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Cognitive competence in Africa and models of information processing: A research prospectus

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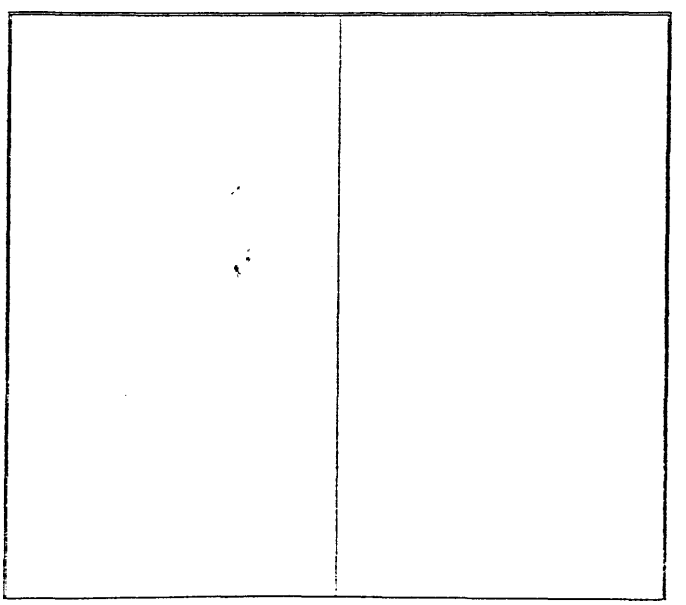

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OPSOMMING

Hierdie verslag begin met 'n heroorweging van een van die sentrale probleme in kruiskulturele kognitiewe navorsing : naamlik die vasstelling van die betekenis van gedragskonstrukte. Met hierdie vraagstuk in gedagte, word pogings tot konstrukdefinisie in die Afrika-verband uitgelig, en belangrike tekortkominge beklemtoon. Teoreties geïnspireerde navorsing gerig op die herleiding van komplekse kognitiewe prestasie na onderliggende komponente van informasieverwerking, word daarna oorweeg. Vervolgens word resultate van beide die psigometriese en informasieverwerkingsbenaderings oorweeg teen die breër perspektief gebied deur die studie van kognitiewe gedrag in werklike alledaagse situasies. In besonder word kennis geneem van die insigte verkry uit mense se inheemse begrippe van die doelstellings en waardes onderliggend aan hulle eie kognitiewe gedrag, aangesien dit betrekking het op die probleem van konstrukbetekenis. Teenstrydighede tussen die komponente van alledaagse kognisie en die prestasie-eise van psigometriese toetse en informasieverwerkingstake word aangeteken. Ten slotte word 'n prospektus geskets vir toekomstige navorsing wat daarop gemik is om die bydraes van 'n inheemse sielkunde van kognitiewe bevoegdheid in Afrika met modelle en metings van informasieverwerking te integreer.

SUMMARY

This report begins with a reconsideration of one of the central problems in cross-cultural cognitive research : that of establishing the meaning of behavioural constructs. With this issue in mind, psychometric attempts at construct definition in the African context are appraised and important shortcomings highlighted. Theoretically inspired research aimed at reducing complex cognitive performance to

underlying information-processing components is then considered. Next, results of both the psychometric and information-processing approaches are reflected against the broader perspective offered by studies of cognitive behaviour in real-world, everyday situations. In particular, insights afforded by people's indigenous conceptions of the goals and values underlying their own cognitive behaviour are noted as they bear on the problem of construct meaning. Disparities between the constituents of everyday cognition and the performance demands of psychometric tests and information-processing tasks are noted. Finally, a prospectus for future research aimed at integrating contributions from an indigenous psychology of cognitive competence in Africa with models and measures of information processing is sketched.

1. INTRODUCTION

The cultural history of the peoples of Africa differs in important ways from that of inhabitants in other parts of the world, including Western Europe and North America. A diversity of natural and man-made environments is to be found within Africa as well, posing a wide range of challenges to human resourcefulness in the face of the need to survive. The human ecology of Africa, as in other parts of the world not entirely dominated by Western cultural traditions, offers Western psychologists a valuable testing ground for theories, concepts, and methods developed within the confines of their own intellectual milieu.

The recognition of Africa as a natural laboratory for cross-cultural research is nothing new, as attested by a voluminous literature and the regular appearance of new bibliographies and reviews (e.g., Andor, 1983; Kendall, Verster, & Von Mollendorf, 1986). In the face of all this, it is legitimate to question how much has been learned about the robustness of their science by Western psychologists, and more to the point, whether Africans have derived any benefit from the attention bestowed on them. These questions are implicit in the purpose of the present report, and serve as motives for the research prospectus that is outlined.

My aim in this report is to offer some thoughts on ways in which research in Africa, and specifically Southern Africa where I am based, might be redirected to achieve a more meaningful indigenous cognitive psychology relevant to the needs of the local context, while at the same time having the potential to contribute to a wider scientific understanding of the universal and the specific in human cognition. To prepare the ground for my proposed research prospectus, it will be necessary first to recap salient landmarks in the history of cognitive research in the Southern African region and to reflect these against the backdrop of international

developments in the field. This will be no extensive review of available literature, but merely a brief justification for the proposed programme of research.

The overview begins with a reconsideration of one of the central problems in cross-cultural cognitive research : that of establishing the meaning of behavioural constructs. With this issue in mind, psychometric attempts at construct definition are appraised and important shortcomings highlighted. Theoretically inspired research aimed at reducing complex cognitive performance to underlying information-processing components is then considered. Next, results of both the psychometric and information-processing approaches are reflected against the broader perspective offered by studies of cognitive behaviour in real-world, everyday situations. In particular, insights afforded by people's indigenous conceptions of the goals and values underlying their own cognitive behaviour are noted as they bear on the problem of construct meaning. Disparities between the constituents of everyday cognition and the performance demands of psychometric tests and information-processing tasks are noted. Finally, a prospectus for future research aimed at integrating contributions from an indigenous psychology of cognitive competence in Africa with models and measures of information processing is sketched.

2. THE MEANING OF CONSTRUCTS

2.1 Extending the nomological net

Cross-cultural psychology involves the study of human behaviour in relation to culture, understood in the widest sense. This poses three central methodological problems : how to interpret the meaning of behavioural variables within and across disparate cultural environments, how to trace linkages to the diversity of ecocultural context variables, and how to

draw valid comparisons of behaviour across cultural contexts (Verster, 1985). All of these problems are implicated in any consideration of cross-cultural research, but only the first is emphasized here.

Irvine (1966, 1969a, b, 1970, 1981, 1983) has done a great deal to focus attention on the problem of establishing construct meaning across cultures, particularly with reference to cognitive test performance. His work is a logical extension to cross-cultural psychology of the landmark formulation of construct validity in differential psychology by Cronbach & Meehl (1955). For the latter authors, "[c]onstruct validity is involved whenever a test is to be interpreted as a measure of some attribute or quality which is not 'operationally defined'" (p. 282). The problem then, is to identify the constructs (attributes, traits) that account for variance in test performance. Such constructs are necessarily theoretical postulates, inferred on the basis of test data. The methodology of construct validation cannot, of itself, impart meaning to behaviour, and the constructs taken to be reflected in such behaviour cannot be observed. The logic of construct validation therefore demands that for a construct to be scientifically admissable, it should occur within a 'nomological network' (Cronbach & Meehl, 1955, p. 290). This is essentially an interlocking system of laws which constitute a theory about the construct.

