The Australian Journal of
INDIGENOUS EDUCATION

INFORMATION PROCESSING AND SCHOLASTIC ACHIEVEMENT IN ABORIGINAL AUSTRALIAN CHILDREN IN SOUTH-EAST QUEENSLAND

*G.M.Boulton-Lewis
H. Neill
G.S.Halford

Twenty high contact Queensland Aboriginal children of mean age six years were tested on two measures of capaciy to process information (cf. Case, et al., 1982 and Halford, 1984) and on two newly devised tasks to measure levels of thinking based on cultural knowledge. The results indicated that these children possess capacity to process information that is the same as Caucasian children of the same age. Because these children have underlying capacity to learn tasks to the same level as any other child the results have implications for schooling. It is intended that this initial trial testing will be followed up in a larger study.

Although it is an unfortunate but well established finding that Aboriginal Australian children are disadvantaged in formal schooling (Bourke and Parkin, 1977; Seagrim and Lendon, 1980; Watts, 1976), it is sometimes asserted that this is a reflection of environment or cognitive style factors rather than of intellectual endowment *per se*. For example, it has been suggested that the backgrounds of Aboriginal Australian children might induce a cognitive style that is not appropriate for formal schooling (Ciberowski, 1976; Harris, 1980; Watts, 1976), or Aboriginal Australian children might use different strategies on selected tasks (Kearins 1976; 1983). Klich and Davidson (1984) suggested that Aboriginal children are more oriented to simultaneous processing, whereas formal schooling depends more on successive processing.

The difficulty of establishing the true intellectual potential of Aboriginal children is partly attributable to the fact that most tests used to measure this are themselves contaminated by the same factors that work to the detriment of schooling. For example, Aboriginal Australians perform less well on most tests of intelligence, although as their cultural contact increases their performance approaches that of Anglo-Australian children (McElwain & Kearney, 1973; McIntyre, 1976). The interpretation of these results is made

---

*Gillian M. Boulton-Lewis and Hope Neill, School of Early Childhood Studies, Brisbane College of Advanced Education. Graeme S. Halford, Department of Psychology, University of Queensland.

difficult, however, by the fact that intelligence test performance is influenced by domain specific knowledge, strategies and cognitive styles.

An alternative approach is to use more precisely defined tests that measure specific information processing parameters, rather than global tests of intellectual functioning or cognitive style. Tests of specific information-processing parameters, because they are based on more refined analyses of cognitive processes, can be designed so as to minimise the influence of background knowledge, style or strategy. This can be achieved in two ways.

The first is to use two versions of a task which are matched on background knowledge, style and strategy required to perform adequately. However, version A differs from version B in making less demands on the information processing parameter of interest. The logic of the method depends on the fact that if children succeed on version A, they must have the background knowledge, styles and strategies that are required. If they succeed on version A but fail on version B, we then have solid evidence that their difficulty is in the specific information-processing factor that the task was designed to measure. On the other hand, if they succeed on both A and B, they are competent in that information-processing parameter. Therefore, this method permits specific information-processing parameters to be isolated from background factors to a much greater extent than do global measures of intellectual functioning. Two versions of a matrix completion task were used in the present study as one attempt to achieve this goal.

The second method is, rather than adapting global measures to the Aboriginal culture, to analyse the specific cognitive process that it is desired to measure, then design a task based on Aboriginal culture that incorporates this process. For example, instead of adapting a test of transitive inference, which is known to be a critical performance in Caucasian-cognitive development, the critical feature of transitivity was analysed and found to be the ability to integrate relations. A test to measure this ability was then designed, based on Aboriginal family relationships. Ability to recognise that if John is the son of Mary, and Mary is the sister of Jane, then John is the nephew of Jane, entails integrating relations, and therefore requires the same essential cognitive process as reasoning that if 'a' is less than 'b', and 'c' is more than 'b', then 'a' is less than 'c'. Thus the same underlying cognitive process was measured but in a task that was culture-appropriate. A similar procedure was used to devise a test based on playing cards, another activity that is familiar to Aboriginal people.

