between the racial groups for each set of objects and locations. The significant relationships between the groups are tabulated below.

Experiment 1

<u>Variable</u>	<u>r</u>	<u>p</u>
Artefactual objects	+ .59	< . 05
Natural objects	+ .57	< . 05
Locations	+ .87	< . 01

Experiment 2

Natural objects	+ .64	< . 01
Locations (artefactual array)	+ .90	< .001
Locations (natural array)	+ .87	< . 01

The six locations where objects were most likely and least likely to be correctly placed in experiments 1 and 2 are depicted in figure 9. On the matrix format of experiment 1, the corners and the left hand row were the most salient locations and the middle locations the least salient. A similar pattern emerged on the random array presentations of experiment 2 where the outer edge locations were more salient than inner locations.

These results show that the Europeans and the Aborigines were using similar strategies in coding the arrays in memory; and, except in the case of the artefactual array in experiment 2, were paying attention to the same objects.

Experiment 3

Graphs of the mean number of correct replacements and the mean error scores with standard deviations for each racial group are depicted in figures 10 and 11.

Three-way ($2 \times 2 \times 2$) analyses of variance (race $\times$ age group $\times$ sex) were carried out on the number of correct replacements and on error scores for: 1. European $\times$ urban Aborigines; and 2. European $\times$ urban plus traditional Aborigines.

The following variables were found to be significant in experiment 3 (see Appendix 4, Tables 13, 14, 15 and 16 for complete ANOVAS).

Experiment 3: Correct Replacement Scores

<u>Variable</u>	<u>F</u>	<u>p</u>	<u>Favouring</u>
1. Race (European $\times$ Aborigine)	$F(1, 120) = 5.80$	$< .05$	Europeans
2. Race (European $\times$ urban traditional Aborigine)	$F(1, 140) = 8.40$	$< .01$	Europeans

Experiment 3: Error Scores

<u>Variable</u>	<u>F</u>	<u>p</u>	<u>Favouring</u>
1. Race (European $\times$ Aborigine)	$F(1, 120) = 4.73$	$< .05$	Europeans
2. Race (European $\times$ urban plus traditional Aborigine)	$F(1, 140) = 11.95$	$< .01$	Europeans
1. Age group (European $\times$ Aborigine)	$F(1, 120) = 10.17$	$< .01$	seniors
2. Age group (European $\times$ urban plus traditional Aborigine)	$F(1, 140) = 10.92$	$< .01$	seniors

The effect of race on both number correct and on error score was more pronounced with the addition of the traditional children to the urban Aboriginal group.

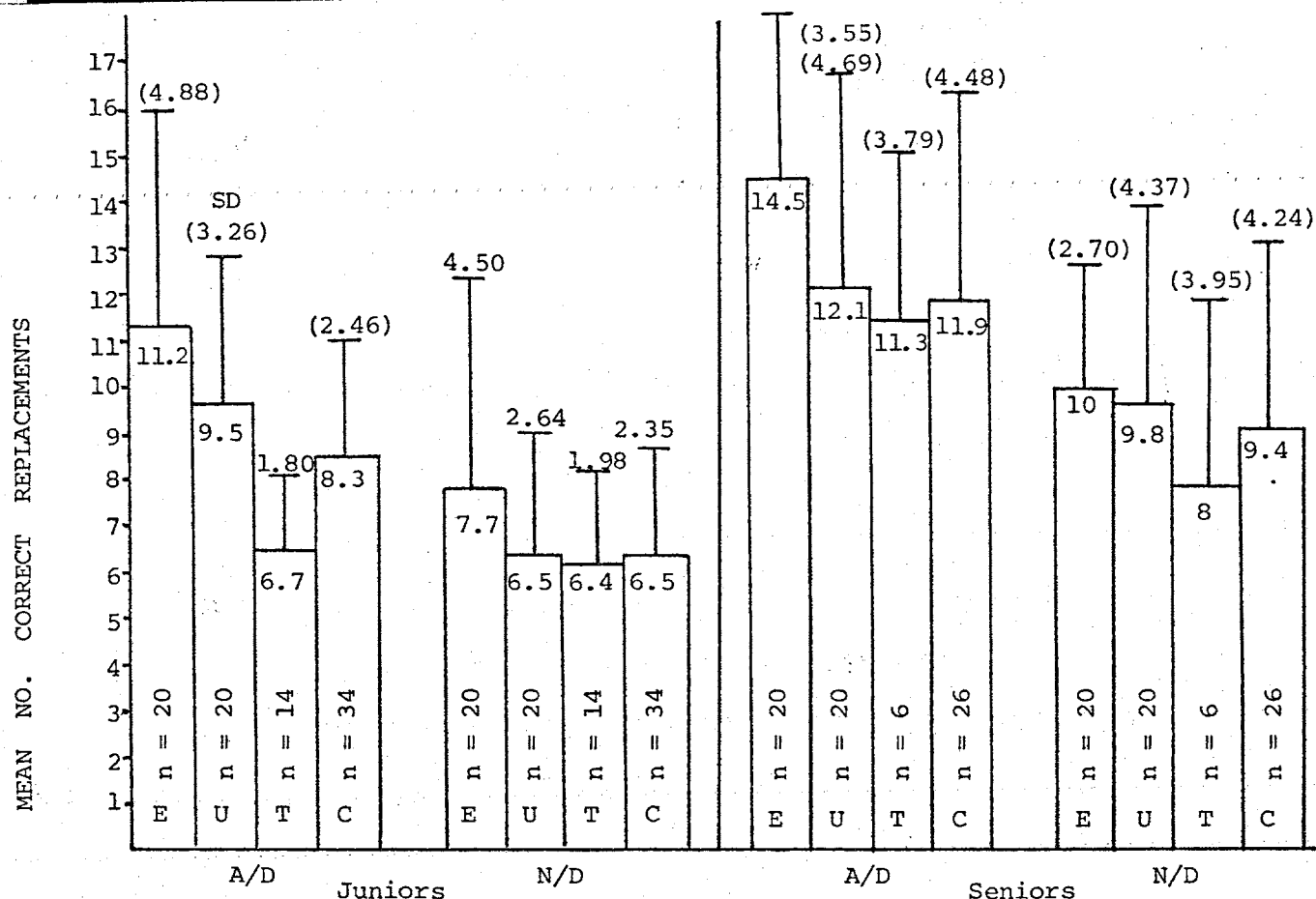


Figure 1 Experiment 1 mean number of correct replacements with standard deviations (in parentheses) for Europeans (E); urban Aborigines (U); traditional Aborigines (T); and combined urban and traditional Aborigines (C) on artefactual (A/D) and natural (N/D) objects.

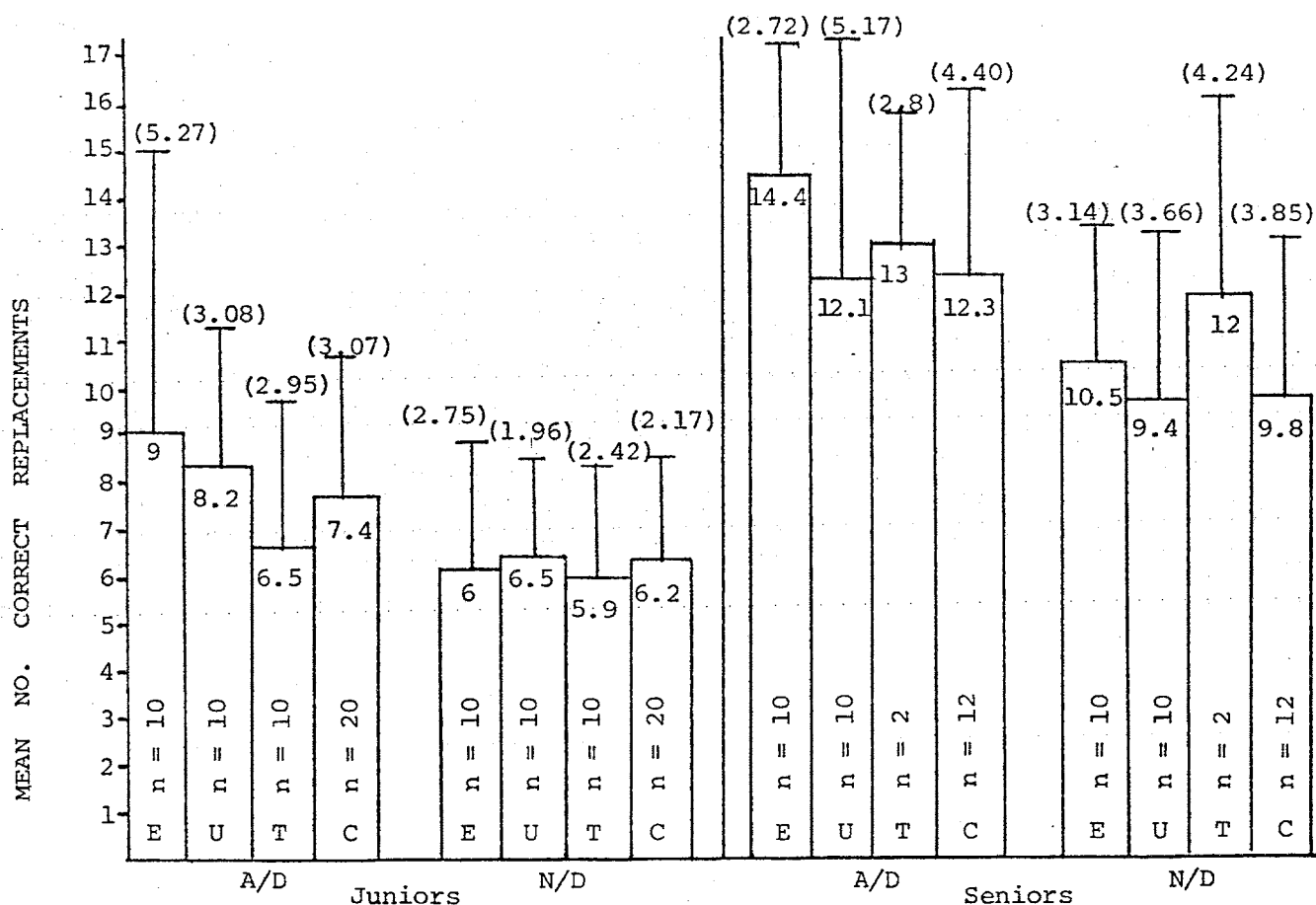


Figure 2 Experiment 1 boys mean number of correct replacements with standard deviations (in parentheses) for Europeans (E); urban Aborigines (U); traditional Aborigines (T); and combined urban and traditional Aborigines (C) on artefactual (A/D) and natural (N/D) objects.

