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**I N V A R I A N C E : A STUDY OF SOME
CONSERVING BEHAVIOUPS IN YOUNG CHILDREN**

A thesis presented in fulfilment of
the requirements for the degree of
Master of Arts in Education
at Massey University

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ABSTRACT

Piaget's theory of intellectual growth describes the child as the architect of his own thinking. The child's initial thought patterns are perception-oriented interpretations of the surrounding world. As his experiences continue they are transformed internally by the child's previous storage level of understanding. This introspection leads to a gradual but spectacular change in the basis of thinking, there is a move from semilogic to rationality. Each act of understanding involves an element of invention which has had no existence before either in the external world or in the subject's mind. The concept of invariance is central to Piaget's theory. It concerns the individual's recognition that a change in an external dimension does not imply a change in quantity unless something has been added or removed.

The fieldwork section of this study provides an examination of some of the known necessary conditions for conserving behaviours. The New Zealand sample followed the pattern outlined by Piaget; many young subjects were included in the group of non-conservers, a middle group of borderline conservers were more likely to conserve quantity than volume, and the third group of subjects were assured conservers and included

fewer younger subjects in their number. These findings are used to illustrate some aspects of the current literature on the necessary conditions for invariance.

The child, who has access to a wide range of recognizable operational variety in his environment, whose experience has undergone some internalized ordering, who has confidence to explore his world, whose present equilibrated structures can make an adjustment to a mismatch, is likely to develop conserving behaviours. The significance of the semiotic function rather than the specific dominance of language is discussed in the study. Piaget recognizes the extending role of language but demonstrates that invariance can be established without language but not without operations.

The sufficient conditions for conserving are not yet definitive, they do arise from the child's active involvement with his environment. The present studies are based on post hoc explanations concerning particular aspects of invariance. The concept is a comprehensive understanding but the current measures are centred on specifics of the whole. Some of the sufficient conditions include the preliminary recognition of permanency of objects which contributes to the identity element in conservation, identity and equivalence by compensation and reversibility are the accepted (sufficient) conditions for invariance in contemporary terms.

The final section examines some of the implications for educators. Teachers have the task of providing individual children with operational challenge. The failure of many studies which attempt to influence a child's conserving responses by language and operational training is salutary.

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PART I : THEORETICAL BACKGROUND

"The ability to conserve, which is acquired as a result of the decentration of the child's attention, is supported by three types of operation which are sometimes explicitly expressed in the child's justification of his response : reciprocity, negation and identity."

(Ginsberg & Opper 1969)

(A) Purpose of this Study

This investigation is concerned on one hand with a brief appraisal of Piaget's theory of conservation and on the other with the analysis of responses to the conservation tasks from a group of Maori and European children. These children were enrolled in junior classes in the Wanganui area. This survey was part of a cross cultural study on the acquisition of conservation concepts undertaken in association with Prof. Murray, University of Delaware (1968 (a)).

The study is based almost exclusively on Piaget's theory of intellectual development, as 'conservation' is a section of that general theory. The views of Chomsky (1968) who argues for the innateness of intellectual structures, Bruner (1960) who emphasises learning by discovery and Elkind (1969) who has restated some of Piaget's thinking on invariance, will receive some recognition.

There is a vast amount of recent research on the topic of conservation. Most researchers endorse

/and

and amplify Piaget's ideas and a small number are using these constructs as a springboard for future refinement.

The initial purpose was to pinpoint the behavioural landmarks which contribute to the acquisition of conserving behaviour. Later the route moved from an examination of sufficient conditions for conservation to a statement of some necessary conditions for this behaviour. The following questions gave the direction of the work.

- (1) RECOGNITION : how does the child recognise that a situation exists; in this case to conserve or not to conserve?
- (2) AREA and BOUNDARY : once the field for action is in focus, how does a child decide what situations are concerned with conservation and what are not?
- (3) EXTENSION : when a conserving situation is actioned, how does the child generalize these ideas into wider situations?

(B) Conservation

"Conservation has thus to be conceived as the resultant of operational reversibility".

(Piaget 1971)

When Crick and Watson were unravelling the structure of the DNA molecule they were continually baulked by the disparity between their interpretation of the data available and the evidence from infra-red photography. The classroom setting provides a daily parallel to that puzzle. In all Junior Schools there

is a continuous stream of response patterns based on the pupils' developmental stage. The difference in thinking patterns ranges from those pupils who can provide rational grounds for some of their judgements to those whose thinking is largely dominated by the appearance of things. Conservation is the Piagetian term to describe the premier milestone in the development of logical thinking; it concerns an operational process of the mind. There is a gradual emergence of an understanding that certain aspects of a changing condition are unchanging despite those changes. It is possible to describe children's thinking in terms of their ability or inability to conserve. The study of this change in perspective has given rise to a vast literature of theories and research projects, but the dynamics of the change still present an enigmatic shadow of the reality.

The route between operational and logical thought is, in large measure, controlled by the individual's ability to conserve. The changing basis for decisions is not clearly marked or irreversible in the early stages, the kinetic charge comes from the child's own activity. There is a time of hesitation but once the ability to recognise the invariance is established for that particular context there is no return to the illogical bases which gave assurance to previous judgements.

Conservation is an individual and universal development in man's thinking. The Geneva school stresses several important elements in this growth.

It is the outcome of an extensive action-reaction-modification circuit. Each individual manufactures his own patterns of thinking; they do not arise from the environment or in a void, but their construction stems from earlier patterns. The elaboration of these patterns may extend over many years.

"The process (of conservation) is completed by about the age of seven and is then followed by an equally long process of structuration."

(Barbel Inhelder 1969)

The patterns are not regarded as fortuitous, but their growth is governed by particular laws at specific times.

"it is more difficult to order serially, to equalize objects whose properties are less easy to dissociate from one's own action, such as weight, than to apply the same operations to properties which can be objectified more readily such as length."

(Piaget 1958)

The dynamic for these developments issues from the thought patterns themselves. As the structures become more elaborate their framework demonstrates an incomplete reconstruction of reality, so that the individual is compelled to formulate a more sophisticated construct.

(C) THE CONSTRUCTION OF CONSERVATION

(i) Man and Environment

Piaget refuses to separate man and environment since he views one without the other as an inoperative situation. The growth of intelligence is concerned with the active construction of the individual as he

lives in the process of his development

"...it is the constant duality of always being simultaneously structuring and structured that accounts for the success of the notion of law or rule employed by the structuralists."

(Piaget 1971)

(ii) Logical Structures

The magnitude of observation and experiment from Piaget's work supports his belief that logical structures are constructed. They take many years to mature, their construction is controlled by a network of special laws, and this construction always initiates further learning.

The blueprint for conservation begins in sensori-motor intelligence. There are a limited number of reactions already present at birth. They include sucking, looking, listening, vocalising, grasping and motor activity of the trunk and limbs. These activities do not emerge spontaneously at birth. Their presence at the pre-natal stage has been well documented, including a recent Auckland study by Prof. Lilley (Massey lecture 1970). The reactions are not a selection, in miniature, of the range available to the individual throughout life. They are the prime components to be specialized and differentiated through the activity of the individual and his environment. This notion of complex transformations developing from a limited initial system is not unique to logical thinking as it is shared by other studies. Ashby's (1952) "Design for a Brain",

/G. Walter's

G. Walter's study of brain patterns, and the term 'regulation' in the area of cybernetics have a similar basis (Furth 1969). Piaget terms these initial structures "general co-ordinations of actions". Their significance is not that they are innate but that they become differentiated by functioning.

(iii) Structure-function route

The rhythm of structure development has a dual structure-function and control. The functional factors are assimilation (an action is actively reproduced and may include new objects into itself) and accommodation (applying schemes of assimilation in modified way to other objects). The structural elements include certain order relationships, the subordination of schemes from simple to complex and the production of correspondences. (Piaget 1971)

(iv) Structural elements

It is not until quite late in sensori-motor thinking that there is evidence that the child is capable of seeking an object when it is no longer present or he may be able to use some part of his environment to cause a reaction. Piaget describes these actions as resulting from a co-ordination of primary assimilation schemes.

"...certain equilibrated structures, those that make for a modicum of reversibility become established."

(Piaget 1971)

To play hide-and-seek or peek-a-boo is a pre-requisite for the award, 'permanency of objects'.

Uzgiris and Hunt (1968) have developed

"...a clear ordinal scale of behavioural landmarks in this development of object permanence."

(Elkind 1969)

The child now possesses some primitive appreciation of the logic of order, inclusion and correspondence. This 'early' conservation may show a tendency to appear and disappear but the schemata persist longer and stronger as the perceptual encounters are increased and multiplied.

"...like the point in a gravitational field around which actual and potential acts of knowing stand in equilibrium."

(Furth 1969)

The child's order relationships are totally immersed in sensori-motor schemes, his sub-ordering schemes are implicit and his correspondence activity is primitive. His goal-seeking and detour behaviour sets, give examples of the beginnings of reversibility in thought.