It should be possible to predict potential school performance from assessments of levels of thinking and capacity to process information. For example, Boulton-Lewis (1984) found with a sample of Anglo-Australian children that as capacity to process information increased so did knowledge of components of length measuring. This study does not assess school performance, but is designed to test whether Aboriginal information processing performance is comparable to previously obtained levels for Anglo-Australian children of the same age. This will be assessed in four task domains - card-counting span, matrix completion, family structure, and playing cards. The last three of these have been designed to meet the criteria of applicability to the Aboriginal culture outlined above. The first, card-counting, was included as a reference test for comparison with other research programs, such as that of Case (1985).

METHOD

Sample

This consisted of 10 boys and 10 girls aged from 5 years 6 months to 6 years 7 months. The mean age was 6 years. All children were living at Cherbourg and attending school in Year 1 or 2.

Cherbourg is an Aboriginal community 290 kilometres north of Brisbane established in 1905 (Koepping, 1977). The population has been described as a high contact Aboriginal group (McElwain & Kearney, 1973). Most of the children tested would be 3rd or 4th generation residents of Cherbourg. The people of the community speak a dialect which allows them to readily understand Standard English.

General Testing Procedure

Children were withdrawn from class in pairs and tested on a one-to-one basis in a separate room by the first and second authors. Because the second author still has family at Cherbourg she was able to relate readily to the children.

MEASURES OF INFORMATION PROCESSING

1. Card Counting Span

Case (1974, 1977) has shown that a span of e + 2 or e + 3 on the counting span task is typical in European children aged 5 to 8 years and that such spans allow cognition of concrete operational tasks such as conservation. Whilst conservation is not a psychological prerequisite to learning some aspects of school mathematics (Halford, 1982) it is a significant cognitive landmark. A child who

has the cognitive capacity to conserve should also have the capacity, given sufficient environmental stimulation, to learn most school mathematics successfully.

Apparatus

The material for this task consisted of four sets of cards at each of four levels as used by Halford, *et al.* (paper submitted). They were designed to be as similar as possible to those used by Case, *et al.* (1982). Each card was made of white cardboard and measured 26cm by 19cm. Three sets of cards at each level contained from 3 to 9 green dots and 3 to 9 yellow distractor dots. There was also a filler set at each level (cf. Case, *et al.*, 1979) which contained at least one card with a total of 1 or 2 green dots. This card was used to discourage guessing over the limited range of totals from 3 to 9.

Procedure

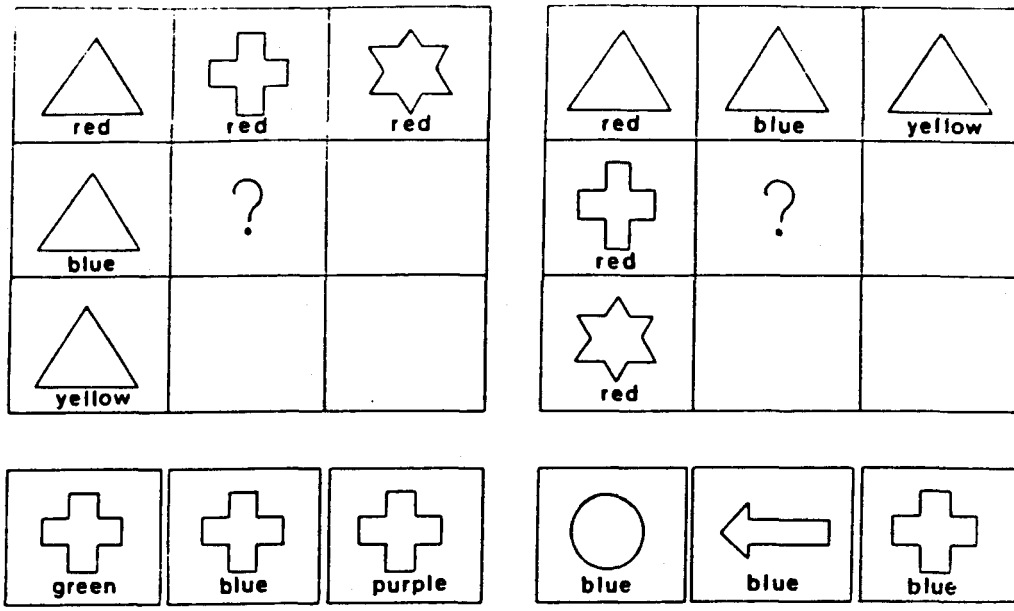
Children were shown the cards level by level. At the first level subjects counted the dots on one card per set, at the second level 2 cards per set, and so on to 4 cards per set. For each set the experimenter put down the first card and the child counted the green dots. The next card was placed over the first card and the child counted again. This procedure was continued with no pauses to the last card and then the child was asked to recall the count totals in order of presentation. A practice trial was given at level 1.