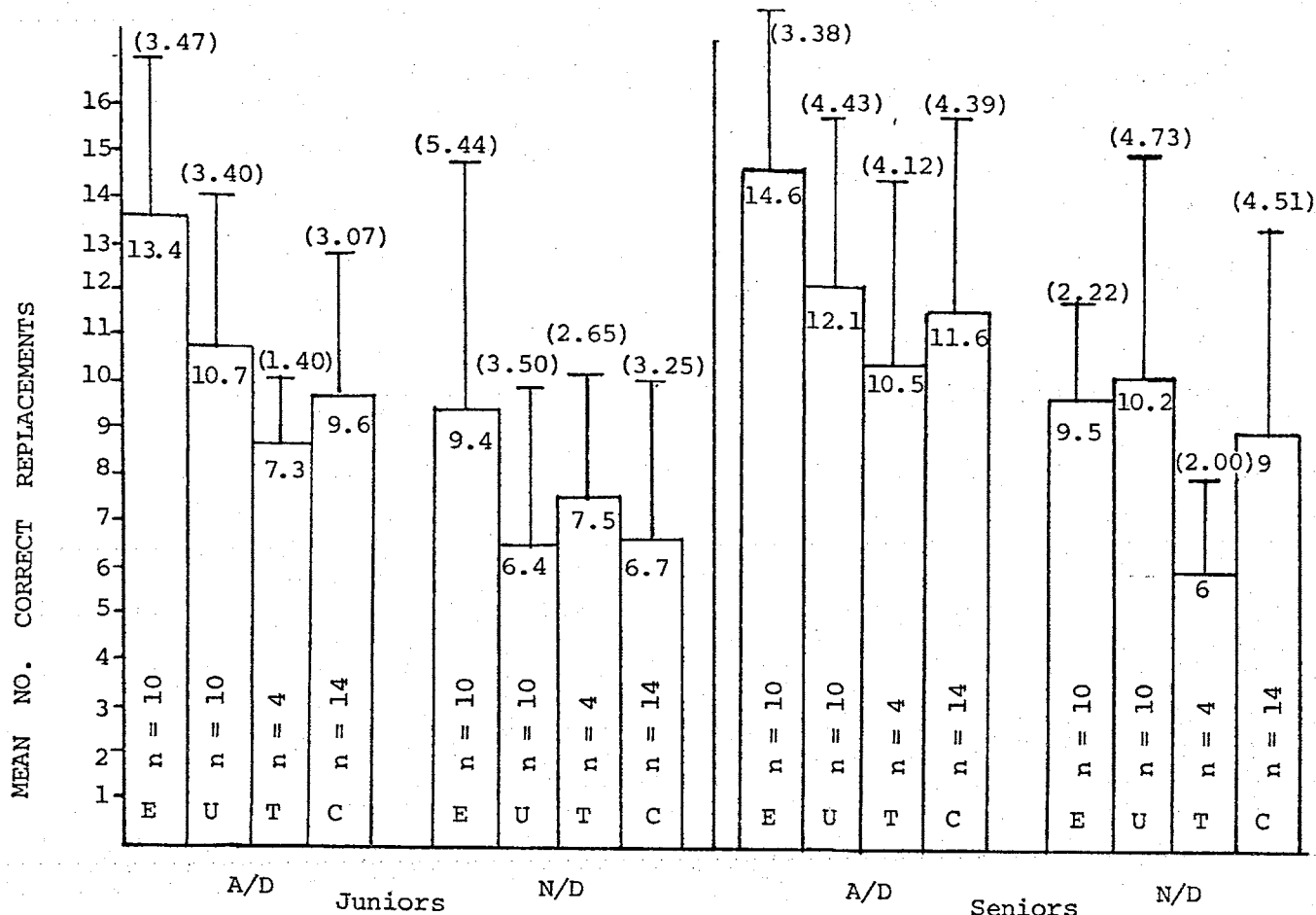


Figure 3 Experiment 1 girls mean number of correct replacements with standard deviations (in parentheses) for Europeans (E); urban Aborigines (U); traditional Aborigines (T); and combined urban and traditional Aborigines (C) on artefactual (A/D) and natural (N/D) objects.

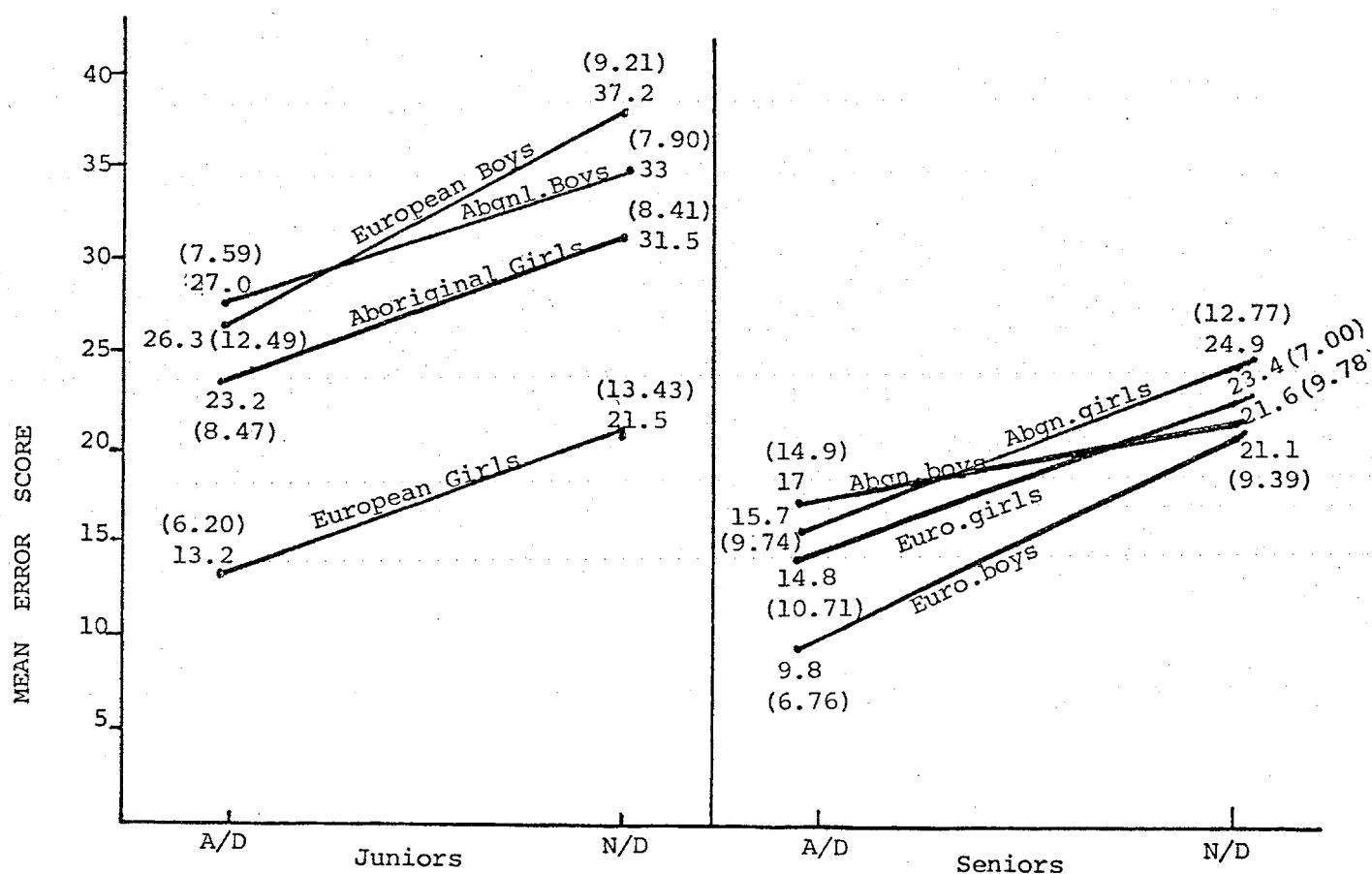


Figure 4 Experiment 1 mean error scores with standard deviations (in parentheses) for Europeans and combined Aborigines (urban and traditional) on artefactual (A/D) and natural (N/D) objects.

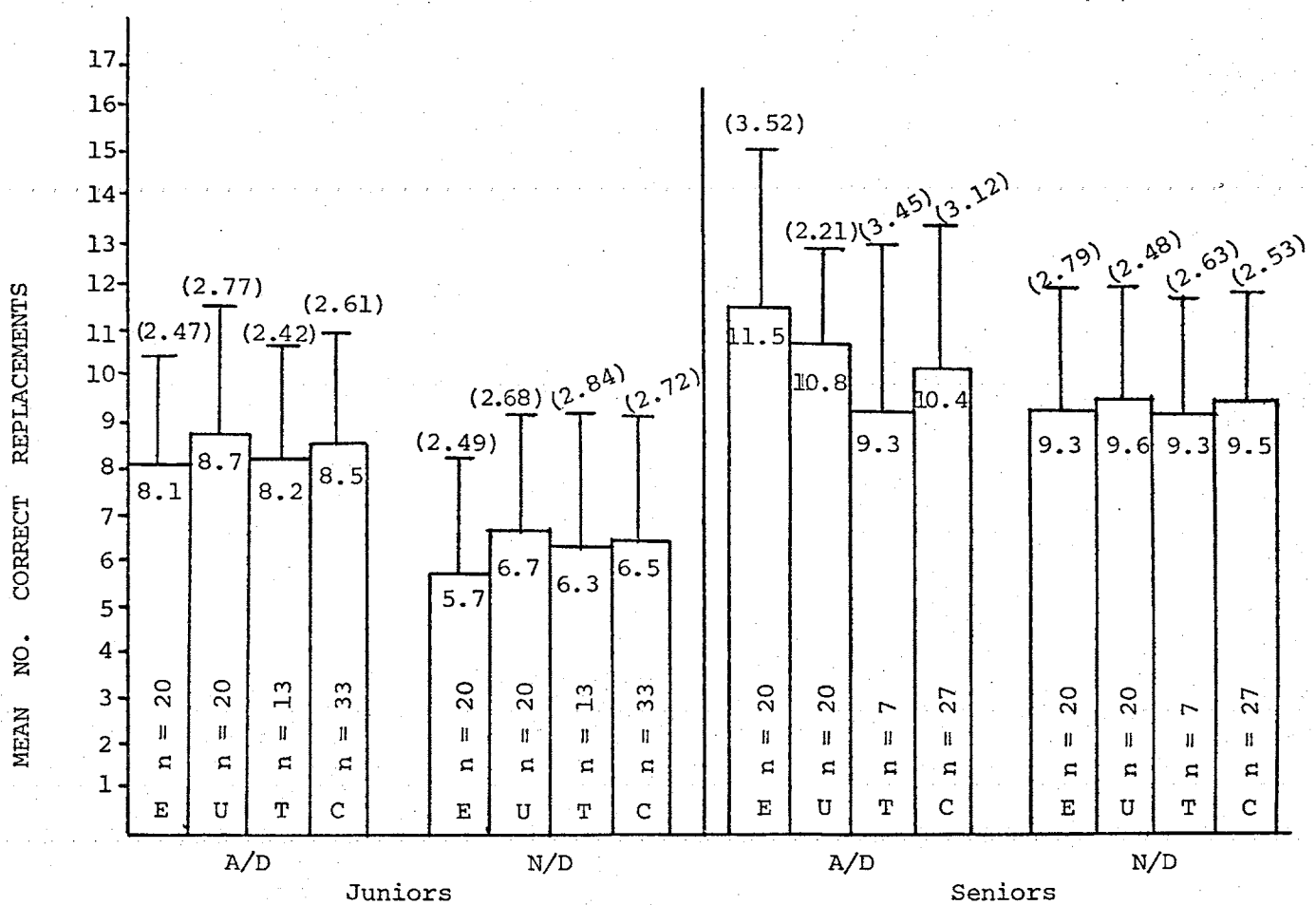


Figure 5 Experiment 2 mean number of correct replacements with standard deviations (in parentheses) for Europeans (E); urban Aborigines (U); traditional Aborigines (T); and combined urban and traditional Aborigines (C) on artefactual (A/D) and natural (N/D) objects.