Representational thinking appears during later sensori-motor development and as the child's growth in imagery, speech and symbolic play increases he reaches a new frontier of both power and bewilderment.

"The child may be able to think of something but it does not by itself give him the means to comprehend the object."

(Furth 1969)

The ability to represent ideas permits the development of reflective abstractions. As pre-operational development continues the child shows an increasing ability to order and rank. His subordination schemes

/are more

are more refined so that there is a distinct classification, his correspondence schemes may include one to many, one to one, or copy to original. Inhelder describes this as a time of 'semi-logic'. The notions of function and identity are present but the ability to think reversibly is yet to come.

"A true notion of conservation is a construction that rests on a fully reversible system of knowing."

(Furth 1969)

Conservation presages the onset of concrete operational thinking, and development is continuous until thought patterns are extinguished. The route began with object permanence and progressed by transformation activity to operational knowing. The child is now able to order materials with an appreciation of reversibility in relationships; subordination schemes are more complex and correspondence schemes include semi-networks. There is an assurance in the child's response to the invariance of quantity regardless of the external arrangement because he is able to classify and to reverse operations mentally.

"Piaget contends that a correct judgement of conservation is the result of a compensating transformation."

(Furth 1969)

Concrete operational thinking, in Furth's terms, has a double emphasis. He names the groupings as 'a hierarchy of classes' and 'a grouping relations'. At first they are the separate systems and there is reversibility in both systems but as the groupings extend and interweave the thinking patterns become formal operational.

(v) Equilibration and Conservation

Piaget designates four factors in intellectual growth. Three involve the individual as a receptor. They are maturation, experience and social transmission. The fourth factor, equilibration, concerns the individual's response to the first three. This is the self-regulating mechanism which conducts the balance between the twin functional factors, assimilation and accommodation. The processing of new information and its incorporation as part of the individual's new mental structure results from equilibration. It concerns regulating and organizing schemes towards operations.

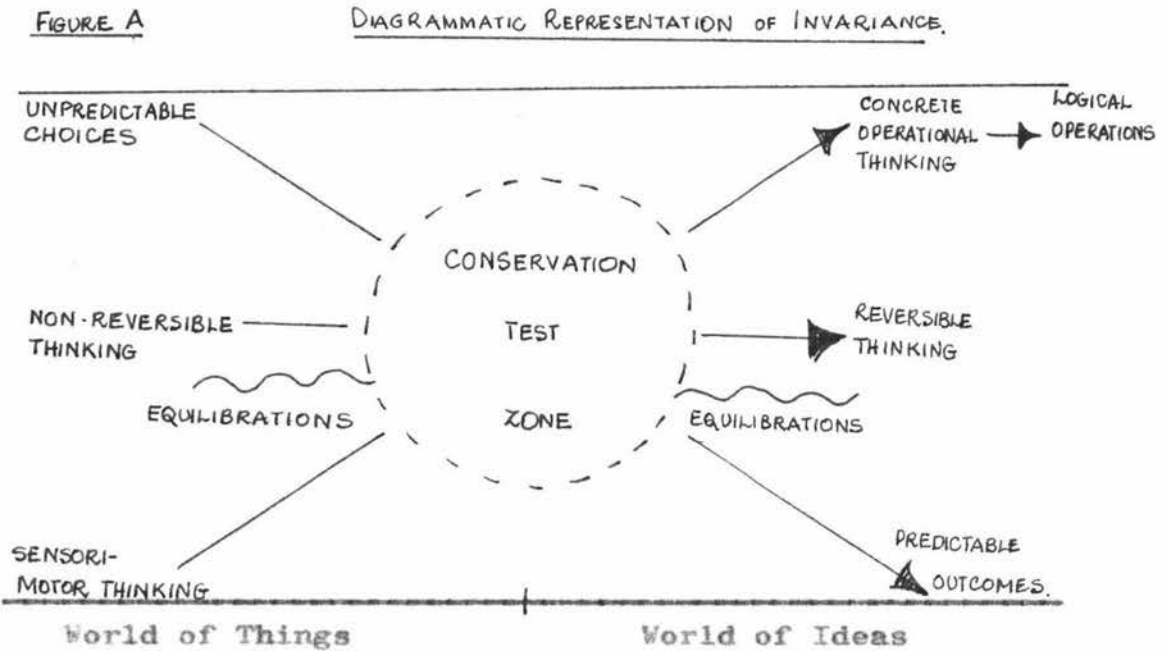
The term has a similar set of properties in biology and in cybernetics, where it is used to describe processes with feed back and feed forward qualities.

"The concept of equilibration implies not only a constant development from less to more stable stages of equilibration but precludes the notion of a static beginning or end product."

(Furth 1969)

The development of conservation results from a continuous network of equilibrations, not all of these proceed in a positive direction, some equilibrations preserve the status quo, others halt development until some irregularity of fit causes the individual to re-assess his earlier decision. The route is an individual specific one, but the direction is always 'toward order rather than chaos' (Inhelder 1955). Furth stresses the dynamic of equilibration when he describes the struggle for 'compensating mechanisms' by which children in the

transition stage toward reversible operations, seek to order their understandings. They cannot recognize an incongruity until their present level of thought is 'sufficiently receptive to the need for stability' (Furth 1969).



Piaget's concept provides an interpretation for the intrinsic form of causality within a total organism and an organizational law to explain the growth of thinking towards logical operational thinking.

(D) SOME RECENT RESEARCH

"To divide developmental continuity into stages recognizable by some set of external criteria is not the most profitable of occupations, the crucial turning point for the beginning of operations shows itself in a kind of equilibration which is rapid and sometimes sudden, which affects the complex of ideas forming a single system and which needs explaining on its own account..."

(Piaget 1950)

/Piaget

Piaget develops the theme that although there may be some similarity with the Gestalt theory the transformations which occur, in fact, often restate the relationships in startlingly new ways.

The implications from Piaget's work for teaching have not escaped the educators or the curriculum 'mandarins' (Marsh, 1970). There has been an immediate interest in the possibility of ordering the encounters that subsume behavioural change and to achieve some understanding of the 'ages' at which these landmarks could be expected.

Hunt (Elkind & Flavell 1969) considers that the traditional learning experiments provide examples of the immediate effects of short-term encounters whereas the effect of long-term encounters may be a more fruitful area to discover the role of experiencing in the modification of behaviour. Hunt has examined the contemporary attempts to encourage conservation and his findings follow.

A. So far short-term encounters are seldom effective (Gruen, Smedslund (many experiments), Elkind and Flavell 1969). There are particular cases where there has been an effective programme. These have involved short-term encounters confined to particular activities.

- (1) Beilin, Gruen, Ojemann and Pritchard have had success when the children have been taught verbal rules. It has been well established that the ability to give verbal rules often enables a high resistance to conservation responses. Bruner and Inhelder have produced similar findings in some recent Harvard experiments.

(Furth 1969)

- (2) Smedslund's experiment involved teaching addition and subtraction as reversible intellectual operations where one nullifies the other.
- (3) Beilin and Franklin found that the transfer is better from non-conservation to conservation when some indication of concrete operational thinking was already present.

B. The long-term experiments give evidence that experiences could influence the 'age' at which behavioural landmarks appear. Success in this area is dependent on the conceptions of cognitive structure, of conflict and of match which arise from Piaget's theory. (Kohlberg 1968)

Some successful long-term experiments include:

- (1) Wacks, Uzgiris and Hunt (1967) have worked with deaf children.
- (2) de Lemos (1967) has researched the culturally deprived children and young adults. In this work 'long-term encounter' was contact with European culture through schooling. These children scored significantly over their colleagues. In contrast to this study, Mermelstein (1964) working with Prince Edward County negro boys and Goodnow (1966) comparing schooled and unschooled Hong Kong children, both found no significant difference between the schooled and unschooled groups.

(Kohlberg 1968)

However, both studies provide direct evidence in support of long-term 'experiencing' encounters, the Smedslund study (1961 - reprinted Sigel & Hooper 1968) also provides some indirect support.

Hunt has criticised the Piagetian studies because they appear to test a particular area of conservation and then accept a general finding.

/However

However, the work of Laurendau & Pinard (Piaget 1970) on geometry and spatial representation exhaustively endorsed Piaget's findings on open and closed figures. Smedslund has investigated individual performances across a range of diagnostic tests of concrete operation and so far he has not found a consistent pattern. The landmarks are real but the routes are obscure.

When Hunt (Elkind & Flavell 1969) has examined the inferences from these studies he makes the following statements.

The landmarks of conservation may be said to occur through long-term repeated encounters with certain kinds of problem circumstances. The nature of these are still indistinct but the elements of surprise and spontaneous interest are worthy clues. The 'problem of match' provides another signpost (Berlyne 1961, 1965). Hunt provides the lines of interest as;

- (a) relevance to what child has already assimilated
- (b) the encounter can be novel but not too strange
- (c) they (encounters) should be sufficiently complex to modify existing understandings but not beyond these limits.