If the subject could recall (position free) any of the 3 sets at a particular level then testing proceeded to the next level, otherwise it terminated. Counting speed was not important. The score for the test was determined at the highest level at which all three set totals were correctly recalled plus 1/3 point for any set total recalled at a higher level. Both position free and position respecting scores were used.

2. Matrix Completion Task

Matrix tasks are by no means new in cross-cultural cognitive studies (Klich & Davidson, 1984), but the task in this study was used to measure the amount of information that could be integrated in a single decision. Two levels of the task were performed, closely matched in all respects, except that at level 2 two attributes had to be considered in choosing an element to fill a particular cell, whereas at level 1 only one attribute need be considered.

LEVEL 1



LEVEL 2

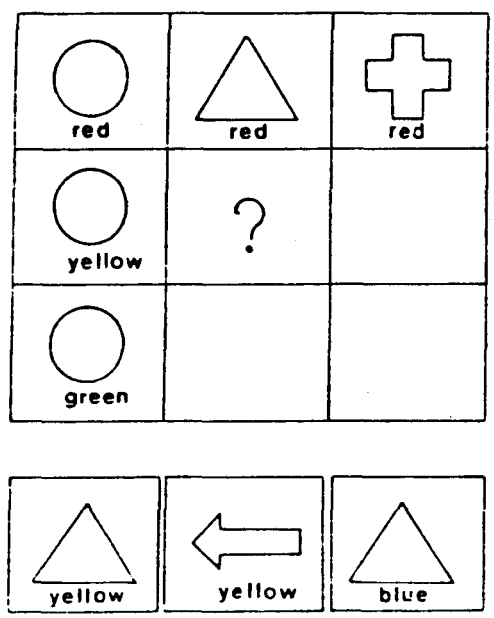


FIGURE 1. MATRIX COMPLETION TASKS USED BY HALFORD (1980)

Halford (1980) found two levels of performance in European children aged 3 to 6 years on the matrix completion task. The 3-year-old children reached criterion on the one attribute task while children aged 4, 5 and 6 years reached criterion on the two attribute tasks. Halford (1980) has demonstrated that one attribute matrix completion is a level 1 task and two attribute completion is a level 2 task. Halford (paper submitted) has identified sets of level 1 and level 2 concepts. It can be hypothesised that a child capable of cognising one level 2 task has the capacity to cognise other tasks at the same level. Cognition of other tasks at the same level will depend also of course on favourable environmental conditions and learning.

Apparatus

The material for this task consisted of a three by three matrix and cards as shown in Figure 1. They were made of white cardboard. The matrix measured 35 x 26cm. It was divided into squares 10cm x 26cm. The set of 30 small cards to complete the matrix were of the same dimensions as the squares on the matrix. Each card contained a shape (triangle, circle, square, star, cross or arrow) made of coloured paper (green, red, yellow, blue or pink).

Procedure

The procedure for this task was similar to that used by Halford (1980). The task is illustrated in Figure 1. Subjects were shown a matrix with one row and one column filled and were asked to select a card from three alternatives to fill the square indicated by the question mark. At level 1 of the task, the three alternatives were always correct in one of the relevant dimensions and choice had to be made by considering only colour (task A) or shape (task B). At level 2 both shape and colour had to be considered in the choice of card. Successful performance on both versions at level 1 establishes that the procedure is viable and the child can use the attributes presented. Performance on level 2 assesses whether the child could integrate both attributes in a single decision. Therefore level 2 performance is a measure of information processing capacity. Children were given learning set training on the task at each level with a succession of problems of the same form but with different items. (This provided a minimum of 16 opportunities to fill the squares at each level.)