Irvine (1981) sees in cross-cultural research an opportunity to extend the logic of construct validation. The aim here is to check on the universality of constructs generated within a single culture. Irvine's (1983) research has demonstrated that the nomological net of laws claimed to be satisfied for human ability constructs in a North American context are not necessarily satisfied in a different cultural context, in this case Africa. At best, Western notions of ability are therefore culturally relative. Different, or modified constructs must be sought to account for cognitive test

variance in the African context. In the next section we examine the extent to which psychometric research in Africa has succeeded in producing indigenous constructs of cognitive competence that satisfy the requirements of a nomological network for validity.

3. PSYCHOMETRIC CONSTRUCTS OF AFRICAN INTELLECT

3.1 The incomparable African race

Psychometric research on the cognitive capabilities of the peoples of Africa, south of the Sahara has a history of at least three score years and ten. The earliest studies (Martin, 1915; Rich, 1917) made uncritical use of standard European IQ testing technology and merely succeeded in replicating ethnocentric prejudices about the nature of 'primitive mentality', as propagated by some of the founding fathers of cross-cultural research (e.g., Rivers, 1905; Lèvy Bruhl, 1910, 1923). In South Africa, where the majority of studies were conducted with the aim of assessing the educability of black children, Fick's (1929; 1939) work represents the culmination of a tradition in which comparative test data were accepted as scientific proof of inherent racial differences in "intelligence". His readiness to see the results as confirmation of the racial inferiority, and consequent lower educability of the 'native' highlighted the far-reaching social and policy implications of this misguided research tradition. The interpretation placed on test scores in this work was clearly that they represented a universal human attribute, identifiable with a construct intelligence, viewed as innate, general cognitive ability. The issue of cross-cultural comparability, or measurement equivalence of test scores was not considered.

3.2 Beyond empiricism

Biesheuvel's (1943) monograph ushered in a new era of thinking in which the influence of environmental context variables on intellectual development was emphasized. His central methodological argument, that the scores of Africans and Europeans on Western intelligence tests were not comparable, owing to a differential familiarity with test content and materials, remains valid and has become an accepted tenet of modern cross-cultural psychology (Berry, 1969; Irvine & Carroll, 1980; Van de Vijver & Poortinga, 1982; Verster, 1985). Yet his arguably more profound theoretical insight, that the effects of culture, home life, nutrition, and instruction, should be included in an understanding of African "intelligence" has not been followed up equally systematically.

On turning his attention to the problem of assessment, Biesheuvel (1952, 1954) was guided by the pragmatic needs of personnel selection and placement. Together with colleagues at the National Institute for Personnel Research (NIPR) in Johannesburg, he (Biesheuvel & Hudson, 1949) produced the General Adaptability Battery (GAB). This instrument was designed to assess the potential of African mining recruits to adjust to the alien technological demands of industrial work. The behaviour operationalized in this test became the basis for the concept of general adaptability.

In contrast to "intelligence", adaptability was viewed not as an attribute of individuals or an abstract function of behaviour, but "as an essential characteristic of behaviour, considered operationally and as a whole" (Biesheuvel, 1972, p. 51). This broad conception does not lend itself to validation within a nomological network of specifiable laws. Van de Vijver & Poortinga (1982) cite adaptability as an example of a conceptual universal, on a par with Wober's (1966) notion of sensotypes. Unless specified in operational

terms, both lie beyond the scope of empirical treatment and claims for their universality cannot be tested. When the operational definition of general adaptability is tied to the testing procedures embodied in the GAB, the centroid factor cited as evidence for construct validity (Biesheuvel, 1954) could just as easily support alternative interpretations, that would equally satisfy evidence of predictive validity against industrial training criteria (e.g., level of Western acculturation, or even willingness to comply with authority).

3.3 The true colour of a chameleon

The overriding concern with measuring adaptability to Western demands for social and technological change deflected interest away from more fundamental questions about African competence, considered from the viewpoint of indigenous developmental goals, values, and behavioural ecology. The pragmatics of selection and prediction in educational and occupational settings became the dominant theme in African psychometric work. Irvine's (1983) assessment of the contribution of this work to the problem of construct meaning prompted the optimistic conclusion, that at least "the criterion, or operational definition of tests in Africa is secure" (p. 50). Independent reviewers (Ord, 1982; Kendall, Verster, & Von Mollendorf, 1986) have reached similar conclusions, suggesting that the criterion-related validity of tests in Africa, perhaps, provides some firm strands in the fragmented nomological net of test score meaning.

But the results of predictive and concurrent validity studies in Africa, against criteria of school achievement and industrial training proficiency by no means provide an unequivocal replication of Western findings. Important anomalies and inconsistencies, especially in the vast **unpublished** literature, demand explanation in the light

of possible culturally mediated influences on performance. The disconcerting phenomenon of validity generalization (Cronbach, 1983), in terms of which almost any cognitive test can be shown to have validity for almost any performance criterion, also detracts from claims for the differential meaning of different tests. Where it exists, the possibility that this phenomenon is due to common variance between test and criterion arising from sources unrelated to the test task cannot be dismissed. Especially in the case of illiterate or semi-literate samples in Africa, where good predictive validities are commonly found with virtually any psychometric test (Grant, 1970; Kendall, 1976) it is likely that factors extrinsic to the test task, such as communication skills, account for common variance between test (ability to follow instructions) and criterion (ability to profit from instruction). As Irvine (1983) has noted, test instructions in the African context become an important focus of theoretical interest in their own right.

Claims for the construct meaning of psychometric tests in Africa cannot, therefore, be said to have benefitted greatly from predictive or concurrent validity studies. The empirical relationship between test and criterion implied in such validity coefficients cannot be interpreted in the absence of theory. Trying to erect a theory of the construct meaning of tests on the basis of predictive validity, is like attempting to define the true colour of a chameleon; with every new criterion the operational definition of a test must be revised.

3.4 A lesson from Tswana teachers

The proliferation of psychometric ability tests in Africa for use in applied settings also gave rise to the opportunity to examine relationships among test scores as a contribution to the problem of establishing construct meaning. The use of factor analysis, with all its attendant methodological

problems, has been central to this research tradition. Irvine (1969; 1979) and Kendall, Verster, & Von Mollendorf (1986) among others have provided useful surveys of the results of factor-analytic studies of intellectual abilities in Africa and the details need not be repeated here. In general, the literature supports the conclusion that when test batteries containing task demands similar to those studied in Western populations are administered to African samples, the patterning of scores revealed through factor analysis presents a familiar picture. Tests tend to cluster into categories such as reasoning, visual perceptual skills, language skills, numerical operations, and psycho-motor skills including gross and fine co-ordination as well as quickness (Irvine, 1979; Verster, 1983a). The test groupings produced in such studies do not, however, satisfy requirements for the interpretation of factors as abilities, or other scientific constructs representing attributes of individuals. Factor structures in Africa are notoriously unstable across different studies and methods of analysis. Particular tests load on different factors in different studies, and the number of factors supported by a particular test battery often differs in different, even closely similar samples. Most of these problems can be illustrated with reference to a single NIPR study, carried out under my guidance among adult Tswanas in Bophutatswana (Crawford-Nutt, 1977).