(Elkind & Flavell 1969)

PART II : FIELDWORK

(A) Description of the Work

Goldschmid and Bentler's 'Concept Assessment Kit - Conservation' (1968) is the instrument Murray has selected to examine the development of invariance in young children. A group of children from an area of the Wanganui Education Board are the subjects of the New Zealand contribution to a cross-cultural study. Murray's study (1968 (a)) is in preparation for publication, and some relevant sections of the New Zealand results have been made available for this study.

The tasks of the Kit are derived from the tasks Piaget has used to examine intellectual functioning. They are representative of the class of abilities concerned with mankind's universal understanding of order and permanence. They are based on Piaget's theory of development and are not concerned with an examination of a body of acquired content. The kit is an attempt to provide some measure of the specific area of invariance.

The test designers believe that by establishing standardised procedures for Piaget's tests they have broken with traditional intelligence tests and provided a measure which is closely linked to theory.

"(I.Q. tests) ... simply present an agglomeration of tasks which empirically have been shown to correlate with school achievement and other indices of intelligent behaviour".

(Goldschmid & Bentler 1968(a))

They are concerned with a general assessment of mental development as well as a particular view of a child's ability to understand and use abstract concepts.

The criteria for test construction were to provide the child with some interesting tasks that would test his understanding of conservation, to ensure that the tests would be easily administered and marked and to make certain that the tests were valid measures. Validity was established on the premiss that the processes involved in these tasks are the basic categories of intellectual functioning. There are three forms of the test, two are parallel, while the third measures a slightly different dimension of conservation, including area and length. Goldschmid and his associates have subjected the three forms to cross validation and reliability tests. The designers have used the forms in pre- and post-measures of accelerated conservation after special training techniques.

Piaget found a high positive correlation between Stanford-Binet scores and the scores for conservation. He believed that the second group were more powerful and fundamental. Goldschmid and Bentler (1968 (a)) have established a parallel between their test and elements of the curriculum, the correlations for an overall curriculum grade, using Forms A & B, is in the order $p < .001$, as is the arithmetic score. The level of correlation for social studies and science is given as $p < .01$.

/Table

TABLE A. INTERCORRELATIONS OF FORMS A,B & C.

N=43

Subject	Forms A&B 24 Items	Form C 12 Items
Growth in vocab.	.32*	.08
Oral expression	.31*	.21
Written expression	.35*	.05
Handwriting	.08	.17
Arithmetic	.52***	.39**
Social Studies	.42**	.31*
Science	.42**	.31*
Art & Craft	.30*	.18
Music	.11	.12
P.E.	.36*	.43**
All subjects combined	.45***	.33*

* $p < .05$
 ** $p < .01$
 *** $p < .001$

These correlations have been replicated by Goldschmid & Bentler (1968 (a) - p.13), the test designers, in other studies. Goldsmid (1967) has also established correlations of .49 with mental age, .31 with IQ and .40 with the WISC vocabulary.

(B) Format

The items of the Kit include two-dimensional space, number, substance, continuous and discontinuous quantity, and weight. The format is based on Piaget's studies. The subject is presented with a standard and a variable stimulus. These are initially equivalent in the perceptual and qualitative sense. The subject is asked to confirm this judgement. The experimenter

/transforms

transforms the variable in view of the subject so that perceptual equivalence is lost. Finally the subject is asked to comment on the equivalence between the transformed variable and the standard.

(iv) square v pyramid

"You have kept the same blocks and made it into a staircase."

Gorden 6y 3m

The child's level of conservation is determined by his comments on the invariance and his explanation for his judgement.

The directions, procedures and scoring are simply stated. The test is not exhausting for subjects or examiner. The materials used include water, small cubes, play dough and dried corn. The New Zealand teachers completed a general information sheet about their pupils. They were asked to assess their pupils, on a five point scale, under the five headings reading, general achievement, social adjustment, muscular development and manipulative control. The last two categories were sub-headed with qualifiers to assist teachers with their ratings.

(C) The Concept Kit in Action

(a) Tasks of the Kit

The activities have been selected as examples of the class they represent and they are expected to provide children with an intrinsically motivated experience. The responses of the subjects varied

/greatly

greatly in this study. Some subjects recognized the pattern and proceeded calmly. Many of this group did not score, but they recognized the territory of the exchange.

'Quiet, slow and deliberate.'

'A little more confident, thought about problems dwelt on them, didn't rush at an incorrect answer as many of the subjects did.'

'Very quiet voice - but not anxious.'

(E's comments)

Other subjects were bewildered by the situation.

'Uncertain - limited response.'

'Flashes of insight. Distractable. Nervous. Erratic.'

'Points - very tense.'

(E's comments)

Some needed assurance from the adult before proceeding,

'Looks at examiner, rather than task...'

(E's comment)

while others seemed unaware of the exchange request in a question,

'Puzzled by being asked, 'Why?', obviously would prefer to leave it without an explanation.'

'(very much coaxing) Very reluctant to speak.'

(E's comments)

The general impression was that the tasks of the Kit were not always intrinsically interesting for all subjects. Many enjoyed them, a few found them worrying. It may have been the artifacts of the kit that distracted the attention of a few subjects from the

/judgements

judgements requested. Gaudia (1971) comments that the tasks of the Kit are probably common to all cultures.

"Fluid levels are as horizontal in a beer bottle as in a vase. Reversals of perspective are as readily observed in an alley as in a boulevard."

Tuddenheim (Gaudia 1972)

(b) Role of the Experimenter

The Kit has standardized procedures and clear directions for examiners. The role of tester and teacher was sometimes confusing. The subjects in this study were tested in their school environs. In many cases the children expect that the adults they meet in these situations are likely to be teachers. Even the youngest subjects gave signs of their already-established socialisation to school. The majority of children accepted the interview situation as an extension of school.

It was often difficult for the examiner to maintain a neutral position. There is a wide range of atmosphere change when subjects are conspicuously successful with the tasks and when there is a lingering silence between the subject and examiner. Sometimes the subject's valiant attempts to make a logical response tempted the examiner.

"...wavered - has nearly grasped this concept, perhaps she had but can't express herself."

Karen 6y 2m - Examiner comment.

The test response is a verbal one, the focus is on an intellectual operation.

/(c)

(c) The Vocabulary of the Test

Early in the programme the examiners discussed the range of verbal fluency, the awareness of the questions, the personality factors of the subjects. It was unwise to expect that verbal fluency was an indicator of success in test scores. Some children were at ease in a verbal exchange while others were visibly vulnerable to the test procedures.

Verbal Instructions

Substance (P18)

- (a) 'Now, is there as much play
doh in this one, as in that
one, or does one have more?'

Discontinuous quantity (P20)

- (b) 'Now, is there as much corn in
this one, as in all of these
together, or does one side
have more?'

The examiner indicates the underlined words by gestures. This may have confused some children who gave their attention to the gestures rather than the words. The key to success lies in the ability to understand the question - unless the subject recognizes the question he cannot score or explain his answer. Lovell and Ogilvie (Sigel & Hooper 1969) preferred to use "most" rather than the grammatically correct "more" in their U.K. study of conservation of substance with Junior School children. At first, the examiners attempted to explain the lack of verbal fluency in some subjects in terms of their intellectual development.

/Further

Further study of the responses will show that all subjects possessed the linguistic power to give a positive response, but some subjects lacked the operational knowledge to interpret the changes.

Goldschmid and Bentler (1968 (a)) make several references to their efforts to neutralize response sets in the kit. Sometimes the language and gestures of the examiner did induce a set response. This reaction involved the examiner in a quick decision whether or not to intervene by a shading of stress in giving the instructions. It may well be accepted that the child who is caught in a response set may be demonstrating that his pre-operational mode of thought is still dominant.

The correct answers included many examples of the principles outlined by the test makers.

'You didn't take any away so there must be the same amount.'

K.C. 7y 2m

INVARIANT QUANTITY (Identity-Elkind)

'Same as the other, if you flattened it, it will still be the same.'

REVERSIBILITY

'...just because one's flattened out, it doesn't change the weight.'

COMPENSATION

These three, invariance, reversibility and compensation or equation of differences, are Piaget's constructs.

PART III : RESULTS

"It was the same before and it's
still the same - it's just in a
different way."

Carron 5y 9m

The total sample for this study (N=276) are pupils from the schools of Wanganui city and its rural environs. The numbers are matched for urban and rural living, age groupings, sex and racial origin. S.E.S. ratings for further analysis have also been determined. This last group was divided between European and Maori. The category Maori was designated by parents at enrolment. The category European was applied to all other children who were not Maori.

Within the sample there is a population of Maori children (N=135). This represents almost every Maori pupil enrolled in junior classes of the Wanganui (Education) city and near areas at that point in time.