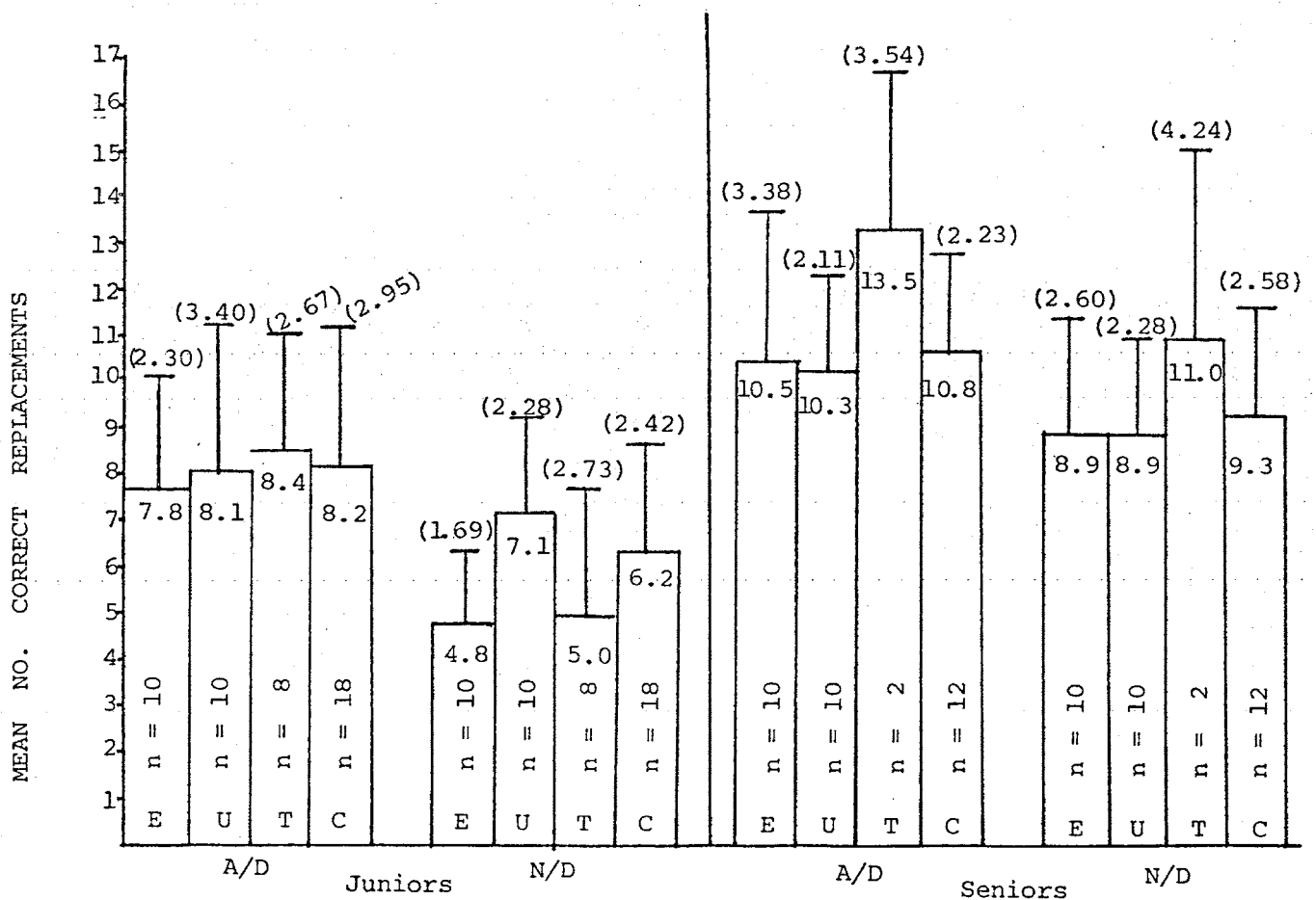


Figure 6 Experiment 2 boys mean number of correct replacements with standard deviations (in parentheses) for Europeans (E); urban Aborigines (U); traditional Aborigines (T); and combined urban and traditional Aborigines (C) on artefactual (A/D) and natural (N/D) objects.

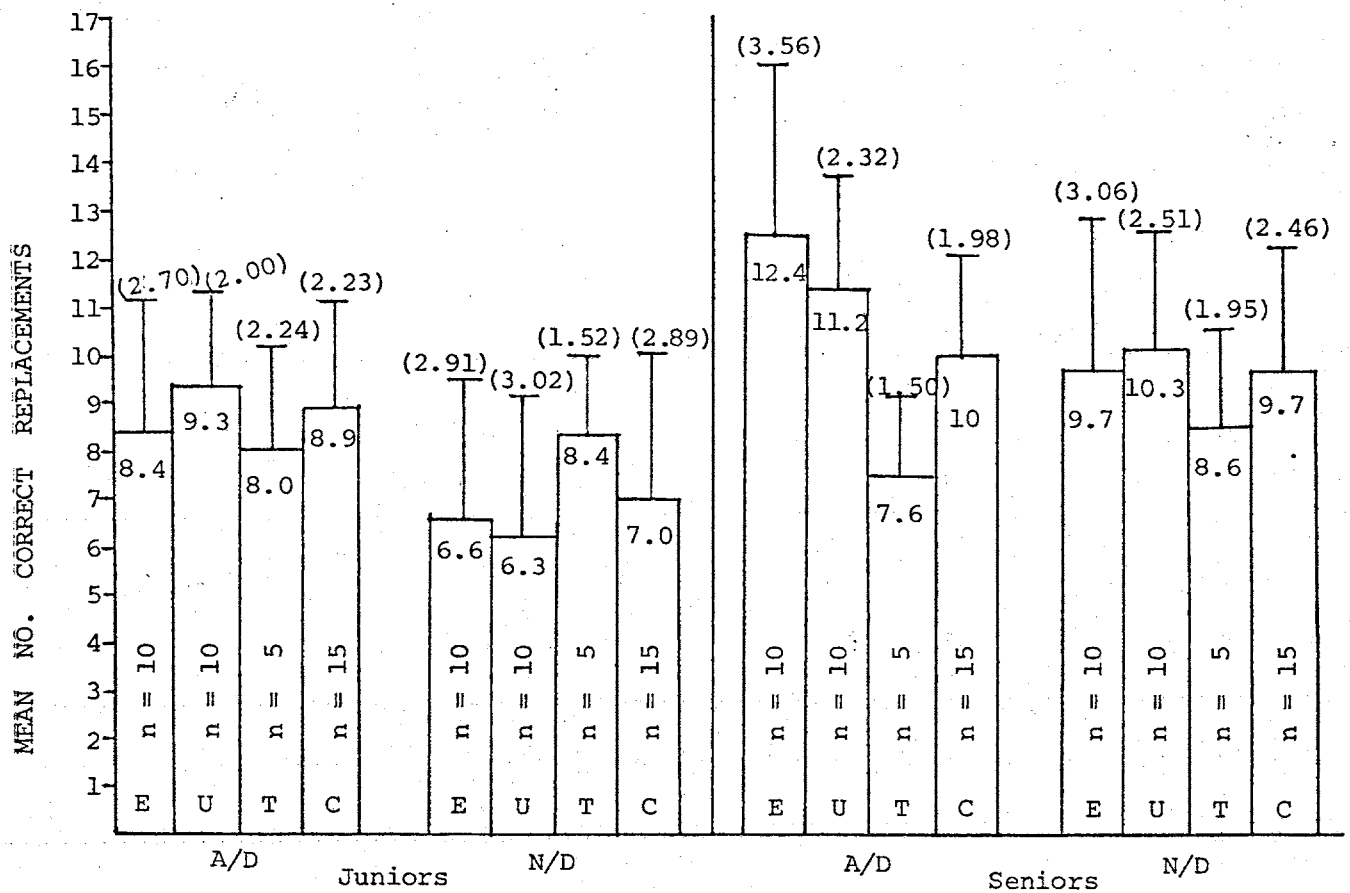


Figure 7 Experiment 2 girls mean number of correct replacements with standard deviations (in parentheses) for Europeans (E); urban Aborigines (U); traditional Aborigines (T); and combined Aborigines (C) on artefactual (A/D) and natural (N/D) objects.

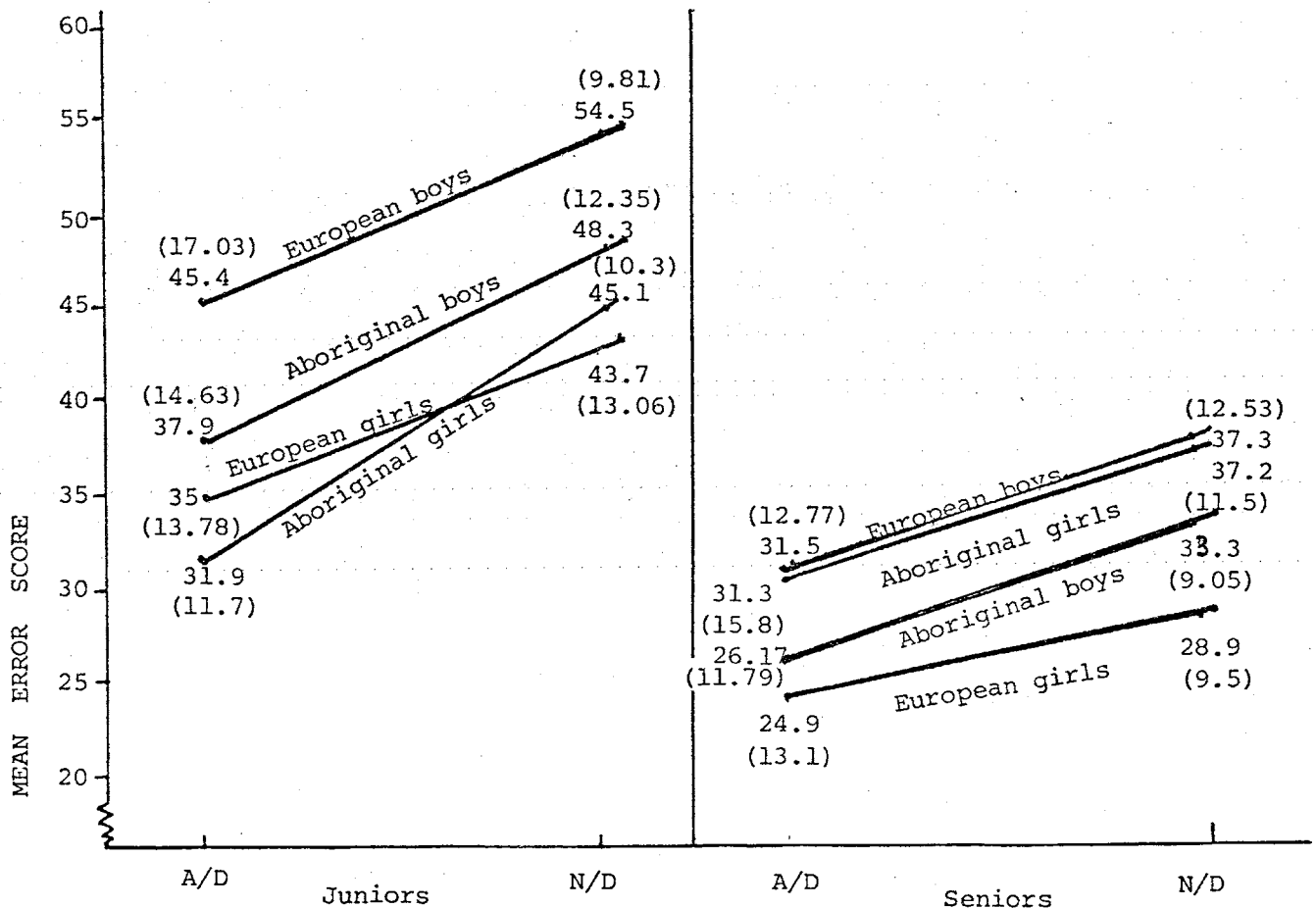


Figure 8 Experiment 2 mean error scores with standard deviations (in parentheses) for Europeans and combined Aborigines (urban and traditional) on artefactual (A/D) and natural (N/D) objects.