This study involved the administration of a battery of 19 psychometric tests to 285 Tswana school teachers. The subjects, ninety percent of whom were females, had a mean age of 34 $\pm$ 8 years and had completed nine years of formal schooling. All subjects, although already serving as teachers, were studying part-time through a private correspondence college to complete their own high school education. For practical reasons, the sample was drawn in two batches in successive years, comprising 101 and 184 subjects respectively. The two batches differed on average by a few years in age and teaching experience, but were found to be

The three analyses failed to produce results yielding to a common interpretation. For interest, Crawford-Nutt's original rotated factor matrices are reproduced here in Table 1.

comparable in most other respects. The battery of tests administered to them was compiled to reference the factorial domains of reasoning (four tests), spatial thinking (three tests), numerical operations (five tests), perceptual speed (three tests), and second language facility in the medium of education (English/Afrikaans) (four tests). Measuring instruments used came from the NIPR's test stock, supplemented by marker tests from the American kit of reference tests for cognitive factors of French, Ekstrom, & Price (1963). All tests were administered in small group sessions by experienced black testers, using demonstration posters to ensure comprehension of instructions and test tasks.

Analysis of the data by means of confirmatory model-fitting techniques (Jöreskog, 1969) failed to support the five-factor structure predicted on the basis of psychometric theory, despite successive easing of restrictions in the model tested. Confirmatory factor analysis was therefore abandoned and exploratory factoring techniques were used in further analyses to probe the dimensions supported by the data. The Little Jiffy Mark IV programme of Kaiser & Rice (1974) produced an MSA = 0.91, indicating that the structural adequacy of the data for the purpose of factor analysis was 'marvellous'. This programme estimated that three factors should be extracted to account for the common variance in the intercorrelations among tests in the battery. Although two-factor and four-factor solutions were tried as well, a three-factor solution was considered to provide a better statistical resolution of the data. Three factors were accordingly accepted and rotated to an oblique simple structure, using the direct quartimin procedure. For comparative purposes, parallel analyses were performed in the total sample (N = 285) and the two subsamples tested in successive years (n = 101 for 1976, and n = 184 for 1977, respectively).

TABLE 1.

FACTOR MATRICES FOR TSWANA TEACHERS
(from Crawford-Nutt, 1977:32).

	1976 sample (n=101)			1977 sample (n=184)			Combined samples (N=285)		
	I	II	III	I	II	III	I	II	III
Reasoning									
Progressive Matrices	63	31	-03	50	41	-05	43	49	-06
Mental Alertness	03	74	13	66	00	25	68	-00	21
Abstract Reasoning	63	14	01	59	25	-20	44	41	-16
Figure Classification	70	18	08	36	59	-06	31	62	02
Space									
NIPR Blox	53	-09	10	17	59	-01	09	41	02
Figure Fitting	71	02	-08	29	54	-16	17	62	-14
Card Rotation	62	-04	15	-10	55	19	-09	55	20
Number									
Computation	-01	40	61	31	-09	63	36	-08	62
Number Ability	25	30	41	60	16	26	51	18	29
Addition	-09	-03	79	-01	26	70	-00	10	69
Division	05	-01	85	18	-08	76	14	-05	76
Subtract & Multiply	17	15	63	-04	10	86	01	09	79
Perceptual Speed									
Repeated Symbols	54	04	-07	-14	67	14	-15	64	11
Identical Pictures	57	-13	00	05	67	-02	-04	62	-01
Maze Tracing	51	29	-11	25	52	-09	21	54	-08
Language									
Eng. Vocabulary	11	50	23	25	52	-09	61	-04	11
Eng. Comprehension	-02	53	11	43	17	11	46	10	09
Afr. Vocabulary	06	72	03	60	11	01	63	09	01
Afr. Comprehension	-00	73	-08	60	-01	04	64	-02	00
I	-			-			-		
II	45	-		44	-		48	-	
III	27	45	-	24	16	-	34	21	-

In Table 1 it can be seen clearly how the loading pattern of tests differs across samples, calling for a different interpretation of factors in each matrix. The difficulty in applying conventional Western ability labels to the columns of loadings led Crawford-Nutt (1977) to attempt an interpretation using Carroll's (1976) then quite new approach of inferring the information-processing requirements shared by tests loading on each factor, using cognitive theory as a guide. This approach to the problem of interpretation proved more useful than the traditional psychometric view that factors should be interpreted as abilities, traits, or attributes of individuals. Yet the informed guesswork required in using Carroll's interpretative framework in the novel context of African test data merely underscored the likelihood that the factors, themselves, were not necessarily psychologically meaningful, beyond a very gross classification of task demands.

The lessons to be derived from this study are echoed in Irvine's (1979) more broadly-based conclusion that the test groupings produced in factor studies of African test performance should not be taken as evidence of abilities, or other explanatory constructs assumed to reside within individiuals. At best, factors may be pointers to underlying sources of explanation for test score variance, in terms of information-processing constructs. The meaning of these, in turn, would need to be established through independent experimentation. In the next section, attempts at uncovering information-processing variables underlying African cognitive performance are considered.

4. COGNITIVE PROCESSES IN AFRICA

4.1 General theory of decomposition

The 1970's saw the gradual displacement of psychometric

studies as the dominant approach in research on African cognition. Theoretical interest became concentrated, instead, on studies of cognitive development within a Piagetian framework (e.g., Heron, 1971; Okonji, 1971; Owoc, 1973; Omari, 1975), cognitive styles (Berry, 1971; Okonji, 1980), the relation between culture and specific skills such as those involved in visual perception (Hudson, 1960; Serpell, 1971; Steward, 1973; Deregowski, 1977) and on experiments of specific context effects on cognitive behaviour (Cole, Gay, Glick, & Sharp, 1971). All of these traditions, and especially the lastmentioned, have posed serious challenges to Western theories of cognition that emphasize constructs across cultures in the form of abilities, or other trait-like attributes of individuals (Laboratory of Comparative Human Cognition, 1982).

It has been only in the 1980's that research in Africa has addressed the specific problem of identifying information-processing components that may underlie complex cognitive performance (Verster, 1976; 1982; 1983b; 1984). This work has close affinities with developments elsewhere, in the fields of mental chronometry (Posner, 1978; Jensen, 1982), componential analysis (Hunt, 1971, 1979; Pellegrino & Glazer, 1980; Snow, 1979; Sternberg, 1977) and the study of individual differences in elementary cognitive tasks (Carroll, 1976; 1980).

A central aim in this line of research is to decompose complex task behaviour, as might be exhibited on standard psychometric tests, or in the real world, into constituent information-processing components. From a cross-cultural perspective a further aim is to check on the generalizability of such processing components, their relative importance in task performance in different cultures, and their interrelationships. This broad aim bears on one of the longest-standing hypotheses in cross-cultural cognitive research (Boas, 1911). This is that basic processes in human

cognition are universal; only the cultural contents and contexts through which they are expressed are expected to differ. To date none of the major lines of enquiry in cross-cultural cognitive research has produced compelling evidence against this hypothesis. Indeed, prominent exponents in different contemporary schools of research have recently reaffirmed confidence in this hypothesis, giving it a modern formulation (Charlesworth, 1976; Irvine, 1979; Van de Vijver & Poortinga, 1982; Laboratory of Comparative Human Cognition, 1982; Berry, 1984; Sternberg, 1984; 1985).