TABLE I



CONSERVATION SCORES

GROUP	N	AGE RANGE	♂	♀	RURAL	URBAN	MAORI	EUROPEAN	TOTAL CONSERVATION SCORE
1	40	5.0 - 5.5	20	20	20	20	19	21	1.750
2	73	5.6 - 5.11	39	34	32	41	35	37	2.246
3	72	6.0 - 6.5	46	26	33	39	34	38	3.055
4	51	6.6 - 6.11	25	26	30	21	26	24	3.902
5	40	7.0 - 7.5	22	18	20	20	19	21	5.675
	276								mean total conservation score

The total conservation score shows successive increases with the age of the subjects and this fits well with the theoretical basis of the kit (Goldschmid & Bentler 1968). The sequence of thought development followed a predictable pattern. Many young children were unable to conserve, the next group scored erratically on some examples (usually quantity), and the last group gave conserving replies in a determined way.

FIGURE B

STAGES IN CONSERVATION RESPONSES

Weight 11	ball	v	pancake
		S	
	(a)	E	(b)
Q : 'Now is the <u>ball</u> as heavy as the <u>pancake</u> or is one heavier?			
Why?'			
Stage 1 Answer - '(a) - because its round' (N.T. 6y 8m)			
Stage 2 Answer - 'Same? - just because one's flattened out, it doesn't change the weight.' (Looks away from task to think.) (A.S. 6y 0m)			
Stage 3 Answer - 'Same - that one was a ball you made it into a pancake and you didn't take any out.' (L.L. 6y 3m)			

(Concept Assessment Kit - Conservation)

Age does not necessarily indicate the ability to conserve, Piaget reminds us that individual subjects move through the route at their personal speeds.

/Furth

Furth (1969) itemizes the studies of several groups of children who live in Western culture settings, showing that the stages outlined above are well established in their attainment of invariance.

The increasing scores in Table I are signposts of the subjects' gradual release from the 'static states' of the situation,

"...most 5 or 6 year olds assert without hesitation that each change in form involves a change in the amount of the water."

(Furth 1969)

The child, who understands the conservation principle, signals that his structure of knowing has advanced to that stage where he is able to review and adjust what he sees, to what he understands about the changes that have occurred.

"...thus the perception of the external transformation follows the ability to construct internal transformations through compensatory mechanisms."

(Furth 1969)

A second feature of the data for Murray's survey (McAlpine 1972) was the negative significant difference between the conservation scores of boys compared with girls and also when the scores of urban and rural subjects were compared. The theoretical basis of the kit would endorse this finding. Goldschmid and Bentler (1968) have been anxious to provide test experiences that were not specific to boys or girls, and that would interest both rural and urban subjects. The subjects in this sample enjoy a geographic nearness which does not allow of a marked difference in

/life-styles.

life-styles. Many researchers have commented on the different rearing patterns of boys and girls. The New Zealand sample would illustrate this view, but the Concept Assessment work provided experiences which are not specifically more related to either sex.

The third outcome of this survey concerns the differing scoring successes when European and Maori scores were compared.

TABLE II

COMPARISON OF MAORI AND EUROPEAN SCORES.

AGE RANGE		MAORI	EUROPEAN	HIGHER MEAN DIFF.	"t" - TEST.
Y M	Y. M.	N = 19	N = 21	E	.01 - .05
5 0	- 5 5	36	37	E	.01
5 6	- 5 11	34	38	E	.01
6 0	- 6 5	26	24	E	.001
6 6	- 6 11	19	21	E	.0001
7 0	- 7 5	Σ134	Σ141	M = Maori E = European	

The difference between Maori and European children is not only significant but becomes increasingly more significant with increasing age and schooling. (5yrs - 7yrs 6mths).

Piaget has always emphasised the duality of man and his environment, he writes of the structures of knowing as belonging as much to man in society as to the society as shown in the man. There have been numerous cross cultural studies to examine the invariance patterns in other cultures (Sigel & Hooper

1969 - Hyde (1959), Goodnow, Greenfield, Price William (1961)). They point to some necessary universal skills, particularly in the conservation of quantity. On the other hand there are indications that some groups explain conservation in other ways. This may be due to variables within the experiment.

The recent controversies on racial differences have diverted many studies from examining the construct validity of the tests. Gaudia (1972) believes that the question of difference is unanswerable at present, and that the focus should concern not a controversy on the inappropriateness of the test for a cultural group but the analysis of the test with the idea it represents.

The kit test construction has been well validated by Goldschmid and Bentler (1968). For the purpose of this study the kit is accepted as the measure, and the scores of the Maori population are significantly different from the European group. The kit is concerned with the logico-mathematical system of Western culture and many subjects in this study may stand in another culture or participate in two or more variations of New Zealand life.

This population was matched as far as possible with the European sample for age, sex and socio-economic rating, although further analysis employing smaller samples on a more closely matched SES basis is to be carried out at a subsequent stage of research. Some of the difference may be explained by personality and perhaps language interpretations, but this group has a particularly interesting matrix.

The historical derivation of this population may provide a frame for the explanation of difference. The subjects can be separated broadly into two distinct streams of sociological change. One group has moved from a secure river tribal setting to the anonymity of a new suburb on the outskirts of a city. The land of the homes has no tribal significance for many of them. The second group live in a close rural community where tribalism has been replaced by a prophetic interpretation of Old Testament beliefs. Both groups of parents have experienced subsistence living. Their children are living in significantly different home circumstances from that of their parents. Some families are nuclear or solo, most relatives are visitors rather than participants in the family. The play behaviour and social transmission role of language are likely to provide a variation from usual New Zealand patterns. They may not experience the behaviours which provide the enjoyment and novelty to venture forward. Furth (1969) refers to some of these patterns as intellectual initiative, the grasping of instructions and familiarity with similar problems. Unknown personality factors which influence the development of conservation further add to the complexity of such study. Sigel (1969) stresses the lack of precise knowledge about the experiences which contribute to this growth in young children. Some work (Almy Chittenden & Murray 1966) has shown that the conservation of quantity appears to be immune from school

/influences

influences, whereas class-inclusion performance can be influenced by programmes.

The fourth consideration in this study concerns the relationship between the conservation scores and the teacher ratings of their pupils. The teachers were asked to provide some general information on the subjects. They were asked to make an assessment on a five point scale using the areas of reading, achievement, muscular development and social development. This was not part of the kit proper but it was added to maintain control of the New Zealand sample. All the teachers who contributed to this study were European.

TABLE III

TEACHER RATINGS

AGE GROUP	OVERALL TEACHER ASSESSMENT		READING	
	MAORI	EUROPEAN	MAORI	EUROPEAN
5.0 - 5.5	3.4	3.0	3.6	3.0
5.6 - 5.11	3.2	2.7	3.2	2.7
6.0 - 6.5	3.7	2.9	3.7	3.0
6.6 - 6.11	3.6	2.8	3.8	2.9
7.0 - 7.5	3.3	2.8	3.4	2.9

Table III contrasts with Table II in that the teachers' ratings of their Maori pupils is in contrast to the scores of these children using the Concept Assessment Kit. In Table II the European pupils score significantly and progressively higher than the Maori group, but in Table III the teachers have reversed this general finding.

The mismatch between the teacher estimates of the pupils' abilities and their conservation scores may deserve some further examination. The teacher's rating may represent a positive identification of the child's personal development. The form may hold some ambiguity for the teachers as it refers to the pupil's progress but not to a ranking system. In this respect the lower Maori conservation scores would not necessarily be reflected in lower achievement scores, or the inconsistency may stem from the teacher's view of the child from another culture, participating in an ascendant culture. There is also the possibility that the teacher's view may be superior to that of the survey.

"The teacher himself may make an assessment of the students capabilities. Even if relevant research was available, the teacher must still perform such an assessment since it is extremely likely that there are wide individual differences with respect to the understanding of any concept at almost any age level."

(Ginsberg & Oppen 1969)

There are other alternatives to these arguments. The teachers may be responding to the climate of race relationships that is world wide at the moment. By over-compensating for these differences they may be accepting, unconsciously, a different and lower standard of achievement from the Maori pupils. There may be particular personality traits which make the Maori child a more responsive pupil and this racial glow may obscure the real world of development. Whether or not any of these possibilities are appropriate, the teacher's knowledge of conservation and the way in

/which

which this important landmark heralds logical thinking is crucial. If the programmes in action ignore the variety of development in any class range the resulting learning will be superficial.

PART IV : DISCUSSION

"I am reminded here of the hunt for the woozle in 'Winnie the Pooh'."

Wohlwill-Piaget's
system as a Source
of Empirical Resource.

It is intended to focus this section towards two of the initial three questions. One query concerns the child's recognition of an invariance situation, the second seeks some topographical knowledge of the territory. These questions stem from a particular view of reality, so to give a more balanced explanation it will be worthwhile to consider and contrast an alternative to Piaget's construct. The next section concerns Elkind's refinement of the term conservation and the last section explores the relationship between thinking and language. The three areas provide the justification for the conclusions.

