

SOME COGNITIVE CORRELATES OF CONSERVATION ABILITY
IN NIGERIAN IGBO SCHOOL CHILDREN

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Objectives

The main aim of this study was to examine possible relationships between performance on 4 Piagetian conservation tasks, and 19 additional cognitive variables. Sub-analyses were undertaken by sex, grade level and age. Age was included as a variable since at each grade level there was considerable range in stated chronological age. Accordingly, three categories of age were established which cut across the grade levels. These were, namely, 8-10 years inclusive (low age), 11-13 years inclusive (medium age) and 14-16 years inclusive (high age).

Theoretical Framework

Over the last decade there has been increasing interest amongst researchers regarding the cognitive development of children as theorized by Jean Piaget. One of the areas most frequently researched concerns the acquisition of the ability to conserve in children. (Piaget and Inhelder, 1969; Almy *et al*, 1966; Heron, 1971; Lloyd, 1971; Za'rour, 1971; Berry and Dasen, 1974; Modgil, 1974; Dasen, 1977).

Conservation is defined by Piaget as the recognition that a physical property remains untransformed despite perceptual evidence to the contrary. It is a significant milestone intellectually within the Piagetian framework. In Piaget's opinion it represents in the individual the passage from reliance on perceptual cues in analysing events to reliance on a new mode of analysis, namely logic.

Piaget considers conservation to be a necessary precondition for all rational activity. He states, that from a psychological point of view, conservation is "a kind of functional a priori" of thought (Piaget, 1964, p.3). By implication, it is a necessary prerequisite to benefitting from much that is taught in school.

Because of the important role conservation is theorised to play in intellectual development it has prompted many psychologists and curriculum specialists to focus on those experiences and instructional materials particularly in mathematics, which will encourage or even train children to conserve. Furthermore, in some cases conservation skill has become a focal point in the determination by teachers of the school "readiness" of individual children (Shayer and Wylan, 1978; SEAMEO-RECSAM, 1978). As such, it is of considerable importance to determine whether Piaget's conceptualisations are in practice applicable. The central question at issue is, "Does conservation skill necessarily relate as it should to other measures of cognition and hence to school achievement?" This question is increasingly being asked and addressed by various researchers (Goodnow, 1962; Heron, 1971).

Methodology

In order to examine the possible relationships between performance on selected Piagetian conservation tasks and various additional cognitive measures, a sample of 270 Nigerian Igbo school children (males = 156, females = 114; Primary Class 5 = 92, Primary Class 6 = 84, Secondary Class 1 = 94; low age = 42, medium age = 166, high age = 62) was selected from 4 schools located in Owerri Township (Imo State,

Nigeria). The schools were identified by officials of the Divisional School board offices at Owerri as being representative of the Owerri urban school population. The sample was drawn by random sampling within clusters, stratified by grade (Primary 5, 6 and Secondary 1) and sex.

Data were collected over a four week period. Each subject was seen on three separate occasions. The first data collection session took place in the respective school settings. A number of group measures were administered by the author with the assistance of classroom teachers. The second session was conducted at the Advanced Teacher Training College, (Owerri) and involved both group and individual 'testing'. During this second session the group measures were administered either by the author or a second trained psychologist. Individual measures were administered by local test administrators¹ trained specifically for that purpose by the author. The third session was conducted once again in the school setting by the author. All testing was conducted in English as results from pretesting in English and Igbo suggested this would be appropriate (Lovegrove and Amajirionwu, 1975).

Data Source

The selection of instruments was related to the purpose of the study and the nature and composition of the sample. In this case, the measures included in the test battery were derived from Piagetian theory and from research in the area of conservation and cognition. Measures considered for inclusion in the test battery were selected to represent each of the following broad areas of cognitive functioning: conservation skill, numerical skill, verbal/linguistic skill, visual/motor/perceptual skill, reasoning skill, and memory. The specific tests included in the battery are described in detail elsewhere (Lovegrove, undated) and briefly below.