The idea that basic cognitive processes may turn out to be universal is a bold one, in need of careful qualification and elaboration. For this purpose it is necessary to recognise different classes of information-processing constructs, for each of which different predictions about individual and group differences can be made and each of which is expected to provide a locus for a different type of influence on cognitive processing performance.

For our purpose, at least three different classes of constructs need to be distinguished in information-processing theory. These are referred to here as executive processes, performance processes, and system limits. Executive processes are higher-order constructs thought to govern the course of information processing. In different theories or models of information processing they have been variously described as control processes (Newell, 1973), strategies (Hunt, 1971, 1979), monitor processes (Carroll, 1976), or metacomponents (Sternberg, 1977). Cattell's (1971) notion of aids, or generalized solution instruments may also be classified with executive processes, as understood here. Strictly speaking, it is a question for experimental verification whether we should speak of a single executive process (executive processor) or several. Current theorizing and empirical evidence would seem to justify the assumption of more than one executive process available to each individual. Although it

is possible that certain executive processes may be innate (Carroll, 1976), in most cases they are likely to arise through learning, whether formal or informal, and to become entrenched through culturally mediated habits in thinking. Executive processes then, which are essentially goal-directed strategies of approach in problem solving and thinking, are a major locus for cultural influences on cognitive development and performance. At least some, if not most executive processes may be culturally relative and hence not represented in all populations.

Performance processes are basic building blocks in human cognition. These are the elementary information processes (Sternberg, 1977) or mechanistic processes (Hunt & Poltrock, 1974) that are commanded, singly or in combination, by higher-order executive processes in the course of goal-directed cognitive activity. Componential analysis (e.g., Sternberg, 1977; Sternberg & Gardner, 1982; Pellegrino, Alderton, & Shute, 1984; Mumaw, Pellegrino, Kail, & Carter, 1984) has done much to clarify the kinds of performance processes we should expect to find in human cognition. Encoding, representation, comparision, perceptual integration, transformation, and response execution (e.g., movement time) are examples of commonly studied performance processes. Carroll (1980) has identified several performance processes that appear to have generality across different cognitive task paradigms in experimental psychology. For our purpose it is not necessary to postulate particular elementary cognitive performance processes. Nor is it essential to agonize over the reductionist problem of identifying the appropriate level of analysis on which to define units of behaviour as elemental. Given the current state of theorizing about cognitive behaviour, the somewhat arbitrary level of analysis favoured by most cognitive scientists seems as good a place to start as any.

The prediction that basic performance processes may turn out

to be universal, in no way obviates the likelihood of individual and group differences in the efficiency of their execution. Differences in performance efficiency, in terms of speed, accuracy, or consistency may arise as a consequence of two types of influence. First, there may be differential limits to the information-processing subsystem in which a particular performance process is executed. This refers to the third class of information-processing construct noted above, namely system limits.

Limits to the cognitive system, with regard to storage capacity, or transmission speed, consistency, or error proneness, are likely to be set by limits on the capacity of the supporting biological system. In this case individual or group differences in efficiency of performance process execution would be attributable to differences in the system 'hardware' (anatomy and physiology). Individual and group differences in system limits are therefore likely to be an important locus of biological influences on cognition. Genetic factors may be an important determinant of such biological influences. But environmental factors may also affect system limits, and hence influence performance process efficiency as well. Environmental factors would manifest their effects at a physical, constitutional level. Among the non-genetic factors expected to operate at this level are health and disease, pre-and post-natal stimulation, nutrition and malnourishment, obstetric and other brain traumas, ageing, life-style induced chronic fatigue, drug and alcohol abuse, etc. Hence system limit effects on performance process efficiency may be due to either genetic factors, or environmentally determined constitutional factors. We have no means available for separating genetic from constitutional effects on limits to the cognitive system, and hence on cognitive process performance.

On the other hand there is a different type of influence on performance process efficiency that does not operate through

the agency of 'hardware' system limits. This influence is essentially environmental in origin and has to do with the 'software' for information processing. I refer here to influences on cognitive development mediated by socialization, learning, and experience. In the unique developmental history of each individual, particular performance processes may be differentially exercised, giving rise to individual differences in efficiency of execution. Similarly, group differences in efficiency with regard to particular performance processes may come about as a result of culturally or socially mediated patterns of emphasis in the frequency or generality of their use. In particular, this is likely to occur when culturally relative, or culturally favoured executive processes make differential demands, in different groups, on the universally available repertoire of performance processes.

To summarise the argument, three classes of constructs, taken from information-processing theory, have been identified as useful in explicating the hypothesis that there may be universal processes underlying complex performance in human cognition (see Figure 1). It is performance processes that are considered to be represented universally, as the basic building blocks of cognitive behaviour. Individual and group differences may arise in the efficiency of execution of these performance processes, in terms of speed, error proneness, or variability. Such differences may be due to either genetic or environmental influences. Genetic effects will be manifest in the form of system limits in the biological 'hardware' for cognitive performance. Environmental factors may influence system limits as well, via the physical constitution, or they may operate through socialization and learning to influence the development of executive processes, that in turn govern the deployment of performance processes.

EXECUTIVE PROCESSES

(strategies, controls, metacomponents)

locus of culturally relative differences in cognition

IDs and group differences due to socialization, learning, cultural habits, ecological press

PERFORMANCE PROCESSES

(mechanistic, basic, elementary processes)

universals in human cognition

IDs and group differences in efficiency (speed, error, variability) due to biological limits and cultural emphasis

SYSTEM LIMITS

(capacity, structure, biological limits)

system architecture universal

IDs and group differences in system limits due to genetic and constitutional factors

Figure 1. Classes of information processing constructs.

Note that the above formulation assumes no specific theory or model of information processing. Nor has any attempt been made to explain what is meant by the cognitive system. For the purpose of the present discussion, it is considered sufficient to assume a generic formulation of information processing, in which notions about the structural architecture of the cognitive system are left implicit. The above formulation is based loosely on the tradition of black-box-in-the-head models of information processing, developed in the work of Atkinson & Shiffrin (1968), Newell (1973), Newell & Simon (1976), Hunt (1971; 1976; 1978; 1979), Carroll (1976; 1980), Sternberg (1977; 1980), Sternberg & Gardner (1982), and others.

4.2 Subsystems across subcultures

In the remainder of this section, I would like to illustrate the application of information-processing concepts to the problem of identifying meaningful constructs in cognitive behaviour, across cultures, in the African context. In the absence of knowledge about other empirical research in this vein, I will draw exclusively on work of my own, carried out in South Africa. Reports on empirical details of this work have been presented elsewhere and need not be repeated here (Verster, 1983b, 1984). In this report I merely wish to focus on the possible implications of some of the findings with regard to notions about culturally relative and universal information-processing constructs, as discussed above.