A 1 E 1	E 2			A 2 E 3
A 6.5 E 6.5	A 16 E 17	A 20 E 19	A 18 E 16	
A 5 E 6.5	A 15 E 20	A 19 E 18	A 17 E 15	A 6.5
A 4 E 5				A 3 E 4

Figure 9a The diagram depicts the matrix locations in experiment 1. The 6 highest and the 6 lowest ranking locations (the numbers indicate the rank given to the location) are marked for the Aborigines (A) and the Europeans (E).

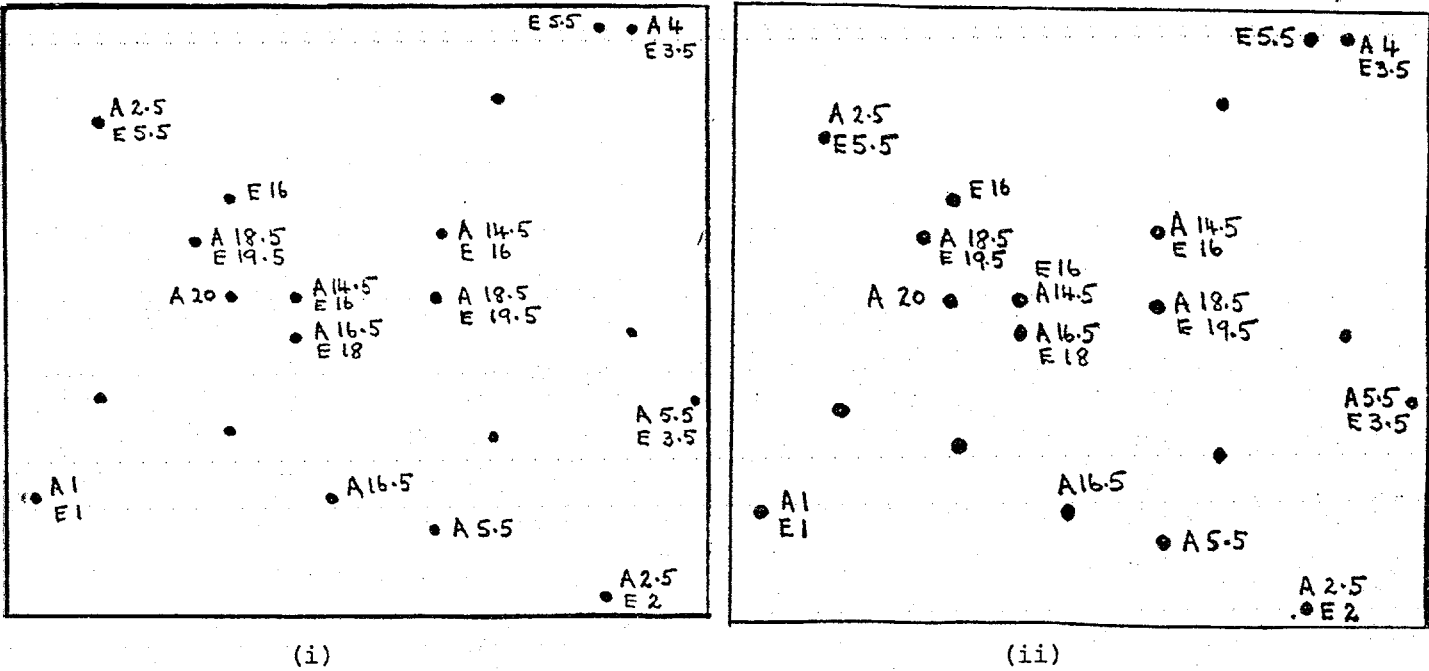


Figure 9b The diagrams depict the locations for the artefactual (i) and the natural (ii) arrays in experiment 2. The 6 highest and the 6 lowest ranking locations (the numbers indicate the rank given to the location) are marked for the Aborigines (A) and the Europeans (E).

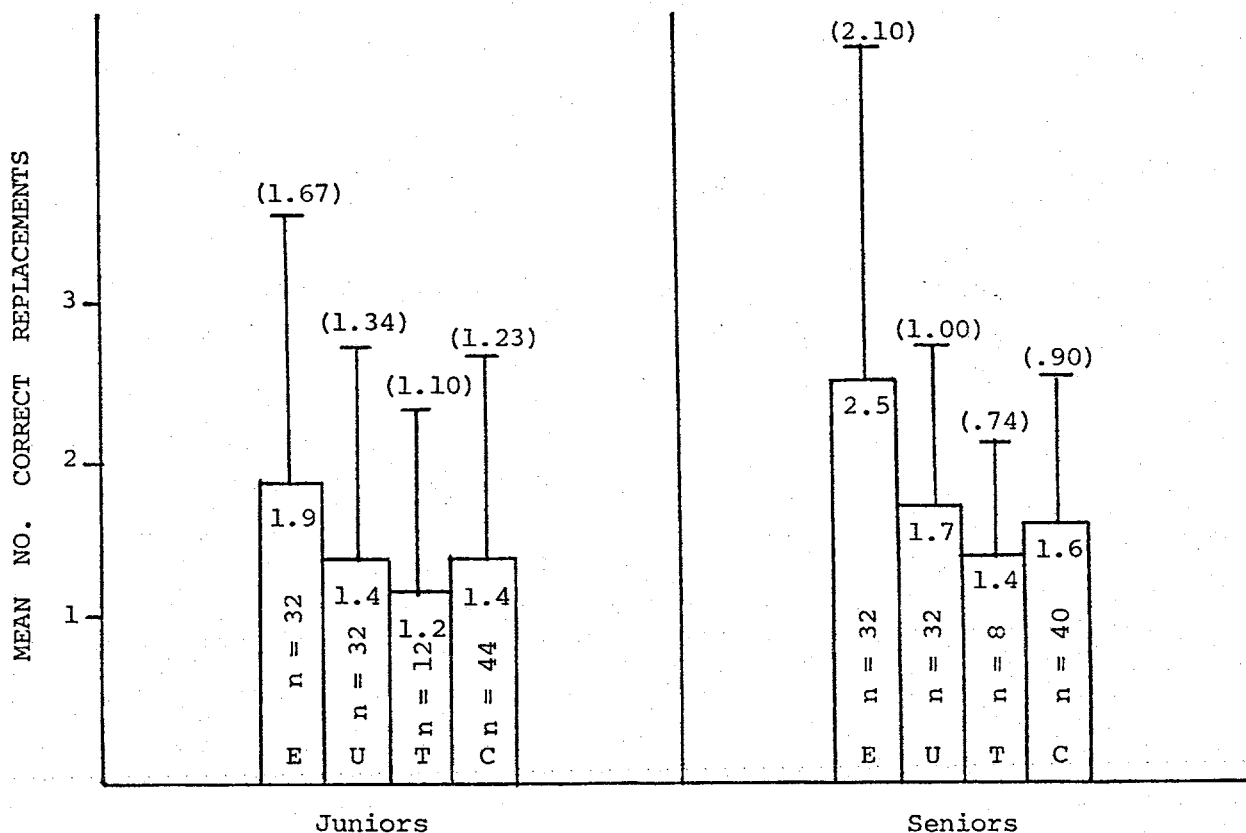


Figure 10 Experiment 3 mean number of correct replacements with standard deviations (in parentheses) for Europeans (E), urban Aborigines (U), traditional Aborigines (T) and combined urban and traditional Aborigines (C).

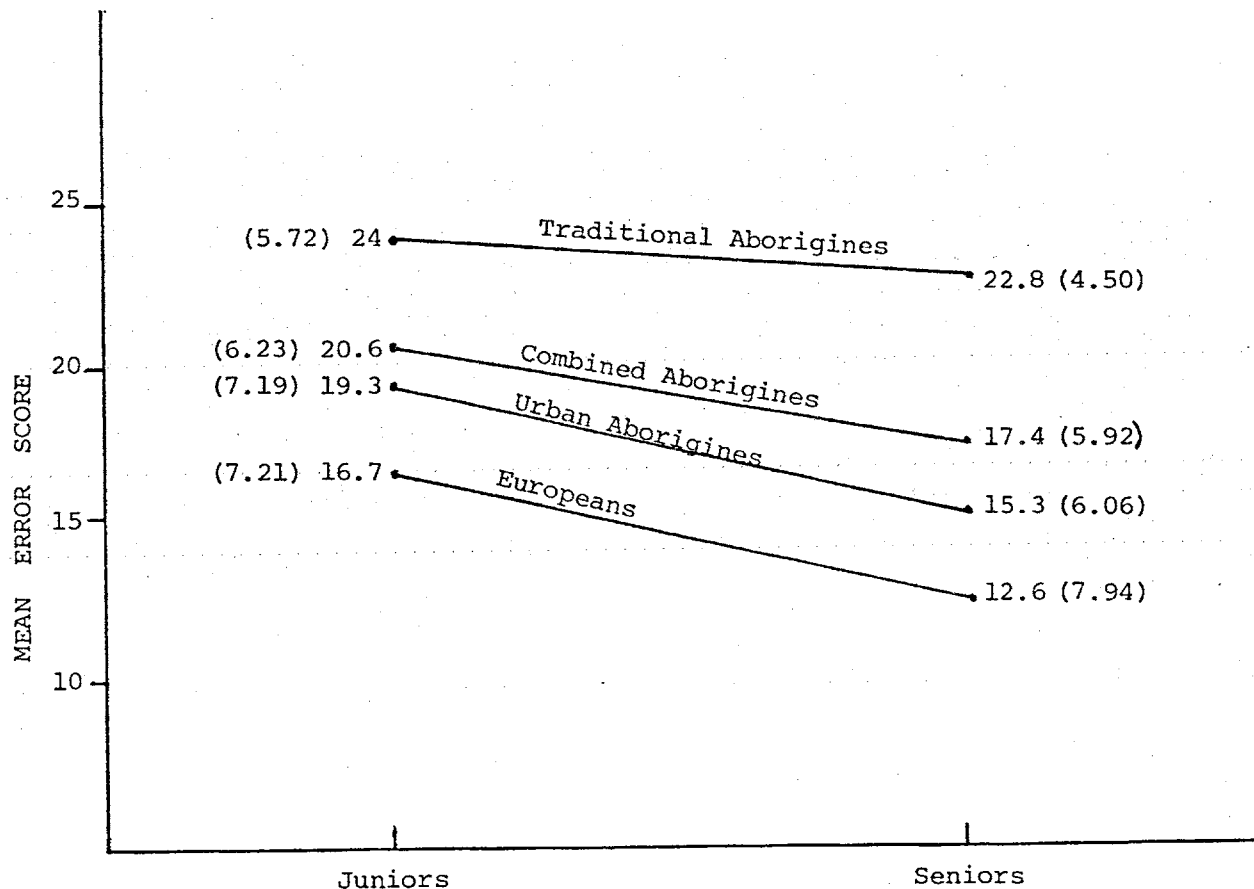


Figure 11 Experiment 3 mean error score with standard deviations (in parentheses). Europeans n = 32; Urban Aborigines n = 32; traditional Aborigines n = 12; combined urban and traditional Aborigines n = 44.