•Extensive or Intensive Analysis

Piaget wrote the "Child's Concept of Number" in 1937 and he was already emphasizing the focus of his work.

"...Obviously, conservation, which is a necessary condition of all experience and reasoning, by no means exhausts the representation of the dynamism of the intellectual process, but that is another matter."

(Flavell 1969)

/As early

As early as 1931 Lewin had developed a schema to examine the formation of science concepts. He traced their beginnings to the historical giants of scientific thinking. Lewin's view is that one mode derives from Aristotle, the other from Galileo.

Elkind (Flavell 1969) has extended this framework to examine two contemporary views of concept development. The customary way of exploring concepts by verbal definition arises from an 'extensive' view of reality in the Aristotelian mode, an alternative is the Piagetian examination of the transformations that leave the exemplar a member of the class. This 'intensive' view follows from Galileo.

These two views are compared by Elkind in terms of essence, function and content of the concept of invariance. This concept is examined as it is regarded as central to the development of logical thinking.

The Aristotelians explain the essence of a concept in terms of the principle of similarity among things, the other view, as represented by Piaget, invokes the principle of identity and conservation. These are not necessarily contrary views in fact. Elkind believes that they represent the reality of things in both multiplicity and uniqueness.

The function of a concept concerns the recognition or the classification of exemplars for the Aristotle mode. Piaget's study examines the discrimination between what is apparent and what is real. Elkind examines these as sections of a whole, the final concern

/is with

is with decisions about the differences "between" as well as "within" things.

The traditionalists seek to explain content in terms of 'extensive' qualities of the population of objects to which the concept belongs. Piaget's focus is to obtain 'intensive' recognition of the property that is left unchanged across the various transformations. For Elkind these modes co-exist, the variations give a clearer delineation of the concept, in fact, it may be that one mode is impossible without the other.

Elkind's study and the earlier sections of this paper contain many instances of Piaget's emphasis on the discontinuity of conceptual properties.

"What the conservation problems propose is that the 'intensive' content of a concept is always relative to the transformations that leave it invariant.*"

Elkind (Flavell 1969)

(*For Piaget, form and content are thus always relative to one another.)

The preoperational subject explains transformation in terms of the 'form' of the substance,

'(b) has more - it's all spread out'
(ball v pancake)

S.B. 6y 3m

whereas the child who has a 'units' concept of substance will explain that these remain constant in spite of other changes.

'...they have the same dough as they had before.'

(ball v pancake)

C.S. 5y 9m

Elkind has examined the logical analysis involved in a statement of invariance, the one above is a verbal

/explanation

explanation based on reversibility. His analysis supports and extends the understanding of Piaget's work. He believes that many readers receive a simplistic understanding of Piaget's construct because some sections involve implicit as well as explicit understandings. Piaget writes for his collaborators who share his conceptual framework of intellectual functioning.

•Conservation : Identity and Equivalence

Elkind has contributed a further refinement of the term 'conservation', he posits it is inclusive of two distinct forms which he has named conservation of identity and conservation of equivalence. In his examination of the present tests of conservation he believes that the test includes a covert form of conservation, in this case identity conservation, which is critical to the determination of the conservation of equivalence.

The conservation of identity involves the child in the recognition of the sameness in some quality, for example quantity, between two items. Then if nothing is added or taken away from one and it is moulded into another shape, the quantity remains the same. It is important to note that the child needs a point of reference here otherwise judgements are erratic. Two experimenters, Vinh Bang and Beilin (1964), have reported that both children and adults have failed to assess weights correctly when they

/were

were presented with a ball and a sausage of clay as the exemplars.

Conservation of equivalence, in Elkind's terms, is the comparison of the transformation with the original state. To do this the subject must have attained the conservation of identity and then employ a form of deduction based on past experience. The subject has to remember the original and test the copy against it. Elkind claims the conservation of identity as necessary but not sufficient condition for the attainment of conservation of equivalence.

Piaget describes conserving behaviour in terms of the 'equation of difference' or 'compensation'. The child comes to see that a change in one dimension is compensated for by a change in a second dimension and this is usually an inverse one. This discovery underlies the child's insight that transformations are reversible and that they leave the object invariant. Elkind would rate this as the identity conservation not equivalence.

Furth interprets Piaget in a broader basis than Elkind,

"Piaget contends that a correct judgement of conservation is the result of a compensating transformation."

(Furth 1969)

To recognize a situation where invariance may apply at least one aspect must remain unchanged otherwise there is no internal possibility of reversibility.

/This is

This is similar to the 'conservation of identity'. The subject must reconstruct the changes and then through 'compensatory reversibility' he can release his thinking from the figural static aspect and move to operational knowing.

"It is both a transformation and a reconstruction on a higher level."

(Furth 1969)

Elkind has not moved markedly from the Piaget tradition (Piaget 1970) but his analysis has aided a better understanding of the progress of conservation. He does not agree that the equation of differences and reversibility are achieved at the same time but he does believe that there is evidence that the conservation of identity precedes the conservation of equivalence and that identity is necessary to the equivalence conservation.

The examination of the test situation in terms of the route between verbal responses and the thinking they reflect is a present interest of Elkind. Piaget has always asserted the inability of children to retrace their thinking route. Their response is in fact a post hoc rationalization rather than the summary of a logical thinking pattern.

• Conservation and Language

Piaget's earliest work in the field of genetic epistemology evolved from an examination of children's verbal replies to Binet's tests. His interest soon moved from the words to the thinking patterns behind

them. Piaget has continued to express this viewpoint, so Furth (1969) describes him as,

"...the only exponent of logical thinking who does not see language as an intrinsically necessary element of operational thinking."

There has been a wide and lively exchange between Piaget and Ausabel (1965), Sutton Smith (1966) and others to determine the extensions of the terms, symbolic functioning and operative thinking.

The symbolic function is sometimes referred to, by Piaget, as the 'semiotic' function. It includes gestures, images as well as socialized language.

"Language is recognized as a special kind of symbol, that is not figuratively related to the objective configuration but too is part of the symbolic function and does not enter directly into the operative component."

(Piaget 1971)

This is not to say that semiotic functioning is unimportant in intellectual functioning. It is significant in the construction and understanding of internal structures. Piaget emphasizes this view because he believes that symbols represent reality states. Operative thinking transforms reality states according to the stage of intellectual development.
(Furth 1969)

There is a significant amount of evidence to support these views. It is clear that a great amount of thinking appears in the sensori-motor stage well before language is available, there are many examples of more complex systems of thinking that function beyond language. Piaget suggests that most

/pre-operational

preoperational children have the language to cope with invariance but lack the thinking patterns to deal with it.

Goldschmid and Bentler (1968) found that children younger than four years did not respond well to their kit,

"part of the difficulty seems to relate to the child's lack of relational terms as 'more' and 'same'."

Piaget (1970) reminds his readers that both of these words have been available to the children for some time prior to their fourth year.

"Lucy has more than me, I've more than her, Alistair has more than me."

Pocket-money by K.M. 7y 6m

(No awareness of distributing an amount of money between the three 1:1:1.)

Speech, for Piaget, is biologically oriented not to knowing but to communicating, its whole system concerns social exchange. The primacy of ego-centrism is broken by communication. As soon as the child is able to make a symbol oriented response, he is able to participate in social transmission.

Although Piaget believes that language is not intrinsically necessary for operational thinking, he recognizes that language has a 'facilitating' role.

Language may direct attention, the focus of attention is a pertinent factor in all conserving behaviour. Richmond (1971) notes that the extent to which language can be assimilated depends on its meaning and usefulness to the child in terms of his

mental activity. Many recent studies (Furth 1969) have attempted to isolate verbal formulations for preoperational subjects, A. Morf (Furth 1969) and Inhelder and Bruner (1969) found that there was little linkage between language training and invariance. Ginsburg and Opper (1969) believe that the ability to verbalize may help to consolidate and generalize concepts. Strong evidence for the significance of cognitive operations rather than language development comes from recent work by Furth (1966) and the studies of Oleron, Vincent and Affolter in Geneva. Both research teams have developed non-verbal response systems for testing the development of thinking for children who have been deaf from birth. The deaf children do show a slower-paced growth, however.

"the basic manifestations of logical thinking in linguistically deprived deaf children were present without any important structural difference."

(Furth 1969)

Other investigators (Y. Halwell in Furth 1969) have found that children blind from birth, often succeed in the language area but their limited sensori-motor experiences gives later logical behaviour less flexibility. Ordinary classrooms provide many examples of pupils whose operational thinking may be developing slowly without the slightest hint of any language difficulty.