My empirical research was conducted in separate samples of high school educated white males, white females, and black males, drawn to represent a wide cross-section of economically active adults in South Africa and its satellite states. The samples differed considerably with regard to cultural, social class, and other life-style variables. Differences between the two major ethnic subcultures, in particular, were pronounced, with a large proportion of blacks coming from

rural backgrounds, while most whites were of urban origin.

Despite these differences, compelling evidence was found for the functional equivalence of information-processing measures across samples. The measures were provided by performance latency scores on a battery of specially designed elementary cognitive tasks, all of which were presented by computer. The battery included twelve tasks, with three different tasks designed to assess cognitive processes in each of four theoretically postulated information-processing subsystems. These included a psychomotor subsystem, a sensory subsystem, a perceptual subsystem, and a conceptual subsystem. Each of the three tasks associated with each information-processing subsystem was intended to engage a different set of specific performance processes, as operationalized in the particular paradigm for task construction. Certain core performance processes were intended to be generic to the three tasks associated with a particular subsystem. Examples of performance processes associated with each theoretically postulated information-processing subsystem are provided in Figure 2.

Subsystem	Performance Processes		
sensory	attend	apprehend	encode
perceptual	compare	integrate	transform
conceptual	form concept	infer rule	transfer relation
psychomotor	respond	control speed	control sequence

Figure 2. Information-processing subsystems.

The performance processes suggested for each information-processing subsystem in Figure 2 are merely illustrative. The processing constructs suggested by the descriptive labels are as yet inadequately defined, but are based on commonly studied constructs in the literature of experimental cognitive psychology (e.g., Carroll, 1980), as described by me elsewhere (Verster, 1983b, 1984). The outline in Figure 2 provides no indication of dynamic aspects of information processing, nor is it intended to represent the architecture of the cognitive system. It suggests only that the cognitive system is structured in terms of a number of conceptually and functionally differentiated subsystems.

Analysis of the empirical relationships among measures of performance latency on the battery of twelve cognitive tasks, using confirmatory factor analysis procedures (Browne, 1982) provided strong support for the construct identity of the four postulated information-processing subsystems, in each of the three samples studied (Verster, 1984). Although the study design did not enable an examination of the construct identity of particular performance processes assumed to be assessed by each task, the finding of a common, differentiated structure of information-processing subsystems, interpretable in terms of the conceptual framework proposed for the research, is reassuring. It can be interpreted as a step towards the identification of cross-culturally universal performance processes in human cognition.

Further evidence of the cross-cultural generalizability of construct meaning of the cognitive performance measures was provided in independent analyses of discriminant and convergent validity. For this purpose independent criterion measures were used representing psychometric intelligence, information-processing tempo (natural reading rate), temperamental factors associated with quickness versus inertia of response, or reflection/impulsivity, and event-related potentials in the electrical activity of the brain (visual

evoked potentials). In all analyses involving these variables, remarkably similar patterns of relationship were found across samples, suggesting equivalence of meaning for the measures of performance process constructs (Verster, 1982, 1984).

4.3 The relativity of executives

The finding that black subjects showed a greater tendency than whites to trade off speed in favour of accuracy on the computerized tasks, especially those associated with the conceptual subsystem (Verster, 1984) seemed consistent with the expectation that culturally relative differences might be found in the use of executive processes. Further support for this hypothesis came from an analysis of attitudes to the computerized testing programme. All subjects who took the battery were invited to complete a debriefing attitude questionnaire designed to assess reactions to the tasks, what they were thought to measure, the quality of instructions, and specific features of the computer-based testing procedure, including software as well as hardware aspects. Overall, reactions were very positive in all three samples. Yet one of the task format features rated as significantly more useful by blacks than by whites was the availability of immediate right/wrong feedback following every response (Verster, 1982). The greater importance attached by blacks to such feedback suggests that this group of subjects might have favoured the use of qualitatively different executive processes, or problem-solving strategies compared to whites.

In an as yet unpublished analysis based on data from the same study, an attempt was made to find further evidence of

culturally relative differences in the use of executive processes in task performance. While certain executive processes were assumed to be necessary in performance on all twelve cognitive tasks in the battery (e.g., Carroll's (1980) monitor process (MONITR)), the three tasks designed to assess information processing in the conceptual subsystem were considered to depend most heavily on the use of appropriate, task-specific executive processes. Paradigms for these three tasks were designed, respectively, to assess processes involved in concept formation, rule inference, and transfer of relations. Each task comprised a set of either 20 or 25 items (problems), each item posing a unique, non-trivially different problem based on the generic task paradigm. A pictorial odd-man-out paradigm was used for the concept formation task, a figural analogies paradigm was used for the relation transfer task, and a novel paradigm, somewhat reminiscent of the item format in the D48 Dominoes test (Black, 1962) was used for the rule inference task. Detailed descriptions of the three task paradigms are given in Verster (1982). To examine evidence for cultural differences in the use of executive processes on these tasks, exploratory factor analyses were performed in each sample on the intercorrelations among item-response latencies on the relevant set of 70 items. If the analyses produced different factor patterns in the two main ethnic-cultural groups (blacks and whites) this might indicate differences in strategies for item-task solution, or use of different higher-order executive and control processes (metacomponents) in item-task performance.

In the event, results of the factor analysis produced no evidence for the presence of culturally relative differences in executive process functioning. Separate analyses in the two major groups of interest (white males and females combined, and black males) produced highly congruent structures, with four factors needed to explain the item-response latency variance in each case. The pattern of

item loadings on the factors allowed a common interpretation in the two ethnic-cultural groups. In both analyses, one factor (designated **factor a)** was defined chiefly by performance latency variance on elementary figural analogy items, while advanced figural analogy problems loaded mainly on another factor (designated **factor b).** A third factor **(factor c)** was defined mainly by items from the concept formation task, plus elementary items from the rule inference task. The final factor **(factor d)** was defined mainly by advanced rule inference problems. The factors produced in these analyses provide little grounds for inferring culturally relative differences in use of executive processes in the solution of problems requiring conceptual strategies in thinking. Rather, the results would seem to offer further evidence of the cross-cultural comparability of basic performance processes in cognition.

A useful framework for interpreting the results of the above analyses is shown in Figure 3.