Discussion

Experiment's 1 and 2

Kearins' (1974; 1977) finding that visual memory skills were superior among Aboriginal children from the Western Desert was not confirmed for children from Alice Springs.

In experiment 1, a replication of the Kearins study, European children correctly replace^d significantly more objects than did Aboriginal children; and no significant effect of race was found on error score. Kearins' hypothesis proposed that Aborigines have evolved superior visual memory skills as a result of a hunting-gathering tradition and the ecological demand imposed by a desert environment. If an evolutionary-ecological demand hypothesis is to be accepted, these skills should be evident in other Aboriginal groups living in a desert environment. Since the results from experiment 1 do not support this prediction, the first part of hypothesis 1 must be rejected.

Kearins' experimental procedure was repeated in experiment 2, but the array presentation was designed to favour the Aborigines. It was predicted that if Kearins' hypothesis was correct the performance of the Aborigines on the visual memory task would be enhanced under experimental condition 2. No significant differences between Europeans and Aborigines were found in experiment 2 for either number correct or for error score; and the performance of the Aborigines remained the same across experimental conditions 1 and 2. As a result, hypothesis 2 must also be rejected.

Data from the present study did not substantiate the evolutionary-ecological theory proposed by Kearins (1974; 1977) but favour Drinkwater's (1976; 1978) "environmental experience" explanation.

Several factors may have contributed to the superior visual memory performance of the Aboriginal children from the Western Desert.

Drinkwater (1976) has suggested that Kearins' results may reflect a high incidence of eidetic memory among Western Desert Aborigines.

The frequency of occurrence of eidetic memory has been found to be consistently low among European cultures (Haber & Haber, 1964; Leask et al., 1969; Richardson & Cant, 1970); but erratically high and low among non-Western cultures (Doob, 1966). Sheehan and Stewart (1972) and Sheehan (1973; 1976) have confirmed the erratic occurrence of the phenomenon among Aboriginal groups. The design of the present study did not permit an adequate investigation of eidetic memory, but by definition it is association^{ed} with perfect recall. In experiment 1, only one Aborigine (aged 11.8 years) from Alice Springs gained a perfect score (natural array); and no perfect scores were recorded by the Aborigines for experiment 2. Kearins (1977, p. 50), in contrast, found that for her Aboriginal sample (aged 11-16 years) 13.6% made error free performances on the artefactual array, and 25% on the natural array which suggests that some of these children were eidetikers. (Kearins did not give the perfect score results for her junior Aborigines).

Harris (1977) has attributed his failure to repeat Kearins' results to the fact that the adolescent Aborigines from the Western Desert attended high school, whereas the Milingimbi Aborigines at the same age had limited secondary school experience. According to Harris (1977), Kearins

managed to have an Aboriginal high school sample that still was sufficiently traditionally oriented to have high 'visual memory', but also sufficiently 'school oriented' to try reasonably hard at the test and to be reasonably 'test-wise' " (p. 482).

Harris found the children at Milingimbi to be "cooperative but indifferent" (ibid p. 482). This explanation receives no support from the present study, since the educational opportunities offered at Traeger Park Primary School were equivalent to those available in any European school. Furthermore, all the children in this study were

enthusiastic to be included in the experimental sample; appeared to be absorbed when performing the task; and were not reluctant to be chosen as subjects on a second occasion.

The most plausible explanation for Kearins' findings, as Drinkwater (1978) has recently suggested, is that the Aborigines in her sample had previously played visual memory games. Harney (1952, pp. 378-379), for example, has described a game which is played by children from the Walbiri tribe. Kearins (1977) used a large sample of Aborigines from Warrabri, a predominantly Walbiri community. In this game, a large circle is drawn on the ground and along the circle-line the 'head' of the game places as many as 50 objects which the other children attempt to memorize. All players then turn their backs on the game and the first player calls an object at a given point and continues to call objects along the line until he is wrong at which time another player takes up the call. According to Harney, these children become so expert that they can correctly recall all the objects after a very short viewing period.

Practice in visual memory game may have also contributed to the greater number of correct replacements made by the Europeans in experiment 1. Five children from the European group were found to be familiar with a party game which consisted of memorizing as many objects as possible from a picture or an array. Another explanation for the Europeans' higher scores on correct replacements is that these children were more conversant with the matrix format and as a result more proficient than the Aborigines at coding items presented in rows and columns. This latter explanation is supported by the fact that the Aborigines' performance remained stable across experiments 1 and 2, whereas the Europeans' performance deteriorated significantly under the random presentation condition of experiment 2.

Significant differences between Europeans and Aborigines were found for number correct but not for error score in experiment 1. These data suggest that the Aborigines' approach to the task may have involved

the internal representation of the array as a gestalt, a method of coding information which has previously been identified with Aboriginal subjects when performing visuo-spatial tasks (Kearins, 1977; Davidson, 1979; Davidson & Klich, 1979). The Europeans, on the other hand, may have concentrated on a smaller number of objects in the array and accurately recalled more of these than the Aborigines, but made relatively large errors on the objects they neglected. However, the analysis of object and location selection by each racial group has indicated that in both experimental conditions 1 and 2, the Europeans and the Aborigines were using the same coding strategies. It is more likely, therefore, that both groups were attempting to code the arrays in the same manner, but that the Europeans scored more correct replacements because, for example, they had previously played visual memory games or were familiar with the matrix format. On the basis of the evidence, the second part of hypothesis 1, which stated that differences in coding strategies would be found between European and Aboriginal children must be rejected and a no differences interpretation accepted.

Kearins reported no differences between the recall of artefactual and natural objects for her Aboriginal sample; and a decided preference in recall for artefactual objects by her European subjects. The results in the present study, however, are in accord with those found by Drinkwater (1976). Across experimental conditions 1 and 2, both the European and the Aboriginal children consistently scored more correct replacements and made lower error scores on the artefactual than on the natural arrays. It has been found (e.g. see Underwood, 1966; Underwood & Shaughnessy, 1975) that high inter-item stimulus similarity causes difficulty in the formation of new associative links, and results in less recall. As the photographs in Appendix 1 confirm, among the artefactual objects there was a greater variability of colour, brightness; form; and general appeal than among the natural objects. Furthermore, in experiment 2, the contrast between the background and the objects was greater for the artefactual than for the natural array.

In both experiments 1 and 2, the senior children performed consistently better than the junior children making significantly more correct replacements and significantly fewer errors. It is empirically well established that older children can recall more items than younger children (e.g. see Brown, 1975; Chi, 1976). The general view in the literature (e.g. Flavell, 1971; Piaget & Inhelder, 1973; Chi, 1976) is that with intellectual development there is an increase in the sophistication of the mnemonic strategies with which a child can structure information coherently in memory. This theory was not tested in the present study, but seniors made consistently fewer errors than juniors which indicates that they were organizing the whole array in memory more successfully than the juniors.

No significant sex differences were found by Kearins. Data from the present study, however, confirmed Drinkwater's (1976) results. The boys made significantly more errors across both racial groups and under both experimental conditions than did the girls.

Sex differences in performance on memory tasks are the exception rather than the rule (Maccoby & Jacklin, 1974). However, sex differences in favour of boys (aged between 9 and 20 years) were found on a spatial memory task by Kail and Siegel (1977). These authors used a task similar to that used by Drinkwater (1976) where letters (sets of 3, 5 and 7) were displayed on a matrix. The effects of letters and positions were analyzed separately and they found that girls recalled more letters, but boys were better at recalling spatial position. These results are contrary to the findings of Drinkwater and the present study. It may be that girls are more proficient than boys in visuo-spatial memory given a larger number of objects to recall and are more proficient at recalling objects in relation to positions than are boys.

Girls perform, on average, better than boys on all aspects of school work in the early grades, a fact that is generally attributed to the differential maturation rate between boys and girls

Table 17

Mean Number Correct Scores ($\bar{X}$) and Standard Deviations (SD). A comparison between Aboriginal children from the Western Desert (Kearins' data - not in parentheses) and Aboriginal children from Alice Springs (Experiment 1 data - in parentheses).

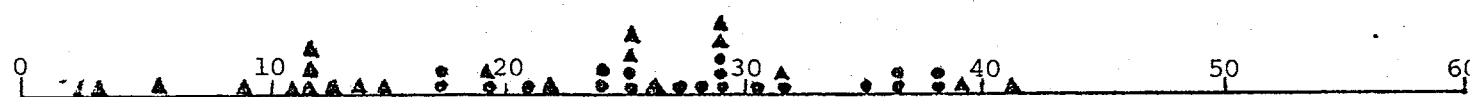
Group	Mean Age	N	Artefactual Array		Natural Array	
			$\bar{X}$	SD	$\bar{X}$	SD
Urban Aborigines	7.5	11	10.3	2.15	9.6	3.67
	(7.7)	(20)	(9.5)	(3.26)	(6.5)	(2.64)
	11.1	16	14.1	2.80	12.8	3.54
	(11.6)	(20)	(12.1)	(4.69)	(9.8)	(4.37)
Traditional Aborigines	7.6	11	11.5	1.80	11.5	2.50
	(?)	(14)	(6.7)	(1.80)	(6.4)	(1.98)
	11.11	12	13.5	3.37	13.5	2.39
	(?)	(6)	(11.3)	(3.79)	(8)	(3.95)

EXPERIMENT 1:

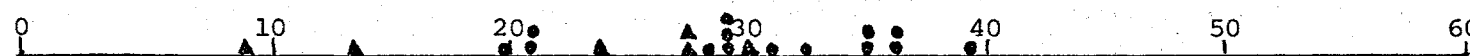
(a) Europeans $n = 40$



(b) Urban Aborigines $n = 40$

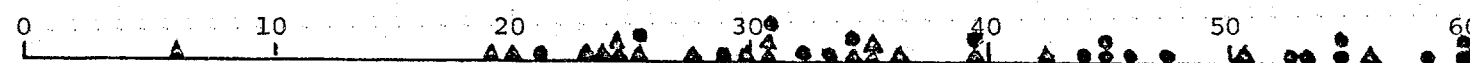


(c) Traditional Aborigines $n = 20$



EXPERIMENT 2:

(a) Europeans $n = 40$



(b) Urban Aborigines $n = 40$



(c) Traditional Aborigines $n = 20$

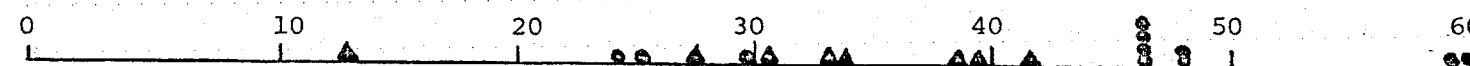


Figure 12: Individual error scores averaged across the artefactual and natural arrays in experiments 1 and 2. (Note the error scores in each experiment were determined using different measuring devices and are not directly comparable).