During training the experimenter named attributes of the cards as they were placed on the matrix; drew attention to the fact that colours ran one way and shapes another; named the attributes of the choice cards; drew attention to the attribute(s) of the row and/or column of the cell to be filled; drew attention to relevant

attributes again if the choice was incorrect; drew attention to the attribute(s) of the correct choice; and left the choice card for each item on the matrix as a model.

Following the training procedure at each level children were given three test problems. They did not proceed to level 2 unless they could complete all three test problems at level 1 correctly. A child was assessed as performing at level 2 if, after training, she/he completed three test problems correctly.

LEVELS OF THINKING WITH RESPECT OF CULTURAL KNOWLEDGE

3. Family Structure

Testing for knowledge of family relations is not new. Piaget (1928) tested European children for sibling and family knowledge and explained his results on the basis of general stage theory. Studies of Zinacantan and Hawaiian children cited in Dasen (1977), where kin terminology and family structure are considerably different from Western structure, found a sequence of comprehension of family knowledge which supported Piaget's stage theory.

Traditional Aboriginal kinship systems are complex and culturally significant. The Cherbourg community is composed of different groups of people with different kin systems (Koepping, 1977) and the people there no longer have detailed knowledge of traditional kinship systems of the kind described for example by Williams (1981). Whilst Cherbourg residents for the most part no longer recall traditional kinship systems, family knowledge is important and they do systematically teach young children about family relationships.

It was assumed that Cherbourg children would have well developed concepts of family structure. The questions were designed to assess the level of capacity to process information about family relationships. Level 1 questions required classifying and single relations. Level 2 questions required compositions of relations. The material for this task was a large poster containing photographs of an Aboriginal family. The network of relations is represented in Figure 2.

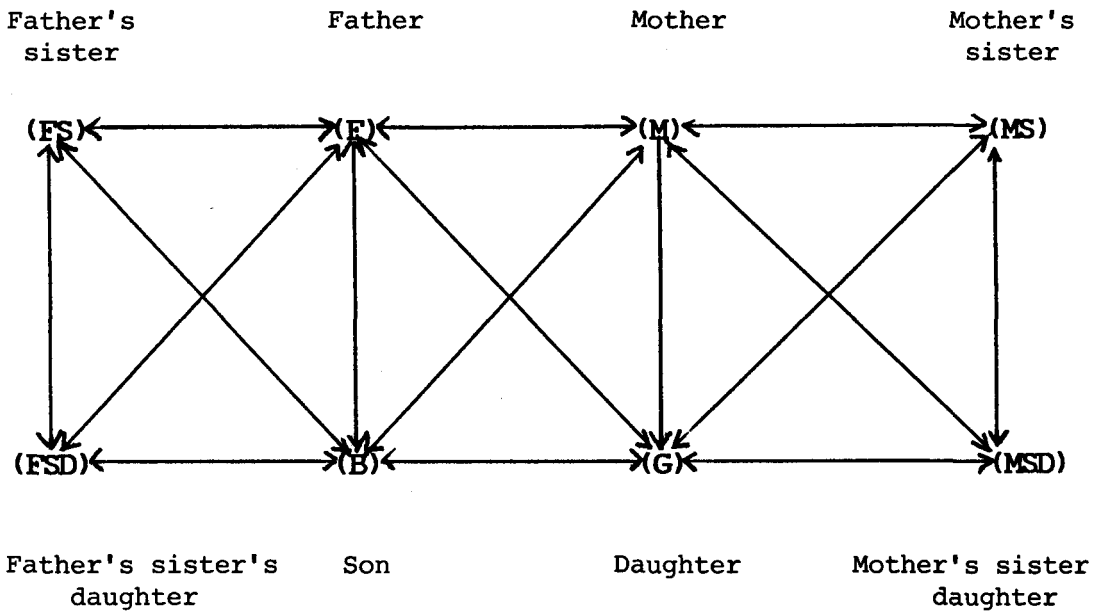


Figure 2 - Network of relations for family structure task.