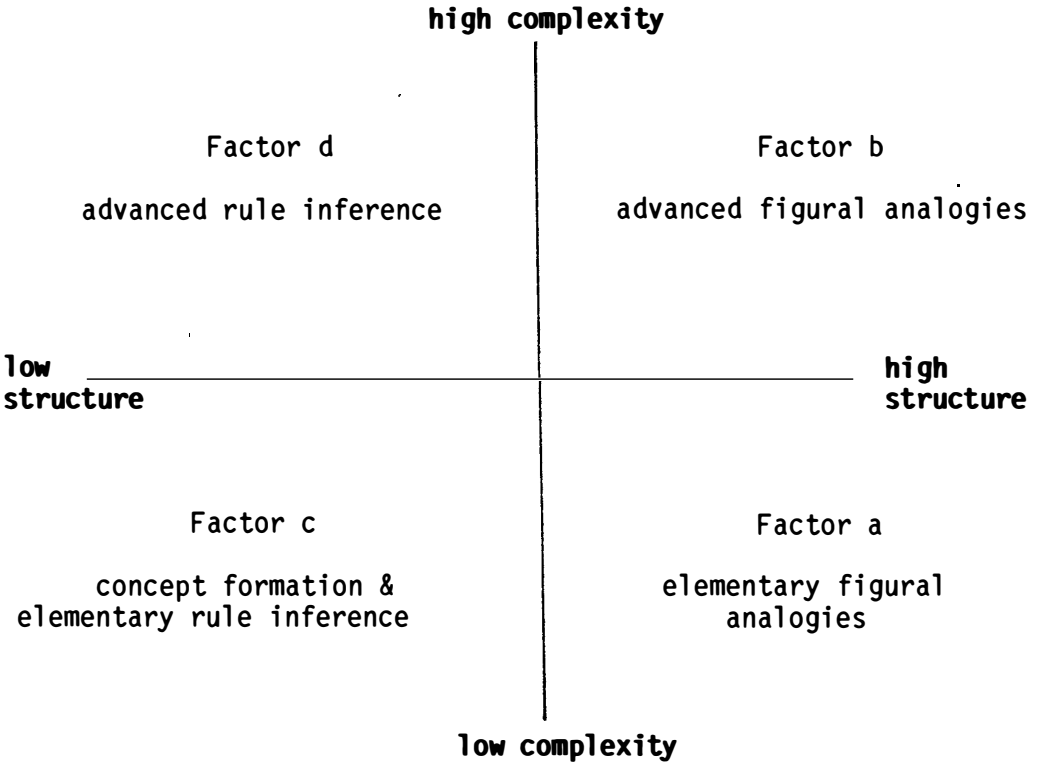

Figure 3. Frame for item-solution latency factors on conceptual tasks.

In this figure the relationships among the four factors are indicated with reference to a two-dimensional frame. This is defined by a vertical axis of high to low complexity, understood as the amount of information represented in an item, and a horizontal axis of high to low structure, understood as the availability of explicit cues for the internal representation of task information and choice of strategy for task solution. The framework in Figure 3 implies that elementary figural analogy problems can be characterized as high in structure and low in complexity. More advanced figural analogies are comparably high in structure, but are of higher complexity. Items from the concept formation task and elementary items from the rule inference task have low structure and low complexity, while the more advanced rule inference problems have low structure and high complexity.

The frame in Figure 3 appears to be a useful heuristic device for aiding in the interpretation of the four factors that account for variance in item-response latencies on the 70 conceptual task items. It suggests that task attributes such as structure and complexity are important determinants of individual differences in speed of cognitive processing. The congruence of factor structures across samples provides further evidence of the cross-cultural generalizability of constructs when information-processing measures serve as dependent variables. Detailed appraisal of the significance of these findings will have to await publication in full of the empirical research involved.

5. INDIGENOUS COGNITIVE COMPETENCE IN AFRICA

5.1 Advancing on reality

The information-processing approach to the study of universal and culturally relative aspects of cognition offers important advantages over traditional psychometric research on

intelligence and ability constructs. In particular, it enables the testing of more precise hypotheses about the loci and causes of individual and group differences in cognitive behaviour. This is because the approach is rooted in a theory of cognition, whereas psychometrics is essentially empirical and pragmatic. But information-processing theory, in its present state of development, cannot claim to be any less ethnocentric than the applied technology of psychometric testing. It is a product of a particular intellectual tradition, based almost exclusively within the narrow confines of the university laboratory. The particular task paradigms studied by information-processing theorists, thus far, have not been shown to have ecological validity (Berry, 1980) in the wider context of everday life in the surrounding culture, let alone in remote cultures. The universal constructs assumed in information-processing models therefore would have to be considered imposed etics, to use Berry's (1969) terminology, with reference to everyday life beyond the university campus, let alone in entirely foreign cultures, such as in Africa.

For information-processing constructs to be accepted as true cross-cultural universals, derived etics in Berry's (1969) terms, it would be necessary to demonstrate their ecological validity and equivalence of meaning across the full range of human cultures and behavioural contexts. In practice this implies a research programme of unrealizable scope (some might say unrealistic intent, e.g., Laboratory of Comparative Human Cognition, 1982). But it may be defended as a useful ideal for systematic research, within the type of framework proposed by Berry (1980). A useful departure point for such research would be to extend the limited range of task paradigms currently available to cognitive psychologists, by adding new tasks taken from settings for cognitive behaviour in the real world. The search for appropriate, ecologically valid task paradigms of this nature involves the study of cognition in its natural, or indigenous context. In the following sections

attention will be focussed on studies of indigenous cognition in African contexts, with a view to identifying possible criteria and settings for ecologically relevant cognitive performance that could be used in constructing new task paradigms to advance cross-cultural information-processing research.

5.2 The indigene reveals the meaning of his tricks

Although research into cognitive performance in everyday, real-world situations is as yet an underdeveloped field, several methods have been introduced to aid in this type of enquiry. One so simple and obvious that it has escaped attention until quite recently, is to ask people directly about what they do, why they do it, and what kinds of skills and qualities they regard as important in doing their thing. The aim in this type of research is to gain an appreciation of the conceptions of ordinary people about the nature of their competencies and the constructs they think are embodied, in contrast to studying conceptions of cognitive competence held by psychologists. Research in this vein has only recently found its way into mainstream intelligence research in North America (e.g., Neisser, 1978, Sternberg, Conway, Ketron, & Bernstein, 1981; Berg & Sternberg, 1985). It has a much longer history in cross-cultural cognitive research, perhaps originating in Africa (cf. Berry, 1984). Its purpose, as put by Wober (1969) is to examine how indigenous peoples perform their own "tricks", as opposed to perpetuating centri-cultural studies of how well they are able to perform on our "tricks".

According to Berry (1984), credit for the first empirical study of folk, or indigenous conceptions of intelligence should be given to Irvine (1966, 1969a, b, 1970), for his work on Shona proverbs. The general idea for this type of study has a history dating at least to the writings of Wundt, Boas, and Rivers. Irvine's analysis of the sayings and beliefs of the people of Mashonaland (part of present-day Zimbabwe) led

him to conclude that intelligent acts, for the Mashonas, were to be understood in the context of a world-view entirely different to that in the West. Conformity, both in personal relationships and in relation to the spirit-world served as a criterion for judging the goodness ("intelligence") of behaviour. The emphasis on relationships, both with the spiritual force of the living and with the ancestral spirits of dead kin, implied that cognitive acts had no meaning outside of an affective climate. This led to a recognition that appropriate tests of Shona intelligence for village life would need to accommodate highly valued socio-emotional components (Irvine, 1970) and that measures of these components might be little related to the intellectual requirements of schooling, which are assessed by conventional intelligence tests.

In a literature study of the values and goals underpinning traditional education in Uganda, Wober (1974) noted a strong emphasis on the development of abilities intended to subserve the maintenance of the traditional culture, rather than to challenge it. This finding agreed well with Irvine's (1969a) observation of the centrality of conformity as a value among the Shona. In his empirical research among the Baganda and neighboring tribes, Wober (1974) attempted to operationalize the objective of studying how well members of another culture perform their own "tricks". His point of departure was to obtain semantic differential ratings of the connotative meaning of a local gloss (conceptually equivalent translation in the local language) for the English term, intelligence. Working with different samples in Uganda, representing different urban-rural, educational, and tribal backgrounds, Wober found both similarities and differences in conceptions about the gloss used for intelligence. Differences proved to be greater between groups of different education within the same tribe, than between groups of similar education in different, through interacting tribal cultures.