▲ = Seniors
● = Juniors

(Maccoby & Jacklin, 1974; Lloyd & Archer, 1976; Sherman, 1978).

This may account for the markedly superior performance of the junior girls in relation to the boys in experiments 1 and 2. The outstanding performance of the junior girls, experiment 1, could be attributed to faster maturation together with the educational advantage they have over Aboriginal girls because they come from a middle-class background. The evidence, however, is inconclusive. In order to account adequately for the complex effect of sex interacting with other variables, further experimental investigation directed specifically at the question of sex differences is required.

The analysis in both Kearins' and the present study has concentrated on differences between Aborigines and Europeans. It should be noted, however, that a wide range of individual differences within each racial group were also evident (see figure 12; and the standard deviations table 17). This indicates that the factors contributing to any differences between the racial groups are likely to be complex. Data which have been collected using Kearins' visual memory tasks with dispersed populations support this conjecture and further suggest that these factors are largely environmental in origin. Harris (1977) and the present study, in Mililingimbi and Alice Springs respectively, found race differences favouring Europeans; Drinkwater (1976; 1978) found no race differences using Aborigines from Palm Island; and Kearins (1974; 1977) reported race differences in favouring of Aborigines in the Western Desert.

Experiment 3

The results in experiment 3 showed that the Europeans were significantly more competent at performing the visual memory rotation than were the Aborigines, and in particular the Aborigines from a traditional background. Dasen (1970; 1974) using a Piagetian rotation task has reported similar results. Hypothesis 3 proposed that as a result of

their hunting-gathering life style and 'cognitive mapping' ability Aborigines would demonstrate superior skill in visual memory on a task requiring a mental rotation. As this was not found to be the case, hypothesis 3 must be rejected.

The inferior performance of the Aboriginal groups is unlikely to be related to a deficiency in their 'cognitive mapping' ability, as it is well documented in the literature (see Lewis, 1976; the review attached to this thesis) that Aborigines are particularly skilful in practical orientation and way-finding in the 'bush'. Since Aboriginal children did not demonstrate these abilities in this experimental situation, which they seemed to respond to and enjoy, the relevance of the experimental task must be questioned. The task was far removed from a real life situation and as a result may not have reflected the cognitive skills which are relevant to Aborigines when moving around in their natural surroundings.

In experiment 3, no differences were found in the number of correct replacements between juniors and seniors, but seniors made significantly fewer errors than juniors. The mental rotation task in experiment 3 was similar to the perspective problems described by Piaget and Inhelder (1967), Huttenlocher and Presson (1973), and Pufall and Shaw (1973). The juniors' performance was in accord with the expectations of Piagetian theory. According to Piaget and Inhelder (1967), children can only solve perspective problems reliably when they have reached the concrete operational stage of cognitive development (around 10 years of age for European children). Only then are they capable of forming a representation of space which is organized as a co-ordinated system of reference. Younger children, on the other hand, are more likely to make egocentric judgements relative to the perspective from which they viewed the array. They can manage to reverse mentally the relationships between some of the objects, but cannot as yet co-ordinate the whole array.

General Conclusion

Data from this study provide no support for an evolutionary-ecological theory and favour an explanation that any differences found between Aborigines and Europeans in visual memory skill will likely result from a complex interaction of factors predominantly of an environmental nature.

References

- 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.
- Brokensha, P. The Pitjantjatjara and their crafts. North Sydney: Aboriginal Arts Board, Australia Council, 1975.
- Brown, A.L. The development of memory. Knowing, knowing about knowing, knowing how to know. In H.W. Reese (Ed.), Advances in child development and behavior. (Vol. 10). New York: Academic Press, 1975.
- Chi, M.T.H. Short-term memory limitations in children: Capacity or processing deficits? Memory and Cognition, 1976, 4, 559-572.
- Dasen, P.R. Cognitive development in Aborigines of Central Australia: Concrete operations and perceptual activities. Unpublished Ph.D. Thesis, A.N.U., Canberra, 1970.
- 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.
- 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.
- Doob, L.W. Eidetic imagery: A cross-cultural will-o'-the-wisp? Journal of Psychology, 1966, 63, 13-34.

- 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. The Australian Aborigines (Revised edition) Sydney: Angus & Robertson, 1974.
- Flavell, J.H. What is memory development the development of? Human Development, 1971, 14, 272-278.
- Haber, R.N., & Haber, R.B. Eidetic imagery: I. Frequency. Perceptual and Motor Skills, 1964, 19, 131-138.
- Harney, W.E. Sport and play amidst the Aborigines of the Northern Territory. Mankind, 1952, 4, 377-379.
- Harris, S.A. Milingimbi Aboriginal learning contexts. Unpublished Ph.D. Thesis, University of New Mexico, Albuquerque, New Mexico, 1977.
- Huttenlocher, J., & Presson, C.C. Mental rotation and the perspective problem. Cognitive Psychology, 1973, 4, 277-299.
- Kaberry, P.M. Aboriginal woman sacred and profane. London: George Routledge & Sons, Ltd., 1939.
- Kail, R.V., & Siegel, A.W. Sex differences in retention of verbal and spatial characteristics of stimuli. Journal of Experimental Child Psychology, 1977, 23, 341-347.
- 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. The visual spatial memory of desert Aboriginal children. University News, Uni. of W. Aust., April, 9(2), 1978. (a).

- 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. (b).
- Kearney, G.E., & McElwain (Eds.) Aboriginal Cognition: Retrospect and prospect. New Jersey: Humanities Press Inc., 1976.
- Laboratory of Comparative Human Cognition (LCHC). What's cultural about cross-cultural cognitive psychology? Annual Review of Psychology, 1979, 30, 145-172.
- Leask, J., Haber, R.N., & Haber, R.B. Eidetic imagery in children: II. Longitudinal and experimental results. Psychonomic Monograph Supplement, 1969, 3, 25-48.
- 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.
- Lloyd, B., & Archer, J. (Eds.), Exploring sex differences. London: Academic Press Inc., 1976.
- Lockard, R.B. Reflections on the fall of comparative psychology: Is there a message for us all? American Psychologist, 1971, 26, 168-179.
- Maccoby, E.E., & Jacklin, C.N. The psychology of sex differences. Stanford, California: Stanford Uni. Press, 1974.
- Meggitt, M.J. Desert people. Chicago: Uni. Chicago Press, 1962.
- Munn, N.D. Walbiri iconography: Graphic representation and cultural symbolism in a Central Australian Society. Ithaca, N.Y.: Cornell Uni. Press, 1973.
- Piaget, J., & Inhelder, B. Memory and intelligence. New York: Basic Books, 1973.
- Pufall, P.B., & Shaw, R.E. Analysis of the development of children's spatial reference systems. Cognitive Psychology, 1973, 5, 151-175.
- Richardson, A., & Cant, R. Eidetic imagery and brain damage. Australian Journal of Psychology, 1970, 22, 47-54.

Sheehan, P.W. The variability of eidetic imagery among Australian Aboriginal children. The Journal of Social Psychology, 1973, 91, 29-36.

Sheehan, P.W. The methodology of cross-cultural psychology.

In G.E. Kearney & D.W. McElwain (Eds.), Aboriginal cognition: Retrospect and prospect. Canberra: Australian Institute of Aboriginal Studies, 1976.

Sheehan, P.W., & Stewart, S.J. A cross-cultural study of eidetic imagery among Australian Aboriginal children. The Journal of Social Psychology, 1972, 87, 179-188.

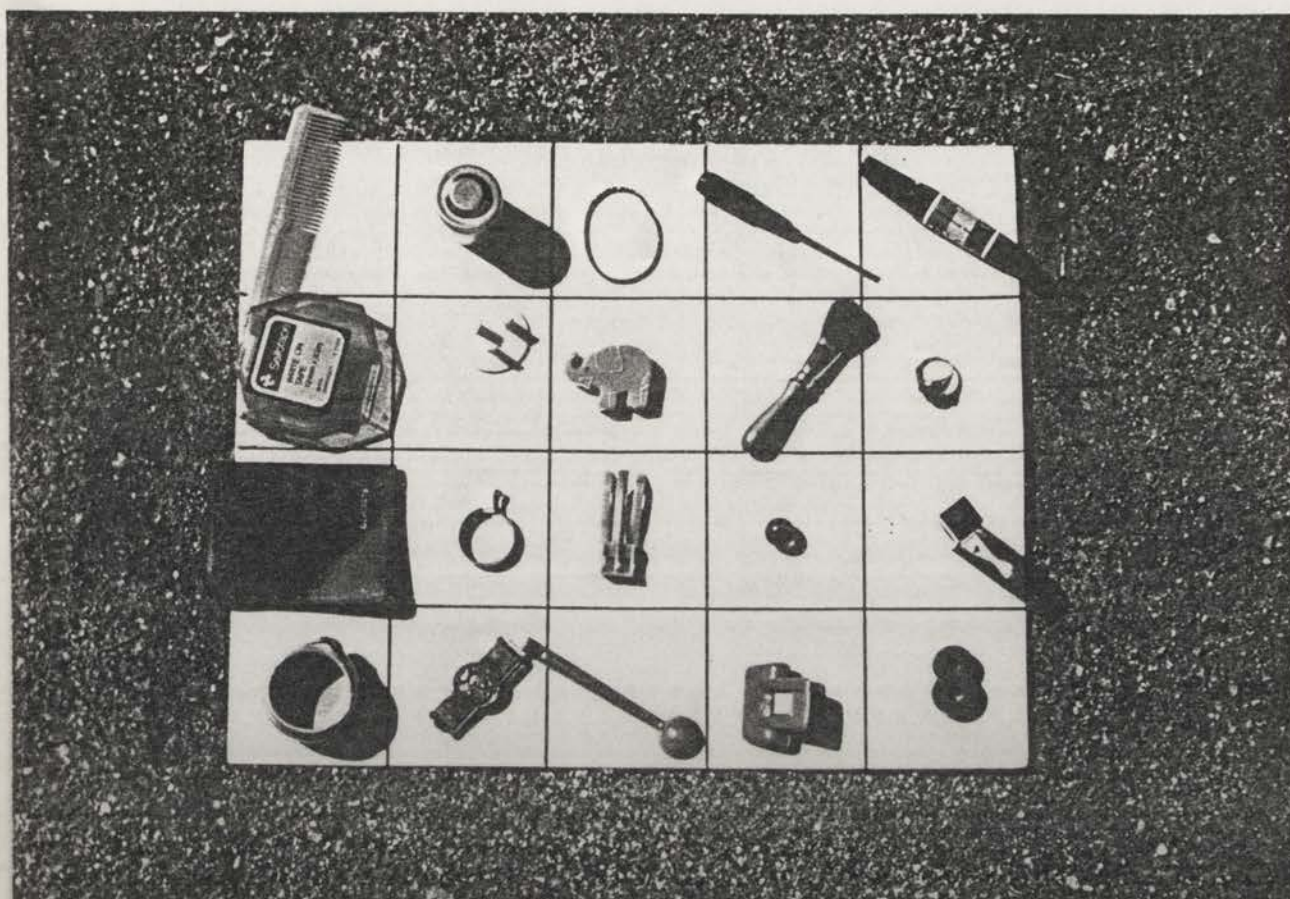
Sherman, J.A. Sex-related cognitive differences: An essay on theory and evidence. Springfield, Illinois: Charles C. Thomas, Publishers, 1978.