Procedure

The child and the experimenter briefly discussed the child's family. The child was then told that the poster showed another family. Each person was given an appropriate name and the relationships were explained. The child's knowledge of each person's name was checked. The child was then asked level 1 and 2 questions about the family. Examples of such questions are as follows:

LEVEL 1C (Classifying/identifying person by role/place in family.)

e.g. What is M (name)? Mother

What is B (name)? Son

Level 1R (Explaining a single relationship between two people.)

e.g. This is G (name) What does she call B (name)? Brother. Why? Because he is her brother (same mother and father/same family.)

LEVEL 2 (Composition of relations)

e.g. This is B (name). What does he call MS (name)? Aunt (mother). Why? Because she is his mother's sister. This requires integration of two relations: if MS is the sister of M, and M is the mother of B, then MS is B's aunt.

To be scored as performing at a particular level the child was required to explain at least two of three relations as described above.

4. Playing Card Relations

Card games have a structure which was considered suitable for the type of analysis required (Davidson, 1979), and are of intrinsic and social interest to Aboriginal people (Peterson, 1977; Koepping, 1977). Some card games are now essentially Aboriginal in rules and methods of play (Berndt and Berndt, 1947; Davidson, 1979; Harris, 1979; Holm and Japanangka, 1976; Robinson and Yu, 1975). Aboriginal children in some communities appear to learn to play cards by watching adults.

Davidson (1979) cited Aboriginal card games as evidence of cognitive ability applied to environmental knowledge. The card games played at Cherbourg, however, have rules more like European games than the rules for "bayb kad" described by Davidson (1979). The tasks described here are designed to measure levels of knowledge of the relations inherent in a structured set of playing cards.

Apparatus

The material for this task consisted of an inexpensive set of playing cards. The linear design on the back of the cards was unlikely to attract the children's attention and distract them from the main purpose of the task.

Procedure

Examples of games at each level are as follows:

LEVEL 1C (Identifying/classifying cards by one attribute.)

All cards of a kind (e.g. Hearts) were selected. The child was shown the cards in random order and asked to name them.

LEVEL 1R (Relations between pairs of cards.)

e.g. All the number cards of a kind (e.g. Clubs) were placed face down on the table. The experimenter turned over a card at random. The child was told that if she/he turned over a card that was greater she/he could keep it. The experimenter and child took turns at this procedure. To keep a card a child had to explain why it was worth more (e.g. 4 is bigger/more than 3).

LEVEL 2 (Composition of relations/transitive reasoning.)

Three cards e.g. 3(a), 3(b) and 5(c) were placed face down on the table. The child was told, for example, that card (a) was equal to card (b) and that card (c) was greater than card (a). The child was then asked whether card (c) was greater than card (b) or whether (b) was greater than (c). The other four examples each included two pairs of greater than, equal to and less than relations.

A 4/5 success rate was required for a child to succeed at each level.

Results

1. Card counting span

The mean card counting span was 2.5. The range extended from 1.7 (for one child) to 3. These results are exactly what one would expect of European children of the same age (cf. Case, 1974, 1977). It indicates that these children have the same underlying capacity to process information as European children of the same age.

2. Matrix completion task

Nineteen of the 20 children reached criterion at level 2 of this task. This result is the same as one would expect of European children of the same age (cf. Halford, 1980).

3. Family Structure

All children in the sample succeeded at Level 2 on this task. All but 2 children described Mother's sister as Mother. This relates to some retention of the traditional Aboriginal kinship patterns where Mother's sister is mother too. The same answer was given for Father's sister. All but 2 children described the son of their aunt ('mother') as brothers. Two children said they were cousins and two of the remaining 18 described them as cousin-brothers (thus using both Aboriginal and non-Aboriginal terms in the one name). All children explained these relationships, however, on the basis of composition of relations which indicates Level 2 performance, despite the non-standard English use of family names.

4. Playing Card Relations

Nineteen of the 20 children succeeded at Level 2. One of the 19 could only perform at Level 2 using court cards because she could not recognise all the numbers. One child was not familiar with the cards at all. Her inability to perform at Level 2 was probably due

to lack of knowledge of playing cards because she had a card counting span of 2 and performed at level 2 on the other two tasks.

Discussion

The results with this small sample indicate that these high contact Aboriginal children possess capacity to process information as measured by counting span and matrix completion that is the same as European children of the same age. Moreover, when tasks were designed to measure levels of thinking of concepts related to their own cultural experience they performed at Level 2 as one would expect of other children of the same age with equally familiar material.