Wober's results revealed a general conception of intelligence as slow, careful, active, straightforward, and sane. It was not seen to be inculcated through magic, or by 'medicine', although it was regarded as pertaining to the soul (mind) rather than the body (matter). Interestingly, the more educated, Western acculturated subjects (teachers) were less inclined to emphasize slowness as a central component in conceptions about intelligence. Wober's villagers also associated intelligence with happy, friendly, hot, and public, as opposed to unhappy, unfriendly, cold, and secretive. The clear impression Wober took from this is that intelligence was not viewed as inward-looking and introverted (metacognitive, we might say in today's jargon), but rather as extraverted, in a public-spirited sense. This finding echoes Irvine's (1970) observation of the importance of social relationships as a context for intelligent behaviour among the Shona.

More recent research along similar lines, in different sub-Saharan societies has tended to confirm the pattern of results produced by Irvine and Wober (e.g., Serpell, 1974, 1977; Putnam & Kilbride, 1980; Super, 1983; Kingsley, 1985). All of these studies reveal a conception of intelligence which emphasizes social competence and conforming, obedient behaviour, within a framework of personal relationships with the living as well as the spirits of the dead. Education and acculturation to Western norms exert a strong influence on indigenous conceptions of competence, particularly with regard to a shift in the relative importance of quickness versus slowness/carefulness as a criterion for intelligent performance.

The general pattern of results revealed through these studies is consistent with recent South African research on values (Cloete, 1981; Godsell, 1983) and can be reconciled with studies of African philosophy (Jahn, 1961; Ruch & Anyanwe, 1981), which testify to the generality of the African world-view across sub-Saharan societies. The Nguni term

ubuntu, and its Sotho equivalent botho (Godsell, 1983) would seem to represent an important value of high centrality in traditional African value systems, that might account for the consistency observed in indigenous conceptions of competence. There is no readily available term in English with which to express this value, although humaneness captures some of its meaning (Godsell, 1983). The philosophical basis of this value is well reflected in the following aphorism of African being, brought to my attention by a colleague (Ngwane, n.d.): "I am because we are, and we are because I am".

5.3 Knowing the native's craft

Studies in indigenous conceptions of cognitive competence, as cited above, provide a useful methodological framework for values and goals of a society that would need to be accommodated in new tasks and measures of cognitive performance, if these are to achieve ecological validity. But asking members of a society for their conceptions of the nature of competence provides no information about the actual performance capabilities of individuals. We only learn what the criteria are for good ("intelligent") performance in that society. Some researchers have gone a step further, in asking members of the target culture to rate, or rank their fellows (peers, children, etc.) on the dimensions of competence they regard as important (e.g., Serpell, 1974; Klein, Freeman, & Millet, 1973; Reuning & Wortley, 1973; Church, Katigbak, & Almirio-Velazco, 1985). This provides a crude scale of individual differences in indigenous competence. Such scales may, or may not correlate with Western measures of "intelligence", which chiefly emphasize scholastic skills and aptitudes. Indigenous ratings are no different, as a method, to the peer ratings, teacher ratings, or supervisor ratings frequently used in applied psychology. Such ratings are subject to various forms of error (Tinsley & Weiss, 1975) and tell us nothing about real behaviour. They are therefore of no use in studying the information-processing components of

indigenous cognition, in natural settings.

To find appropriate tasks in which to study behaviour in its natural context, we need to take cognisance of the everyday, culturally defined activities of the members of a society. We need to know of their crafts, arts, domestic chores, and economic pursuits. The meticulous studies in anthropological cognition of Cole and associates (Gay & Cole, 1967; Cole, Gay, Glick, & Sharp, 1971; Cole & Scribner, 1973; Scribner & Cole, 1978) have become standard references for examples of how tasks for experimentation can be located within culturally organized experience. The aim in these studies is to examine intra-cultural, context-specific effects on cognitive behaviour. Followers of this tradition are advocates of the context-specific approach in culture and cognition research (Laboratory for Comparative Human Cognition, 1972). They do not concern themselves with inter-cultural comparisons, although the cross-cultural universality of certain basic cognitive processes is explicitly assumed (e.g., Cole, et al., 1971:214; Cole & Scribner, 1974:193) and it is acknowledged that certain conditional comparisons of cognitive performance are possible across cultures (cf. Sternberg, 1984).

Price-Williams (1975) has outlined a useful framework for deriving experimental tasks for use in inter-cultural comparative studies, based on knowledge about the indigenous crafts practiced by natives within different ecocultural contexts. His graduating steps design, as illustrated in Figure 4, suggests how one might construct tasks in a series of "graduating steps", from the naturally occuring setting, to the standard experiment (p. 46).

Step	Task	Material	Context
Zero Level	- all familiar : the usual situation -		
One	Familiar	Unfamiliar	Familiar
Two	Familiar	Familiar	Unfamiliar
Three	Familiar	Unfamiliar	Unfamiliar
Four	Unfamiliar	Unfamiliar	Unfamiliar

Figure 4. Graduating steps design.
(Price-Williams, 1975:46).

The template in Figure 4 shows how the concept of familiarity is systematically varied, with reference to three experimental attributes : the task demands, materials used, and context of behaviour. The two extreme steps in this framework amount to polar opposites on a hypothetical emic-etic continuum (Price-Williams, 1975). Applying the framework systematically in cross-cultural research, it becomes possible to derive a set of task paradigms which enable functionally equivalent measurement of those cognitive processes that can be traced successfully, within and across cultures, over the full range of graduated steps in experimentation. Such processes would satisfy requirements for labelling as pan-cultural universals, or derived etics. A simple thought-experiment, in which children in different cultures are confronted with the "Zero Level" task of choosing from an array of irregularly shaped candy pieces (or other valued consumables) the one that maximizes satisfaction, should illustrate how the graduated steps design might be employed to derive etic cognitive processes essential to quick and accurate three-dimensional space perception!

5.4 Forces from beyond the spirit-world

Studies considered in the preceding sections have treated mainly of traditional African cultures. The deliberate intention has been to contrast contexts for behaviour in these cultures with those assumed in conventional, Western-orientated cognitive research. The effect achieved, hopefully, has been to underscore the limitations and ethnocentric bias inherent in much contemporary Western theorizing and methodology in cognitive psychology. In the traditional societies of sub-Saharan Africa, thought and action are governed by a pervasive consciousness of the spiritual forces that give meaning and individuality to both the living and the dead. According to traditional African philosophy (Ruch & Anyanwu, 1981) the pursuit of harmony and solidarity among members of the group, through a personal

relationship of subordination to the spiritual life-forces that operate through beings (living individuals and deceased ancestors), is the prime motivation for behaviour.

But in many parts of Africa, the traditional beliefs and ways have been increasingly eroded and displaced by forces of a different kind, that originate beyond the spirit-world of tribal life. These are the pervasive forces of colonial imperialism, industrialization, urbanization, education, and Western acculturation. Whether these should be viewed collectively as the forces of modernization, or development, is a value judgement we need not make. The disruption of traditional life has been nowhere more harshly experienced than in South Africa, where the force of political domination, backed by an ideology of racial consciousness, has become the antithesis of the traditional core value, humaneness (ubuntu, botho).