The linguistic explanation of the relationship between language and thinking ranges from the logical

/positivists

positivists, who view logic as simply a linguistic convention, to Chomsky who contends that language is based on logic and that this reason is innate. The mind contains a system of common notions that enable it to interpret the maelstrom of the external world. (Piaget 1971)

"The most fundamental and at the same time the most controversial of Chomsky's hypotheses is that we are born with a disposition to acquire language."

M.M. Lewis (Minnis 1971)

Bruner and Piaget have been involved in a long controversy of whether language determines thought. (Sigel & Hooper 1969) Bruner (1968) and his associates believe that conservation is improved by verbalisation. Bruner and Braine believe that the ability to conserve is more likely to be found in the thinking of children 4 - 5 years old rather than older children, as Piaget's work demonstrates. Gruen (Sigel & Hooper 1969) describes Bruner's view of conservation as the stage in thinking where the 'symbolic' mode becomes dominant over the 'iconic' (perceptual) mode. Bruner argues that this does not necessarily occur through logical operations. Frank, a colleague of Bruner's, has provided evidence to support this theory. She found that children gave conserving answers at much earlier years than Piaget predicts and that children were able to predict the invariance when the transformations were screened from the subjects. These studies hinge on Bruner's framework of thinking.

/My

"My colleague (Bruner) thinks that a notion of the principle of identity is sufficient as a notion of conservation." (Piaget 1970)

Piaget requires a judgement and justification, whereas Bruner's researchers deem a subject a conserver if the first judgement is correct.

Smedslund (Sigel & Hooper 1969) has examined Frank's (1963) findings. He terms the subject's answers 'symptom responses' and he believes the results can be shown inferior to Piaget's construct because they have a low correlation with the subjects operations in subtraction and addition work.

Secondly, the symptom response is not markedly resistant to extinction and its predictive quality is low. Gruen (Sigel & Hooper 1969) believes it would be fairer to accept each school of thought as an acceptable illustration of two differing views. The term 'pseudo-conservation' is given to the infra-logical stage where the correct response is given but the underlying logical operations are not yet available.

Sinclair (Piaget 1970 and Sigel & Hooper 1969) has worked in Geneva to examine the conservation responses in linguistic terms. She found that the conserver was able to express double differences in one statement and in general used a more sophisticated patterning of words to provide greater precision in terms. A training programme by Mae Sinclair proved to have little effect. She believes that both groups possessed the linguistic patterns but in further

/evidence

evidence, for the separateness of logic and language, the conserving group were able to use the language.

'Why do people wear rubber shoes?'

'The prickles don't dig right up and hurt you ... concrete, sharp stones can dig up.'

Peter 6yrs

• Recognition of Conservation

The harbinger of conservation is the child's growing awareness that objects exist, even when they cannot be seen. This development usually appears during the first two years of life. Throughout the next five years or so there is an extended time of exploration concerning the basic properties of the world. The earliest thinking has a static, figural component. As the storage begins to interweave, the thinking patterns provide the child with stable interpretations of reality.

'I saw an Army helicopter.'

'How did you know it was an Army one?'

'(gestures) L-O-N-G, and green an round painting red - it's Army.'
(the roundel).

New entrant K.O. 5y 0m

New experiences and further thinking patterns upset this equilibrium and the child finds mismatching and dissatisfaction with his previous decisions. In his search for order again the search for the unchangeable takes precedence. At first the child focuses on the external properties of objects but increasing introspection and deduction leads him to

/the

the conclusions stated many times in this paper, that if nothing is added or removed the material remains the same even if its perceptual outline is changed, and that the first instance and the final have a relationship that is based on a logic deduction by the child which can be justified. The unevenness of conservation skills derives from the child's satisfaction with illogical decision, the infra-logic of Piaget.

• The Parameters of Conservation

"Operativity does not derive from events. It is not built into the hereditary structure. The simple logical rules have to be constructed, the rules are not outside it takes time."

Piaget (Sigel & Hooper 1969)

Conservation is not a generalized activity the order of conservation is believed to be quantity first, weight and then volume. From 7 - 8 years (approx.) the child is able to deny perceptual clues and he begins to apply logical process to practical problems and concrete situations. It seems that the objects of his world, that he can dissociate himself from, (e.g. quantity), are conserved earlier than others. The child's thinking results from a co-ordination of actions - combining, dissociating, ordering and setting up correspondences. His dependence on perception gradually wanes as he comes to appreciate the significance of his action. Complete invariance in a sub-class is established when the

/child

child has the ability to think reversibly. The logical structures of the child's thinking are flexible enough to allow for variations in a subclass without disturbing the basic essence. There will always be further development but the core of invariance remains.

Elkind explains conservation in terms of a deductive argument which supports the equation of differences, this gives rise to the logical explanations of a conservation judgement.

"What they reflect is that the child now feels that conservation is a logical necessity, and that he must justify it."

Elkind (Sigel & Hooper 1969)

V : EDUCATIONAL IMPLICATIONS

Although the concept of invariance has been discussed in terms of quantity, weight and volume, it has a much wider significance. Conservation is concerned with all aspects of personality, social interaction, value judgements as well as the logico-mathematical system. Children and adults who have a poor understanding of invariance are at a considerable disadvantage in many phases of life, since their judgements are perceptual instead of rational.

2 November, 1972

Sorry Mr M... for annoying you at Maths time, and makeing (N.B. his spelling) funny noises to annoy you so you couldn't carry on with what you were doing.

Yours sincerely

Billy M.'

Syr's Potorua

Conservation is the breath of life for future development. As the growth of this concept coincides with the pre-school and early school years, programmes for this population require particular attention. The educational implications will be discussed within a framework used by McAlpine (1972) to emphasize the involvement of parents and teachers in the child's growth during these years. The quality and variety experiences, the significance of sequence and unity, the balance of intellectual and expressive activities and the individual characteristics of children will be used to focus on the acquisition of conservation.

/Conceptual

• Conceptual development from Experience

The child is the agent of his own development, unless he can construct his own framework of reference, his task becomes less satisfactory.

"Piaget's work has made plain all the vital education that goes on in the child quite independently of the educational processes ..."

Nathan Isaacs (Weber 1971)

Play, a comprehensive term for a wide range of intellectual, emotional and social learning, is the most visible activity of the pre-school child. The play situation provides the child with the cause as well as the opportunity to move from egocentric to objective judgements.

Weber (1971) describes play experiences as the child's way of selecting elements of past experiences which embody his intellectual and emotional needs of the present. It is a way of obtaining information feedback. The child at play is continually confronted with the unexpected, the energy of a young child dealing with saucepans may demonstrate this challenge. There are innumerable ways in which the child may explore these objects. One way concerns the correspondence of saucepans and lids. The child finds that each lid may or may not fit any saucepan. This is a situation of cognitive conflict, the child has to reorganize his route of actions if matching lids and saucepans interests him. The flexibility of fit with circular shapes provides a range of acceptable solutions as well as clear

/examples

examples of non-fit solutions. The thinking transformations that the conservation tests attempt to order are the products of these endless experiencings.

The role of the adult, at home and in home-extension institutions, is to provide each child with the opportunity to extend his developmental stage, rather than an attempt to boost the child to a subsequent stage. The adult can provide time and opportunities for the child's explorations.

The teacher at the early school level is concerned with selecting the experiences that are 'worthwhile' (Peters 1967) and those that are appropriate to the child's home experiences. Kohlberg (1968) stresses the significance of the home experiences and for some teachers the task will be to supplement and to provide experiences which have not been available at home. This implies variety as well as flexibility in the materials used. Marsh (1969) in the mathematical field, Matterson (1966) in exploratory play, Huriwitz (1972) in art, represent the vast array of recent innovators, who are encouraging teachers to provide simple pliable materials to aid the child in his work.

Goldschmid & Bentler (1968), Kohlberg (1968), Elkind (1969) and Smedslund (1961) refer to the confident way in which conservers approach materials, they appear to possess an inner discernment that things should make sense of some sort. Many behavioural examples of this type were discussed during the field

/work

work section of this study.

Smedslund's study (Chittenden 1970) highlights the second order strength of environmental stimuli. After a group of non-conservers had been subjected to a training programme, they were able to predict the constancy of weight. Later during the post test the examiner surreptitiously altered the material so that the predictions could not be verified. When the examiner asked the subjects to explain this confusion, the trained group reverted to their original explanations based on perceptual judgements - pseudo-conservers! The original conserving group explained the difference in terms of a poor weighing instrument or a 'something fishy going on' explanation.

Many experiments of this nature (Sigel & Hooper 1969) support Piaget's view of the difficulty in attempting to accelerate a global concept like invariance. The priority is to establish environments which encourage cognitive development.

**. Sequence : Unity and Continuity in
Conserving Experiences**

It is not unlikely that all children meet the experiences which may contribute to conservation. There is no doubt that the range of conserving behaviours in early childhood years is widespread and distinctive. (Goldschmid & Bentler 1969). Each child accepts or rejects experiences on the bases of their relevance to his present storage structures. Conserving behaviours show some dependence on an awareness of sequence.