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

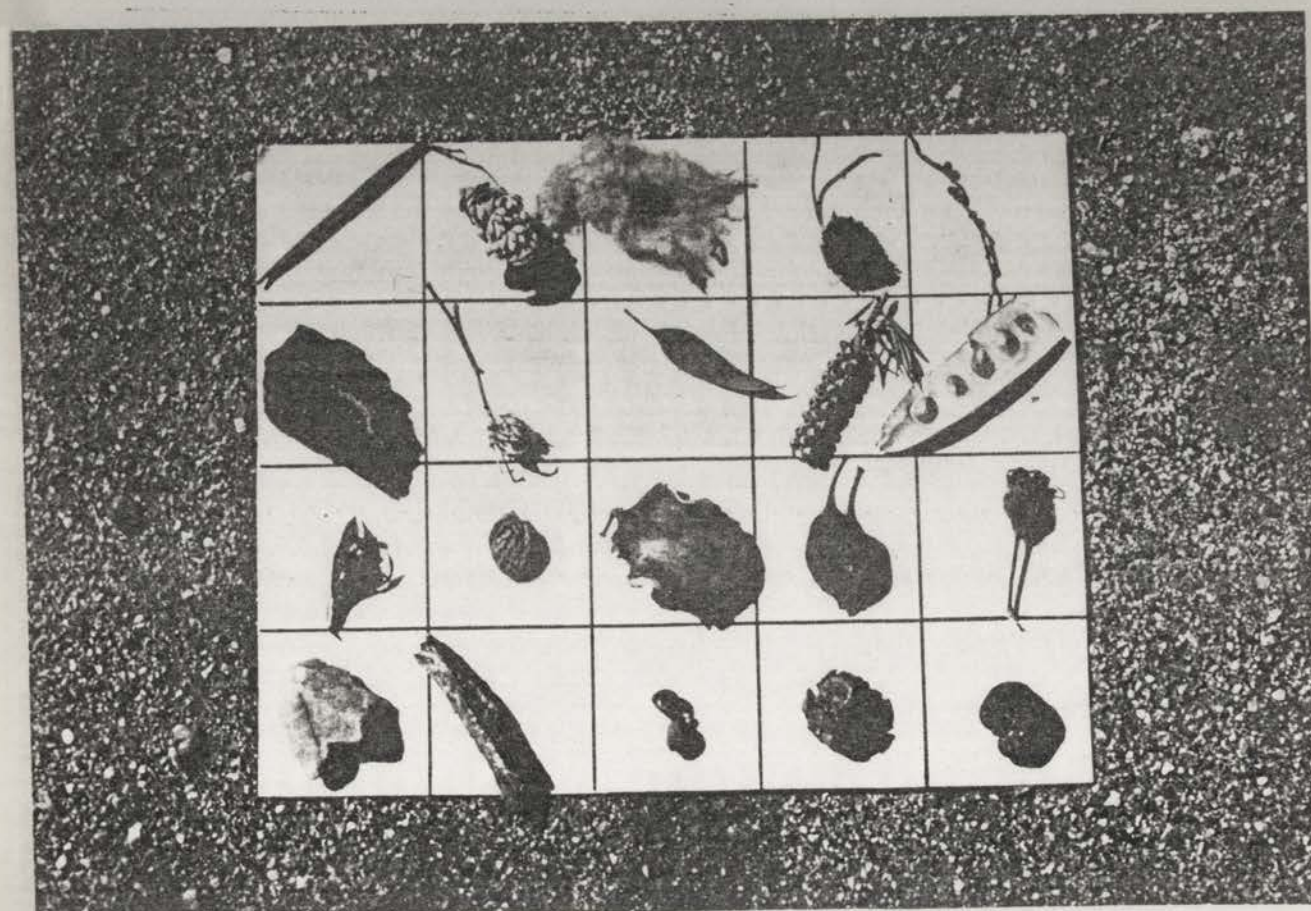
Underwood, B.J. Experimental psychology. New York: Appleton-Century-Crofts, 1966.

Underwood, B.J., & Shaughnessy, J.J. Experimentation in psychology. New York: John Wiley & Sons, Inc., 1975.

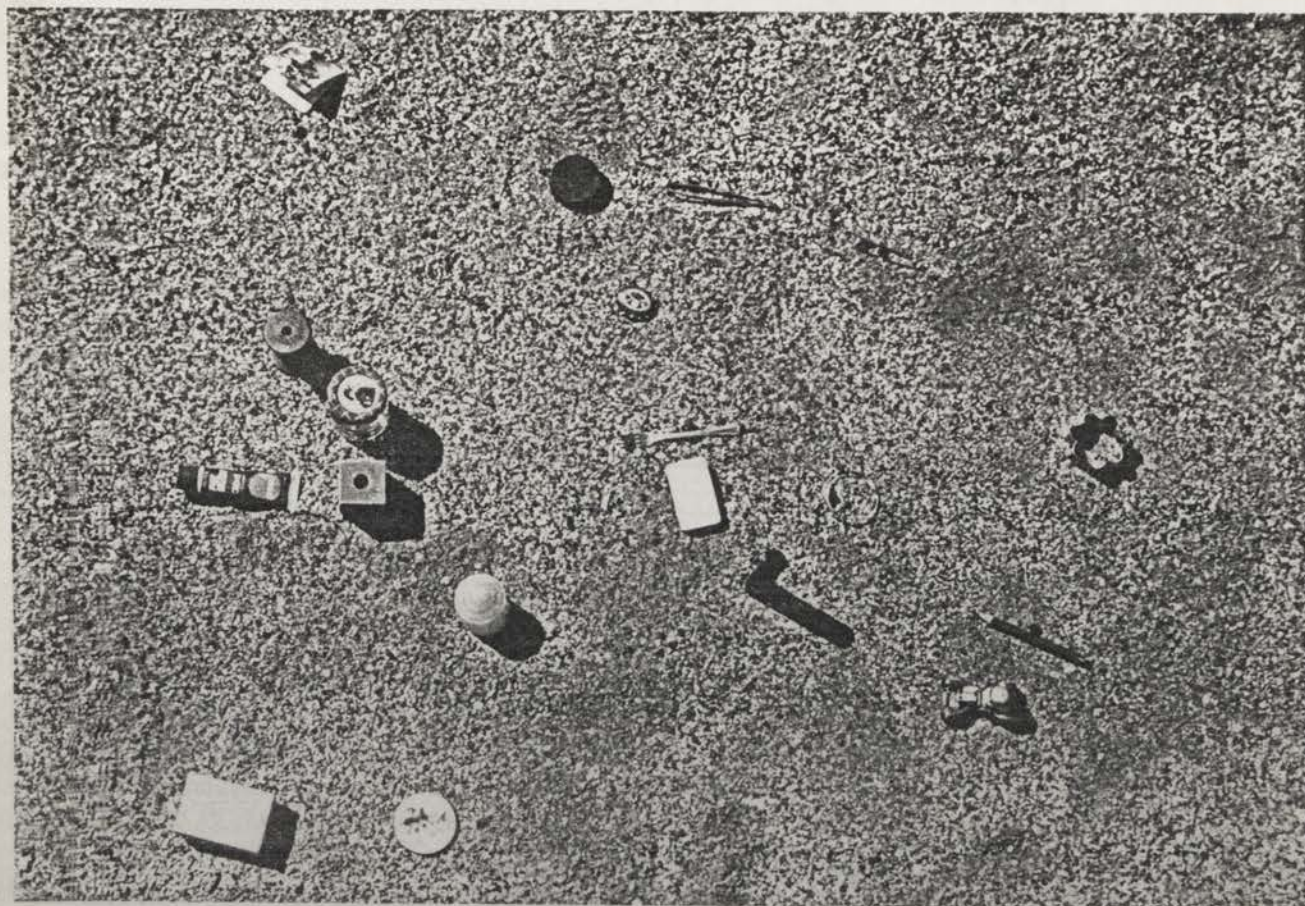
APPENDIX 1a: ARRAYS OF OBJECTS EXPERIMENT 1



ARTEFACTUAL OBJECTS (A/D)



NATURAL OBJECTS (N/D)



ARTEFACTUAL OBJECTS (A/D)



NATURAL OBJECTS (N/D)

APPENDIX 1c: THE ARRAY OF OBJECTS EXPERIMENT 3

POINT B



POINT A

APPENDIX 2a: SAMPLE RECORD SHEET EXPERIMENT 1

Subject No.1 (Name) Age: Sex: School:

Order Presentation: A/D ① N/D ②

Display.

A/D

elastic	bowl	peg	screw driver	marble
comb	clip	plug	clamp	hook
bottle	8	diary	sticky	texta
film	ring	elephant	spoon	brush

Results.
A/D.

Correct :

Error:

N/D

quartz	pine nut.	burst pod	rose hip	pip
grey gum nuts	gall	bean	twist	sun flower
leaf	flat pod	palm wood	mica	boat pod
drift wood	wool	seeds	dates	banksia

N/D

Correct:

Error:

Comments:-

APPENDIX 2c: SAMPLE RECORD SHEET EXPERIMENT 3

Subject: No.1 (Name)Age:SexSchool-

Question	Order	Answer	Correct	Error.
scissors				
bottle top				
peg				
sharpener				
house				
battery				
egg cup				
cork				

Subject: No.2. (Name)Age:Sex :School:

Question	Order	Answer	Correct	Error.
battery				
sharpener				
scissors				
coin				
cork				
house				
match box				
key labels.				

APPENDIX 3: EXPERIMENTAL INSTRUCTIONS(a) Experiment 1

"I am interested in how well children can remember things."

(Practice session) "See this sheet of cardboard here made up of squares (indicate)? There are four things in four of the squares - see? I want you to look carefully at these things for a short time and try to remember where they are. (Pause 10 seconds). Do you think you can remember where they are? I'm going to mess them up (tip objects next to child). Now you try and put them back where they were."

(Experimental session) "Now come and sit over here (indicate). Under each of these cloths, there is a sheet of cardboard just like this one (show the card), but with things in every square. Under that cloth (point) are things I collected around my home and at school and under that one (point) are things I found in the bush."

"When I lift the cloth, I'm going to give you 30 seconds or a short time until the hand gets right around (show the stop watch and how it works) to have a very good look at the things on the cardboard. Then I'm going to mess the things up and I want you to put them back where they came from." (After 30 seconds lift the card and tip the objects in a pile next to the child) "Now see if you can put the things back where they were. You can take as long as you like. There's no hurry and if you want to you can change the things around after you have put them down."

(The child can play with the stop watch while the experimenter is scoring the first display).

(Move to second array) "Come and sit over here. You do exactly the same thing as you did before. I will give you 30 seconds (indicate on the stop watch) while you try and remember where all the things go, and then I'll mess the things up and you have to put them back in their right places. This time the things under the cloth are from around the home and the school/the bush."

(b) Experiment 2

"I am interested in how well children can remember things."