The conservation tasks utilised were those of weight, volume, length and area. Standard Piagetian administration procedures were followed (Piaget and Inhelder, 1974; Piaget *et al*, 1960).

Numerical skill was assessed by means of a problem solving test and four mechanical arithmetic tests. The problem-solving measure was a 30-item multiple choice test developed by the author with a split-half test reliability calculated to be .97. The mechanical arithmetic tests were those from the Kit of Reference Tests for cognitive factors (French *et al*, 1969) (Addition Test, N-2, Part 2; Division Test, N-2, Part 1; Subtraction and Multiplication Test, N-3, Parts 1 and 2). Test-retest reliabilities for these measures ranged from .92 - .94.

Verbal-linguistic skill was assessed by three measures: Word Knowledge, Speed of Reading and Reading Comprehension. The Word Knowledge test was composed of 50 items derived from the 100-item ACER, Silent Reading - Form C, Part 1. Test-retest reliability was calculated to be .87. The Speed of Reading Test was an 18-item, speeded reading close test (multiple choice) in short story form, developed by the author. Test-retest reliability was calculated to be .79. The Reading Comprehension measure was a 40 item, close test developed by the author with a test-retest reliability of .85.

¹Psychologists and other field workers are well aware of the problems associated with observation and data collection utilising subjects of a cultural background different from that of the field worker (Kamara and Easley, 1977). To increase the cultural sensitivity in those instances where responses of subjects might be ambiguous and require further questioning, possibly in the indigenous language, local test administrators were trained to administer the individual measures included in the test battery. To overcome the disadvantages of such an approach stringent training and supervision procedures described elsewhere (Lovegrove, undated), were utilised.

Visual/motor/perceptual skill was assessed by the WISC Block Design subtest; A Horizontality test similar to that utilized by Dasen *et al* (1973); the Bender Gestalt; the Maze Tracing Speed Test, SSI (French *et al*, 1969). Test reliabilities for these measures are reported to range from .71 to .91.

Reasoning skill was assessed by means of the Cattell Culture Fair Test (Scale 2; Form A; Tests 1, 2, 3); a series of author developed (similar to Thurstone's Primary Mental Abilities, Verbal Meaning Test), pictorial reasoning items; and, the Goodenough-Harris Draw-a-Person test. Test-retest reliabilities for these measures ranged from .72 to .77.

Memory was assessed by an Auditory Number Span Test to 12 digits similar to the WISC Digit Span subtest and a test of memory of the Bender Gestalt designs. Test-retest reliabilities were .71 and .73 respectively.

Results and Conclusions

In terms of descriptive results, means and standard deviations are available for each of the variables. Table 1 summarises these results. Where ANOVA results indicated the existence of significant sex, grade or age main effects this is also indicated.

TABLE 1
SUMMARY STATISTICS

| VARIABLE | MEAN | STANDARD DEVIATION | SIGNIFICANT DIFFERENCE MAIN EFFECT BY: | | |
|----------------------------|-------|-----------------------|---|-------|-----|
| | | | SEX | GRADE | AGE |
| CATTELL CULTURE FAIR | 15.02 | 7.37 | | ** | |
| VERBAL MEANING | 14.76 | 3.91 | | | |
| READING COMPREHENSION | 21.04 | 9.25 | | | |
| ARITHMETIC PROBLEM SOLVING | 15.83 | 5.27 | | | |
| WISC BLOCK DESIGN | 9.89 | 7.80 | | | |
| HORIZONTALITY | 1.76 | 1.21 | | | |
| BENDER GESTALT | 4.23 | 2.87 | | | ** |
| MAZES | 2.38 | 1.98 | | | |
| WORD KNOWLEDGE | 7.07 | 4.32 | | ** | ** |
| ADDITION | 9.03 | 3.34 | | | |
| SUBTRACTION | 13.95 | 6.21 | | | |
| MULTIPLICATION | 8.49 | 4.94 | * | | ** |
| DIVISION | 8.13 | 5.63 | | ** | |
| SPEED OF READING | 6.71 | 3.53 | | | * |
| AUDITORY NUMBER SPAN | 7.15 | 1.52 | | | |
| CODING | 57.58 | 16.16 | | | |
| PERCEPTUAL SPEED | 15.46 | 5.25 | | | |
| BENDER GESTALT MEMORY | 11.44 | 5.45 | | | |
| DRAW-A-PERSON | 29.42 | 12.20 | | | |
| CONSERVATION | 9.06 | 2.38 | | | |