The variety and richness of pre-operational development provides the child with myriad sensory examples about how things are. In a conserving situation, the child is asked to make a judgement about some quality which is still continuing but has 'no adequate sensory evidence at the time' (Wallach, Furth 1968). To make this decision the child has to proceed from an experience bank about the nature of things in differences and similarities.

One of the adult's tasks is to provide a time-dimension which permits the child to construct this gradual adaptation to reality. Some home circumstances present the child with a clear daily structure, other homes may function on a looser structure, significant persons in the home may vary, routines may be minimal, exhaustion rather than time may form an activity boundary. The teacher may need to provide a predictable pattern within a developmental day so that the child of the second group can participate in a wider heritage.

Watson (Sigel & Hooper 1969) has suggested another aspect of the teacher's task which can encourage conserving behaviours. He refers to

'...the ability to discriminate time-disturbed stimulus as a critical element...'

This has immediate implications in the child's ability to discriminate speech patterns. The supportive role of language has been accepted (Piaget & Inhelder 1964, Bruner and associates 1966). Cognitive structures may be reinforced by the syntactical sequences of language. Low order concepts can be formed and used

without language, later

"...speech (which has to be learned) is essential for the formation and use of higher order concepts which collectively form, our scientific and cultural heritage."

(Skemp 1962)

Cultural and class differences have been established independently in play activity (Piaget 1951, Sutton Smith 1967) in creativity (Lieberman 1965), in conservation test scores (Goldschmid and Bentler 1968) and in syntactical structures within groups (Bernstein 1961), and between groups (Sinclair 1966). A high degree of inter-relationship has been inferred between the areas but further research is needed. The teacher's task, in the meantime, is to establish a linkage between the child's cultural setting and his own aspirations. His logical operational viewpoint permits greater manoeuvrability.

Most of the work in attempting to accelerate conservation has been in the area of mathematical development (Smedslund 1961, Wohlwill 1961, Gruen 1965) and science understandings (Chittenden 1970, Nuffield Junior Science Project 1966). The alert teacher will find the signs and signals of developing invariance in all aspects of classroom and playground interaction.

- Balance : Aesthetic, Emotional, Social and Intellectual Growth

Although Piaget has examined the child's thinking in a wide range of spheres including language, play,

/morality

morality and causal thinking, his work in mathematical and scientific thinking has dominated the present study. It is important now to discuss the wider issue, each of these areas has its own growth pattern and rhythm, they do not proceed on a broad front, although they have different profiles they are interdependent. Social interaction is a necessary condition for transition from one developmental stage to another. The child cannot free his egocentrism unless he can confront the social and physical world in a variety of forms.

"...he must needs 'play out' what he thinks and symbolize his ideas by means of gestures or objects and represent things by imitation, drawing and construction."

Piaget (Elkind 1969)

The range of these experiences prior to school affect the development of conservation. Sigel refers to these 'life experiences' and the need for further investigation of the nature of the cultural setting and conserving skills. The teacher's role in helping the child to recognize the illogical bases of his judgements has been mentioned but the means of doing this is found in other than the logico-mathematical field. Piaget sees socialization as the development which provides the stress that induces cognitive transformation.

The teacher's observations of the child's work in the expressive fields can maintain an awareness of the difference between a child's 'manifest' and 'true' understanding of an underlying principle like conservation.

/Individual

. Individual Differences : Interests,
Abilities, Pacing and Optimal Match.

Each of these elements represents a powerful force in the development of invariance, they are the subjects of much contemporary research. In this study they will be used in a general form since their full recognition is beyond the present work.

The variety of individual responses to the conserving tests has been mentioned in the field work section. The role of experience has been recognized by all authors referenced in this work but the specific delineations of the experiential variables are not yet established.

Personality characteristics of the early conserving child include an open-minded approach to new materials, a sense of enjoyment from novelty, a seeking for order as if the child knew an order exists, and an ability to detour when explorations meet an impasse.

There is also some likelihood that some social settings encourage children to make sense of their world while others may include many exciting experiences but lack the significance for the child which would lead to equilibrations.

The pacing of conservation experiences has provided several general but few specific findings (Hunt 1961, Smedslund 1961, Sigel 1966). Hooper (1968) comments on the individual's response repertoire as the standard for type and quality of experiences. The child needs to recognize the success of his operations,

/and to

and to use these understandings in other settings. In this respect the teacher's awareness of optimal match is a vital element in the teaching programme. The critical questions remain how to establish the optimal match in each pupil, how to structure those experiences which assist in the growth of conservation, and the wider process of equilibration.

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APPENDIX A

CONSERVATION SCORES : Results of t-testsAge Group I (5y 0mm - 5y 5mm) N=40

Overall Mean Total Conservation Score = 1.750

No significant differences (by t-tests) for
Rural/Urban
Male/Female

No significant difference (between .01 and
.05 level) for Maori/European (Higher mean for
European)

5 point Teacher Rating Scale:

Overall average = 3.4 (Maori) 3.0 (European)
Reading = 3.6 (Maori) 3.0 (European)

Age Group II (5y 6mm - 5y 11mm) N=73

Overall Mean Total Conservation Score = 2.246

No significant difference for Rural/Urban
Male/Female

Significant difference (at .01 level) for Maori/
European (H.M. for E.)

Average of Teacher Ratings = 3.2 (Maori) 2.7 (European)
Reading = 3.2 (Maori) 2.7 (European)

/Age Group III

Appendix A contd...Conservation Scores : Results of t-testsAge Group III (6y 0mn - 6y 5mn) N=72

Overall Mean Total Conservation Score = 3.055

No significant difference for Rural/Urban
Male/Female

Significant difference (at .01 level) for
Maori/European (H.M. for E.)

Average Teacher Ratings = 3.7 (Maori) 2.9 (European)
Reading = 3.7 (Maori) 3.0 (European)

Age Group IV (6y 6mn - 6y 11mn) N=51

Overall Mean Total Conservation Score = 3.902

No significant difference for Rural/Urban
Male/Female

Significant difference (at .001 level) for
Maori/European (H.M. for E.)

Average Teacher Ratings = 3.6 (Maori) 2.8 (European)
Reading = 3.8 (Maori) 2.9 (European)

Age Group V (7y 0mn - 7y 5mn) N=40

Overall Mean Total Conservation Score = 5.675

No significant difference for Rural/Urban
Male/Female

Significant difference (at .0001 level) for
Maori/European (H.M. for E.)

Average Teacher Ratings = 3.3 (Maori) 2.8 (European)
Reading = 3.4 (Maori) 2.9 (European)

Total Sample N=273

APPENDIX B.

CONCEPT ASSESSMENT KIT—CONSERVATION

Marcel L. Goldschmid and Peter M. Bentler

RECORDING FORM
FORM A

SCORES			
Task	Behavior	Explanation	Total
A			
B			
C			
D			
E			
F			
Total			

NAME _____ DATE _____

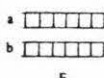
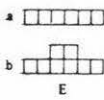
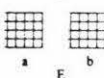
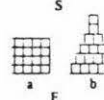
DATE OF BIRTH _____ AGE _____ SEX _____

SCHOOL _____ GRADE _____

EXAMINER _____

COMMENTS _____

(A) TWO-DIMENSIONAL SPACE

ITEM	DIRECTIONS	VERBAL INSTRUCTIONS	RESPONSE	SCORE
<p>I. 2 equal lines</p> <p>S</p>  <p>E</p>	<p>Build 2 lines, each with 6 blocks of wood, saying:</p> <p>When finished ask:</p> <p>If the subject says they are both the same, say: And go on to (II)</p> <p>If he says they are not the same, say: Demonstrate to subject by pointing that they are the same, then, when S agrees, go on to (II)</p>	<p>Watch what I do.</p> <p>Is there as much wood here* as there or does one have more? Yes, they are both the same.</p> <p>Look. This one is just as big as that one. See, they are both the same.</p>		
<p>II. 2 unequal lines</p> <p>S</p>  <p>E</p>	<p>Take 2 additional blocks, saying:</p> <p>Then, say:</p> <p>Record. Then ask:</p> <p>Record, and say:</p>	<p>Look. I am putting these blocks here.</p> <p>Now tell me. Is there as much wood here as there, or does one have more? Why?</p> <p>Let's do something else.</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	
<p>III. 2 equal squares</p> <p>S</p>  <p>E</p>	<p>Build 2 squares with 16 pieces of wood each, saying:</p> <p>When finished, ask:</p> <p>If the subject says they are the same, continue with (IV).</p> <p>If the subject says they are not the same, say: Demonstrate to subject by pointing that they are the same, then, go on to (IV)</p>	<p>Watch what I do.</p> <p>Is there as much wood here as there, or does one have more?</p> <p>Look. This one is just as big as that one. See, they are both the same.</p>		
<p>IV. square vs. pyramid</p> <p>S</p>  <p>E</p>	<p>Then, take the blocks from the right square and build a pyramid with a base of 5 blocks and successive levels of 4, 3, 2, 1 and 1 blocks, saying:</p> <p>When finished, ask:</p> <p>Record, then ask:</p> <p>Record.</p>	<p>Watch what I do.</p> <p>Now, is there as much wood in this one as in that one, or does one have more? Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	

*When saying the first underlined word, point to (a); when saying the second underlined word, point to (b). Follow this procedure for all underlined words.