It has been proposed in recent theoretical explanations of cognition (e.g. Fischer, 1980; Halford, 1982) that levels of cognitive performance are a function of increasing capacity to process information in interaction with environmental stimuli. It is suggested here that the differences in Aboriginal cognitive strategies that have been identified in other research could be learned differences dependent on different learning contexts rather than on inherent cognitive differences. If that is the case the challenge in teaching Western scientific concepts to Aboriginal children lies in teaching both appropriate content and strategies.

This study is, of course, only an initial trialling of some tasks with a small sample. The results nevertheless have implications for schooling. These children apparently have the potential underlying capacity to learn tasks to the same level as any other child. That many do not do so is probably a function of educational and environmental factors. This paper is not the place in which to address schooling issues in detail. However, these children probably need to learn mathematics initially in situations that cause the discipline to seem useful in everyday life. They need to select, verbalise, process, recall and symbolise class, pattern and structural concepts relevant to school mathematics from such everyday experiences. That is, they need to be systematically taught concepts and strategies necessary for school mathematics in an educational environment that enhances their usefulness. Mathematics curricula can be designed, and sequenced so that the demands of learning tasks and teacher strategies fit with what is known of children's increasing capacity to process information (Boulton-Lewis and Irons, 1984, Halford and Boulton-Lewis, 1985).

It is probably also important for these children to have as models Cherbourg people who have succeeded in becoming bicultural and who can function effectively in both Aboriginal and European

cultures. Greater employment prospects and socio-economic rewards would perhaps provide another motivating factor for these children to utilise their potential capacity to succeed at school.

REFERENCES

Berndt, R.M., 1977: *Aborigines and Change: Australia in the '70s.* New Jersey: Humanities Press.

Berndt, R.M. and Berndt, C.H., 1947: Card games amongst Aborigines in the Northern Territory. *Oceania*, 17, 248-269.

Boulton-Lewis, G.M., 1984: Length Measuring Knowledge, Information Processing Capacity in Young Children and Implications for Curriculum Planning. Doctoral Thesis, Uni. of Qld.

Boulton-Lewis, G. and Reuille Irons, R., 1984: Recent cognitive theories and early childhood curriculum. Selected oral presentation at Fifth International Congress on Mathematical Education, Adelaide, August.

Bourke, S.F., and Parkin, B., 1977. The performance of Aboriginal students. In S.F.Bourke & J.P.Keeves (Eds): *The Mastery of Literacy and Numeracy.* Melbourne: Australian Council of Educational Research.

Bryer, F.K., 1976: Interpretation of test scores: performance on multiple classification matrix tasks in an Aboriginal culture. In Kearney G.E. and McElwain D.W. (Eds) below.

Case, R., 1974 : Structures and strictures: some functional limitations on the course of cognitive growth. *Cognitive Psychology* 45 (1), 59-87.

Case, R. 1977: *The Process of Stage Transition in Cognitive Development.* Final report, National Institute of Child Health and Human Development, September.

Case, R., 1978: Intellectual development from birth to adulthood: A neo-Piagetian interpretation. In R.S.Siegler (ed.), *Children's Thinking: What Develops?* Hillsdale, N.J.: Erlbaum.

Case, R., Kurland, M. and Daneman, M., 1979: Operational efficiency and the growth of M-space. Paper presented at the Biennial Meeting of the Society for Research in Child Development. San Francisco, California: March.

Case, R., Kurland, M. and Goldberg, J., 1982: Operational efficiency and the growth of short-term memory span. *Journal of Experimental Child Psychology*, 33, 386-404.

Case, R., 1985: *Intellectual Development: Birth to Adulthood.* New York: Academic Press.

Ciberowski, T., 1976: Cultural and cognitive discontinuities of school and home: remedialism revisited. In G.E.Kearney and D.W.McElwain, (Eds) below

Dasen, P.R. (Ed.), 1977: *Piagetian Psychology: Cross-Cultural Contributions*. New York: Gardner.

Davidson, G.R., 1979: An ethnographic psychology of Aboriginal cognitive ability. *Oceania*, XLIX No.4, 270-293.