** = $p < .01$

* = $p < .05$

The four conservation tasks, were combined into one conservation scale. Horst's modified version of the Kuder-Richardson formula 20 for estimating the internal consistency of test items of differential difficulty (Guilford & Fruchter, 1973, 418) was applied to this scale to yield a coefficient of .76. Table 1 also provides mean and standard deviation statistics for this variable.

In terms of applying inferential techniques to the data collected, the hypothesis tested was that the multiple correlation between the criterion (conservation) and the predictors (the additional cognitive variables) is zero in the population from which the sample was drawn.

A series of multiple regression analyses was conducted to test this hypothesis. Separate analyses by sex, age and grade as well as for the entire sample were undertaken. Results suggested that for the sample taken as a whole and for the medium aged subjects analyzed separately the multiple regression coefficients were significantly different from zero. Tables 2a and 2b summarise these results.

TABLE 2A
MULTIPLE REGRESSION RESULTS
TOTAL SAMPLE

| Analysis of Variance | df | S.S | Mean Square | F | P |
|----------------------|-----|---------|-------------|------|------|
| Regression | 19 | 229.93 | 12.10 | 2.37 | <.01 |
| Residual | 248 | 1265.92 | 5.10 | | |

TABLE 2B
MULTIPLE REGRESSION RESULTS
MEDIUM AGE SUBJECTS

| Analysis of Variance | df | S.S | Mean Square | F | P |
|----------------------|-----|--------|-------------|------|------|
| Regression | 19 | 170.54 | 8.98 | 1.76 | <.05 |
| Residual | 142 | 725.42 | 5.11 | | |

Perusal of Tables 2A and 2B indicates that the null hypothesis may be rejected. That is, there is a significant multiple relationship between conservation and the predictors ($p < .01$) for the sample as a whole. Further results indicated, however, that the percentage of conservation variance explained by the other cognitive variables is only 9.2%. One measure alone, Horizontality, accounts for 6% of this variance. There is likewise a significant multiple correlation between conservation performance and the other cognitive variables when the medium age subjects are analysed separately ($p < .05$). Again, however, only 8.8% of conservation variance is accounted for by the other cognitive variables, and Horizontality alone accounts for two-thirds of this variance.

It is consequently of questionable usefulness to examine which of the predictor variables yielded significant specific regression coefficients. It is apparent that conservation performance, although internally consistent across the various conservation tasks, is not related to the skills assessed by the other cognitive variables to any practically useful extent. The predictors utilized at best account for less than 10% of conservation variance. The fact that statistically significant multiple-regression co-

efficients were obtained for the sample as a whole and for the medium aged subjects analysed separately, may be attributed to the sample size.

Educational Relevance of the Study

In practical terms, at least for the Nigerian Igbo school sample tested, the relationship between conservation skill and other cognitive variables is such that conservation should not be considered a necessary pre-requisite to benefitting from much that is taught in schools. Any temptation to focus on those experiences and instructional materials, particularly in mathematics and science, which encourage or even train children to conserve would appear to be undeserved. Accordingly, in the area of conservation Piaget's theory could well be of less practical relevance than has been assumed by many curriculum developers (SEAMEO-RECSAM, 1978).

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