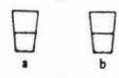
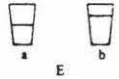
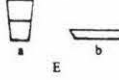
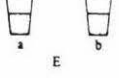
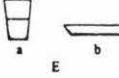
(B) NUMBER

ITEM	DIRECTIONS	VERBAL INSTRUCTIONS	RESPONSE	SCORE
<p>I. parallel red and white chips</p> <p>S</p> <p>a ●●●●●●</p> <p>b ○○○○○○</p> <p>E</p>	<p>Place 6 red chips in a straight line about 4 inches apart. Parallel to and below the red chips, place 6 white chips in corresponding position, also in a straight line, saying:</p> <p>When finished, say:</p> <p>If subject says there are as many red as white chips go on to (II)</p> <p>If he says one line has more than the other, say:</p> <p>Demonstrate to subject by pointing that they are the same, then, when he agrees, go on to (II)</p>	<p>Watch what I do.</p> <p>Are there as many red chips as white chips or are there more red chips than white chips?</p> <p>No, look. There is one red chip for every white chip. Do you see now that there are as many red chips as white chips?</p>		
<p>II. red vs white chips</p> <p>S</p> <p>a ●●●●●●</p> <p>b ○○○○○○</p> <p>E</p>	<p>Leave the two lines of chips in a horizontal position, one line below the other, but spread out the white chips (6 inches apart), and move the red chips closer together (2 inches apart), saying:</p> <p>When finished, ask:</p> <p>Record, and ask:</p> <p>Record.</p>	<p>Watch what I do.</p> <p>Now, are there as many red chips as white chips, or is there more of one kind?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	

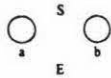
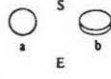
(C) SUBSTANCE

<p>I. 2 equal balls</p> <p>S</p> <p>a ○ ○</p> <p>b</p> <p>E</p>	<p>Make two equal balls of play doh (each 3 oz.), saying:</p> <p>If the subject says they are both the same, go on to (II)</p> <p>If the subject says one ball is larger, say:</p> <p>Continue to adjust the two balls until the subject says they are the same.</p>	<p>Here are two balls of play doh. There is the same amount of play doh in each ball. They are both alike. Is there as much play doh in this ball as in that one, or does one have more?</p> <p>Let's make them the same. I am taking a little bit away from this one and adding it to that one.</p> <p>Now, is there as much play doh in this one as in that one?</p>		
<p>II. ball vs. hotdog</p> <p>S</p> <p>a ○ /</p> <p>b</p> <p>E</p>	<p>Roll one ball into a hotdog (6 inches long - use ruler), saying:</p> <p>When finished, ask:</p> <p>Record, and ask:</p> <p>Record.</p>	<p>Now watch what I do. See, I am making this ball into a hotdog.</p> <p>Now, is there as much play doh in this one, as in that one, or does one have more?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	

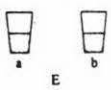
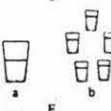
(D) CONTINUOUS QUANTITY

ITEM	DIRECTIONS	VERBAL INSTRUCTIONS	RESPONSE	SCORE
<p>I. 2 equal large glasses</p> <p>S</p>  <p>E</p>	<p>Place the two large glasses filled with an equal amount of water (150 ml) before the child, and say:</p> <p>Then, ask:</p> <p>If the subject says they both have the same amount, go on to (II)</p> <p>If the subject says one has more, adjust the water level, saying:</p> <p>Then, ask:</p> <p>Continue to adjust the water in the two glasses until he says that they both have the same.</p>	<p>See, here are two glasses both filled with the same amount of water.</p> <p>Is there as much water in <u>this</u> glass as in <u>that</u> one, or does one have more?</p> <p>Let's make them the same. See, I am pouring a little from this glass into that one.</p> <p>Now, is there as much water in <u>this</u> one as in <u>that</u> one or does one have more?</p>		
<p>II. 2 unequal glasses</p> <p>S</p>  <p>E</p>	<p>Pour 25 ml of water from an extra glass into the large glass at right, remove the extra glass, but leave it on the table, saying:</p> <p>Then ask:</p> <p>Record, and ask:</p> <p>Record.</p>	<p>Watch what I do. See, I am pouring a little water from this glass into that one.</p> <p>Now, is there as much water in <u>this</u> glass as in <u>that</u> one, or does one have more?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	
<p>III. large glass vs. dish</p> <p>S</p>  <p>E</p>	<p>Pour water from right glass (which has more water) into the flat dish, saying:</p> <p>When finished, ask:</p> <p>Record, and ask:</p> <p>Record.</p>	<p>Watch what I do.</p> <p>Now, does <u>this</u> one have as much water as <u>that</u> one, or does one have more?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	
<p>IV. 2 large glasses</p> <p>S</p>  <p>E</p>	<p>Place the two large glasses filled with an equal amount of water (150 ml) before the child, and say:</p> <p>Then, ask:</p> <p>If the subject says they both have the same amount, go on to (V).</p> <p>If the subject says one has more, adjust the water level, saying:</p> <p>Then, ask:</p> <p>Continue to adjust the water in the two glasses until he says they both have the same.</p>	<p>See, here are two glasses both filled with the same amount of water.</p> <p>Is there as much water in <u>this</u> glass as in <u>that</u> one, or does one have more?</p> <p>Let's make them the same. See, I am pouring a little from this glass into that one.</p> <p>Now, is there as much water in <u>this</u> glass as in <u>that</u> one, or does one have more?</p>		
<p>V. large glass vs. dish</p> <p>S</p>  <p>E</p>	<p>Pour the water from right glass into the dish, saying:</p> <p>Remove empty glass, but leave it on the table, and ask:</p> <p>Record, and ask:</p> <p>Record.</p>	<p>Watch what I do.</p> <p>Is there as much water in <u>this</u> one as in <u>that</u> one, or does one have more?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	

(E) WEIGHT

ITEM	DIRECTIONS	VERBAL INSTRUCTIONS	RESPONSE	SCORE
<p>I. 2 equal balls</p> 	<p>Make two equal balls of play doh (each 3 oz.), saying:</p> <p>Give the balls to the child, and say: (Be sure that the subject picks up the balls and weighs them in his hands.)</p> <p>If the child says they weigh the same, go on to (II). If the subject says one weighs more, say:</p> <p>Give balls back to subject and ask: Continue to adjust the two balls until he says they weigh the same.</p>	<p>Here are two balls of play doh. One ball is as heavy as the other ball.</p> <p>Is one ball as heavy as the other, or is one ball heavier than the other?</p> <p>Let's make them the same. I am taking a little bit away from this one and adding it to that one.</p> <p>Now are they the same? Is one ball as heavy as the other?</p>		
<p>II. ball vs. pancake</p> 	<p>Make the right ball into a pancake. Flatten the ball until the diameter is 4 inches (use ruler), saying:</p> <p>When finished, ask: (Do <u>not</u> allow the subject to pick up the ball or pancake)</p> <p>Record, and ask:</p> <p>Record.</p>	<p>Watch what I am doing. See, I am making one of the balls into a pancake.</p> <p>Now, is the <u>ball</u> as heavy as the <u>pancake</u>, or is one heavier?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	

(F) DISCONTINUOUS QUANTITY

<p>I. 2 large glasses</p> 	<p>Place the two glasses, filled with an equal amount of corn (150 ml), in front of the child, saying: (Level the surface in both glasses.)</p> <p>If the subject says they both have the same, go on to (II). If the subject says one has more, say:</p> <p>Continue to adjust the corn in the two glasses, until he says they both have the same amount.</p>	<p>See, here are two glasses both filled with the same amount of corn. Is there as much corn in this glass as in <u>that</u> one, or does one have more?</p> <p>Let's make them the same. See, I am pouring some corn from this glass into that one. Now, is there as much corn in <u>this</u> one as in <u>that</u> one, or does one have more?</p>		
<p>II. large glass vs. 5 small glasses</p> 	<p>Pour the corn from the large glass into the small glasses (arranged in a circle, close together) in equal amounts, saying:</p> <p>When finished, ask:</p> <p>Record, then ask:</p> <p>Record.</p>	<p>Watch what I do. See, I am pouring the corn from this glass into all of these glasses.</p> <p>Now, is there as much corn in <u>this</u> one as in all of these together, or does one side have more?</p> <p>Why?</p>	<p>Same <input type="checkbox"/></p> <p>a has more <input type="checkbox"/></p> <p>b has more <input type="checkbox"/></p>	