Fischer, K.W. 1980: A theory of cognitive development. *Psychological Review*, 87 (6), 477-531.

Goodnow, J.J., 1976: Some sources of cultural differences in performance. In G.E.Kearney and D.W.McElwain (Eds) below.

Halford, G.S., 1980: A learning set approach to matrix multiple classification: evidence for a theory of cognitive levels. *International Journal of Behavioural Development*, 3, 409-422.

Halford, G.S., 1982: *The Development of Thought*. Hillsdale, N.J.: Erlbaum.

Halford, G.S. (paper submitted). Children's utilisation of information: a basic factor in cognitive development.

Halford, G.S., 1984: Can young children integrate premises in transitivity and serial order tasks? *Cognitive Psychology*, 16, 65-93.

Halford, G.S., Maybery, M.T and Boyle, F.M. (paper submitted). How does cognitive processing affect information stored in short term memory?

Halford, G.S. and Boulton-Lewis, G.M., 1985: On tailoring mathematical instruction to children's ability to process information. *Research in Mathematics Education in Australia*, Nov. 35-40.

Harris, J.W., 1979: *Ethnoscience and Education in Traditional Aboriginal Communities*. M.Ed.Thesis, Uni. of Qld.

Harris, S., 1980: *Culture and Learning: Tradition and Education in North-East Arnhem Land*. Darwin: N.T. Dept of Education.

Holm, N. and Japanangka, L., 1976: The mathematics of card playing in an Aboriginal community. *The Aboriginal Child at School*, 4: (5), 19-22.

Kearins, J., 1976: Skills of desert Aboriginal children. In G.E. Kearney and D.W.McElwain (Eds), below.

Kearins, J., 1983: A quotient of awareness. *The Aboriginal Child at School*, 11 (3), 24-34.

Kearney, G.E. and McElwain, D.W. (Eds), 1976: *Aboriginal Cognition: Retrospect and Prospect*. New Jersey USA: Humanities Press.

Klich, L.Z. and Davidson, G.R., 1984. Toward a recognition of Australian Aboriginal competence in cognitive functions. In J.R.Kirby (Ed.): *Cognitive Strategies and Educational Performance*. London: Academic Press.

Koepping, K.: Cultural patterns on an Aboriginal settlement in Queensland. In Berndt, R.M., 1977, above.

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

McElwain, D.W. and Kearney, G.E., 1973. Intellectual development. In G.E.Kearney, P.R.deLacey, and G.R.Davidson (Eds): *The Psychology of Aboriginal Australians*. Sydney: Wiley.

McIntyre, L.A., 1976: An investigation of the effect of culture and urbanisation on three cognitive styles and their relation to school performance. In G.E.Kearney and D.W.McElwain, (Eds), above.

Neill, H, 1985. Personal communication.

Peterson, N.: Aboriginal involvement in the Australian economy in the Central Reserve during the winter of 1970. In Berndt, R.M., 1977, above.

Piaget, J, 1928: *Judgement and Reasoning in the Child*. London: Routledge and Kegan Paul.

Robinson, M.W. and Yu, P., 1975: A note on Kuns: an Aboriginal card game from the north-west of Western Australia. *Newsletter, Department of Aboriginal Affairs*, 11, 41-49

Seagrim, G. and Lendon, R., 1976: The Settlement child and school: intellectual assimilation and accommodation. In G.E.Kearney, and D.W.McElwain (Eds) 1976, above.

Seagrim, G. and Lendon, R. 1980: *Furnishing the Mind: a Comparative Study of Cognitive Development in Central Australian Aborigines*. Sydney: Academic Press.

Watts, B.H., 1976: *Access to Education: an Evaluation of the Aboriginal Secondary Grants Scheme*. Canberra: AGPS.

Williams, D, 1981: *Exploring Aboriginal Kinship*. Canberra, Aust. Curriculum Development Centre.

.....

Kaurna men near Tulukudank or present day Marino watch H.M.S. Buffalo, flagship of 'South Australia's' 'first fleet' sail up St Vincent's Gulf to begin the invasion of their land. A careful reconstruction from the Aboriginal perspective. (Artist: A. Best).