(Practice session) "See these things on the ground (indicate)? There are four things and each one is on a blue thumb tack (lift up one object and show the child). I want you to look carefully at these things for a short time and try to remember where they are. (Pause 10 seconds). Do you think you can remember where they are? I'm going to mess them up (sweep objects next to the child). Now you try and put them back where they were on the blue spots."

(Experimental session) "Now come and sit over here (indicate). Under each of these cloths, there are 20 things scattered on the ground. Each thing is on a blue thumb tack (demonstrate to the European children who did not have a practice session). Under that cloth (point) are things I collected around my home and at school and under that one (point) are things I found in the bush."

(The instructions are the same as for Experiment 1, with the word 'ground' substituting for 'cardboard' and the objects being swept up rather than tipped).

(c) Experiment 3

(The instructions for the practice and the experimental sessions are identical except that in the practice only five objects and three duplicates are used and the viewing period is 10 seconds.)

"I am interested in how well children can remember things. Underneath this cloth (indicate), there are 16 things the same as these ones (show the duplicate objects). The things are in a circle (draw a circle in the air to indicate circle shape and size). When I lift up the cloth, I'll give you 30 seconds (demonstrate on the stop watch), till the hand on the watch goes right around, and I want you to look carefully at the things and try to remember where they are. After that, I'm going to turn you

around so that you can't see and I'm going to cover up each thing with one of these pots (show the pots). Then I'll move you around to there (point) and I'll show you eight of the things and ask you to remember where they are. Ready?"

(A 30 seconds viewing time) "Now turn around and face over there. (The experimenter quickly covers the objects with the pots). You can turn around now and come over here (lead to position B). I haven't moved any of the things. They are still there and each one is hidden by a pot. I want you to try and remember where these eight things are (hand the child the eight duplicates). Put each of these things on top of the pot that you think is hiding its twin. Don't look under any of the pots, just see if you can remember. You can move the things around after you have put them down if you want to and there's no hurry. Take as long as you like."

(After the child finishes) "Let's see how many you got right."

(Lift pots to show the children).

APPENDIX 4: ANOVA Tables 7 - 16

Source	SS	df	MS	F
<u>Between</u>	<u>1969.775</u>	<u>79</u>		
Race	75.625	1	75.625	4.036*
Age group	378.225	1	378.225	20.184**
Race x Age group	3.025	1	3.025	.161
Sex	60.025	1	60.025	3.203
Race x Sex	11.025	1	11.025	.588
Age group x Sex	50.625	1	50.625	2.702
Race x Age group x Sex	42.025	1	42.025	2.243
Error Race x Age group x Sex	1349.200	72	18.739	
<u>Within</u>	<u>1164.000</u>	<u>80</u>		
Object	409.600	1	409.600	41.772**
Object x Race	25.600	1	25.600	2.611
Object x Age group	.900	1	.900	.092
Object x Race x Age group	4.900	1	4.900	.500
Object x Sex	8.100	1	8.100	.826
Object x Race x Sex	.400	1	.400	.041
Object x Age group x Sex	3.600	1	3.600	.367
Object x Race x Age group x Sex	4.900	1	4.900	.500
Error Object x Race x Age group x Sex	706.000	72	9.806	
	<u>3133.775</u>	<u>159</u>		

* $p < .05$ ** $p < .001$

Table 7: Summarized Correct Replacements ANOVA Experiment 1

Source	SS	df	MS	F
<u>Between</u>	<u>14703.976</u>	<u>79</u>		
Race	384.400	1	384.400	3.111
Age group	3276.101	1	3276.101	26.513**
Race × Age group	15.624	1	15.624	.126
Sex	624.101	1	624.101	5.051*
Race × Sex	275.624	1	275.624	2.231
Age group × Sex	525.624	1	525.624	4.254*
Race × Age group × Sex	705.602	1	705.602	5.710*
Error Race × Age group × Sex	8896.900	72	123.568	
<u>Within</u>	<u>8670.000</u>	<u>80</u>		
Object	3610.000	1	3610.000	53.673**
Object × Race	87.025	1	87.025	1.294
Object × Age group	3.024	1	3.024	.045
Object × Race × Age group	48.401	1	48.401	.720
Object × Sex	21.024	1	21.024	.313
Object × Race × Sex	32.401	1	32.401	.482
Object × Age group × Sex	14.401	1	14.401	.214
Object × Race × Age group × Sex	11.023	1	11.023	.164
Error Object × Race × Age group × Sex	4842.700	72	67.260	
	<u>23373.976</u>	<u>159</u>		

* $p < .05$ ** $p < .001$

Table 8: Summarized Error Score ANOVA Experiment 1

Source	SS	df	MS	F
<u>Between</u>	<u>1272.100</u>	<u>79</u>		
Race	13.225	1	13.225	1.097
Age group	342.225	1	342.225	28.381*
Race × Age group	12.100	1	12.100	1.003
Sex	18.225	1	18.225	1.511
Race × Sex	14.400	1	14.400	1.194
Age group × Sex	2.500	1	2.500	.207
Race × Age group × Sex	1.225	1	1.225	.102
Error Race × Age group × Sex	868.200	72	12.058	
<u>Within</u>	<u>453.000</u>	<u>80</u>		
Object	172.225	1	172.225	48.666*
Object × Race	1.600	1	1.600	.452
Object × Age group	10.000	1	10.000	2.826
Object × Race × Age group	5.625	1	5.625	1.590
Object × Sex	.000	1	.000	.000
Object × Race × Sex	.025	1	.025	.007
Object × Age group × Sex	.625	1	.625	.177
Object × Race × Age group × Sex	8.100	1	8.100	2.289
Error Object × Race × Age group × Sex	253.800	72	3.539	
	<u>1725.100</u>	<u>159</u>		

* $p < .001$

Table 9: Summarized Correct Replacements ANOVA Experiment 2

Source	SS	df	MS	F
<u>Between</u>	<u>22321.945</u>	<u>79</u>		
Race	150.156	1	150.156	.699
Age group	4568.906	1	4568.906	21.267**
Race x Age group	432.307	1	432.307	2.012
Sex	1035.307	1	1035.307	4.819*
Race x Sex	620.156	1	620.156	2.887
Age group x Sex	28.057	1	28.057	.131
Race x Age group x Sex	18.906	1	18.906	.088
Error Race x Age group x Sex	15468.150	72	214.835	
<u>Within</u>	<u>9843.500</u>	<u>80</u>		
Object	3413.258	1	3413.258	43.931**
Object x Race	213.906	1	213.906	2.753
Object x Age group	472.656	1	472.656	6.083*
Object x Race x Age group	79.805	1	79.805	1.027
Object x Sex	.305	1	.305	.004
Object x Race x Sex	9.507	1	9.507	.122
Object x Age group x Sex	41.006	1	41.006	.528
Object x Race x Age group x Sex	18.907	1	18.907	.243
Error Object x Race x Age group x Sex	5594.150	72	77.697	
	<u>32165.445</u>	<u>159</u>		

* $p < .05$ ** $p < .001$

Table 10: Summarized Error Score ANOVA Experiment 2

Source	SS	df	MS	F
Between Subjects	601.188	39	15.415	0.904
Within Experimental Conditions	189.113	1	189.113	11.093*
Interactions	664.887	39	17.048	
	<u>1455.188</u>	<u>40</u>		

* $p < .01$

Table 11: Summarized Number Correct (Artefactual Objects) for
Experimental Conditions 1 and 2 - European Subjects

Source	SS	df	MS	F
Between Subjects	725.55	39	18.604	2.860
Within Experimental Conditions	36.45	1	36.450	5.607*
Interactions	253.55	39	6.501	
	<u>1015.55</u>	<u>40</u>		

* $p < .05$

Table 12: Summarized Number Correct (Natural Object) for
Experimental Conditions 1 and 2 - European Subjects

Source	SS	df	MS	F
<u>Main Effects</u>	<u>22.396</u>	<u>3</u>	7.465	
Race	14.621	1	14.621	5.802*
Sex	2.255	1	2.255	.895
Age group	5.582	1	5.582	2.215
<u>2-Way Interactions</u>	<u>2.438</u>	<u>3</u>	.813	
Race × Sex	.181	1	.181	.072
Race × Age group	.922	1	.922	.366
Sex × Age group	1.356	1	1.356	.538
<u>3-Way Interactions</u>	<u>3.508</u>	<u>1</u>	3.508	
Race × Sex × Age group	3.508	1	3.508	1.392
Explained	28.342	7	4.049	
Residual	302.400	120	2.520	
	<u>330.742</u>	<u>127</u>		

* $p < .05$

Table 13: Summarized Correct Replacements ANOVA Experiment 3

The race variable is European × urban Aborigines

Source	SS		MS	F
<u>Main Effects</u>	<u>793.124</u>	<u>3</u>	264.375	
Race	241.846	1	241.846	4.728*
Sex	29.796	1	29.796	.583
Age group	520.044	1	520.044	10.167**
<u>2-Way Interactions</u>	<u>118.323</u>	<u>3</u>	39.441	
Race × Sex	57.383	1	57.383	1.122
Race × Age group	.034	1	.034	.001
Sex × Age group	60.791	1	60.791	1.188
<u>3-Way Interactions</u>	<u>15.316</u>	<u>1</u>	15.316	
Race × Sex × Age group	15.316	1	15.316	.299
Explained	926.763	7	132.395	
Residual	6138.165	120	51.151	
	<u>7064.927</u>	<u>127</u>		

* $p < .05$ ** $p < .01$

Table 14: Summarized Error Score ANOVA Experiment 3

The race variable is European × urban Aborigine

Source	SS	df	MS	F
<u>Main Effects</u>	<u>26.885</u>	<u>3</u>	8.962	
Race	19.246	1	19.246	8.396*
Sex	1.025	1	1.025	.447
Age group	5.680	1	5.680	2.478
<u>2-Way Interactions</u>	<u>2.413</u>	<u>3</u>	.804	
Race × Sex	.754	1	.754	.329
Race × Age group	.967	1	.967	.422
Sex × Age group	.551	1	.551	.240
<u>3-Way Interactions</u>	<u>4.868</u>	<u>1</u>	4.868	
Race × Sex × Age group	4.868	1	4.868	2.124
Explained	34.166	7	4.881	
Residual	320.915	140	2.292	
	<u>355.081</u>	<u>147</u>		

* $\underline{p} < .01$

Table 15: Summarized Correct Replacements ANOVA Experiment 3
 The race variable is European × Combined Aborigines
 (urban and traditional Aborigines)

Source	SS	df	MS	F
<u>Main Effects</u>	<u>1213.920</u>	<u>3</u>	404.640	
Race	611.540	1	611.540	11.952*
Sex	5.071	1	5.071	.099
Age group	558.451	1	558.451	10.915*
<u>2-Way Interactions</u>	<u>145.295</u>	<u>3</u>	48.432	
Race x Sex	102.645	1	102.645	2.006
Race x Age group	.133	1	.133	.003
Sex x Age group	39.010	1	39.010	.762
<u>3-Way Interactions</u>	<u>30.625</u>	<u>1</u>	30.625	
Race x Sex x Age group	30.625	1	30.625	.599
Explained	1389.839	7	198.548	
Residual	7163.151	140	51.165	
	<u>8552.990</u>	<u>147</u>		

* $p < .01$

Table 16: Summarized Error Score ANOVA Experiment 3

The race variable is European x Combined Aborigines
(urban and traditional Aborigines)