An immense challenge faces cognitive research in the contemporary Southern African situation, where increasing numbers of blacks, especially young people, find themselves in depersonalized acculturation modes, akin to those described by Berry (1974) as marginality, or deculturation. The forces operating on communities to produce such disaffection, have alienated individuals from the cultural identity of their forebears. Yet they are given little cause to seek positive relations with those they regard as oppressors. By statute they can be neither assimilated nor fully integrated into the dominant, numerically threatened white society. In the schools of contemporary black townships, where teaching is disrupted and buildings are destroyed in rising defiance against a system of imposed education that is rejected, the call is for "people's education". Can this political slogan be given constructive meaning through sensitive research in which indigenous needs become the basis for deriving new values and goals for education and intellectual development? Elsewhere, I have argued (Verster, 1983c) that this is the

scope of the challenge that must be faced in formulating future-orientated education and research policies for South Africa.

6. PROSPECTUS FOR FUTURE RESEARCH

A benchmark volume of readings from North America, published a decade ago (Resnick, 1976) revealed a clear consensus among authorities on the nature of human intellect, that constructs such as intelligence, or its constituent abilities as operationalized in standard psychometric tests, have outlived their scientific usefulness. In similar vein, McClelland (1973) has argued that we should rid our vocabularly in scientific psychology of such terms as intelligence, or specific ability labels (reasoning ability, verbal ability, number ability, spatial abilities, etc). We need to accept that there are no real-world referents for these terms : the constructs ("abilities") they are supposed to signify do not exist in nature.

In contrast, the kinds of constructs postulated in information-processing theory at least have the potential to represent natural phenomena. Performance processes such as information encoding, mental representation of an external object, inference of an abstract rule, or psychomotor response execution are potentially real behaviours, just as walking, running, or jumping are real. These are all empirically verifiable elements of behaviour; things that individuals and groups can do. They are conceptually and functionally differentiated components of complex, real-world behaviour. Hence information-processing theory provides a foundation for a science of cognitive behaviour. Contemporary psychometric practice can have no similar claim to a basis in science. At best, psychometrics represents a sophisticated technology, much as alchemy did in its day. In the wrong hands, it can become a scientifically indefensible, morally reprehensible

means of social manipulation in the service of ideology.

The cognitive research that I believe is needed in future programmes should be based in general information-processing theory. The generic classes of constructs taken from this body of theory, notably performance processes, executive processes, and system limits, provide a value-free structural framework within which to study cognitive behaviour, within and across cultures. The specific content, or character of constructs that might be identified within each of these classes has purposely been left unspecified. Only through programmatic empirical research can we know the nature of these constructs.

Such research would need to begin within particular societal, or ecocultural contexts, using indigenous conceptions of the criteria of competence and everyday knowledge and task skills as the starting points for experimentation and measurement. Using the 'graduating steps design' of Price-Williams (1975) as a guiding device, task attributes such as structure and complexity of performance demands, materials, and context could be varied systematically with a view to separating context-specific or culturally relative processes from high transfer, general-purpose processes. Progressing to inter-cultural comparisons, Berry's (1984) framework for relating indigenous (emic) and cross-cultural (derived etic) constructs in cognitive functioning, suitably modified to replace the psychometric performance categories with those from process theory, as illustrated in Figure 5, then becomes a useful heuristic scheme within which to pursue the complementary goals of indigenous and universal cognitive psychology.

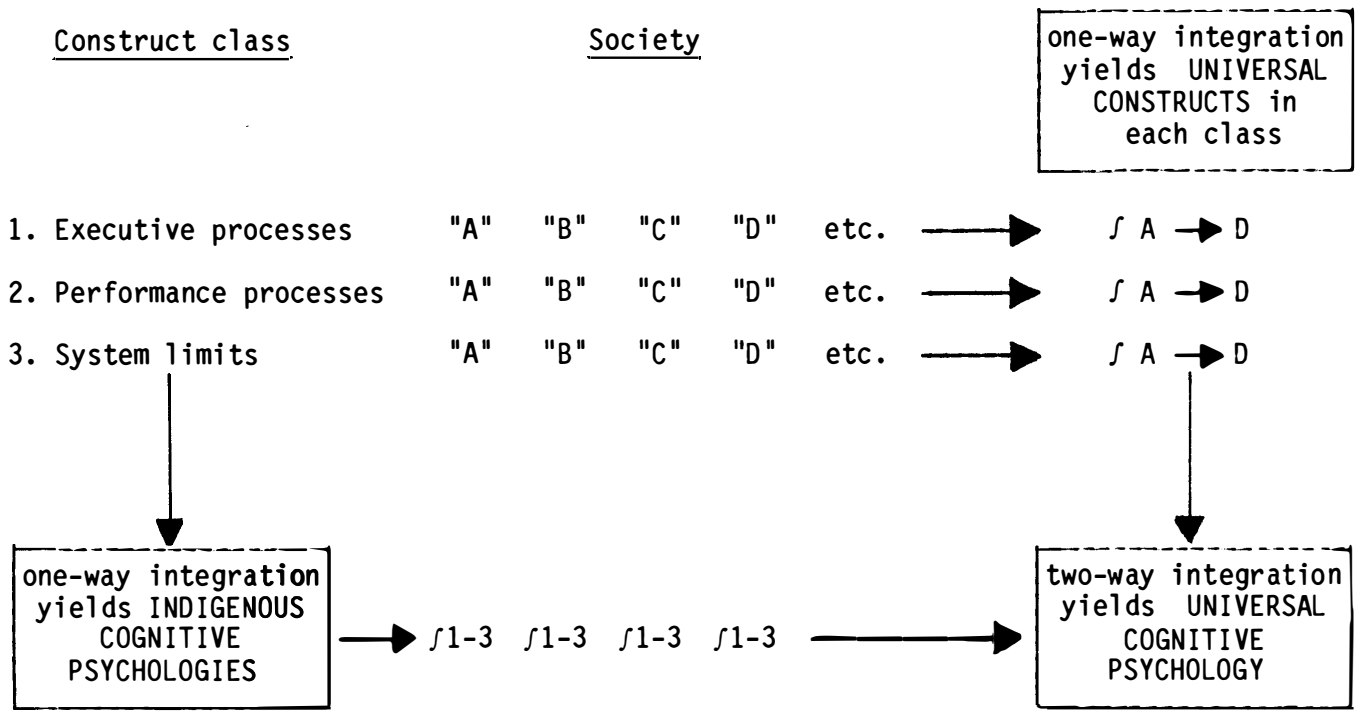

Figure 5. Framework for pursuing indigenous and universal cognitive psychology. (Adapted from Berry, 1984:356).

Adoption of this prospectus as a guideline for research in a particular societal context, such as in Southern Africa, demands sensitivity to local circumstances and needs. The Southern African situation is an exceedingly complex one, characterized not only by cultural pluralism, but by rapid sociocultural transition and change, implying multilateral influence and conflict. The development of appropriate cognitive competencies for survival in and of this beleaguered society is a major priority for research and related education policy. The goals and values towards which such development should be directed, are themselves issues for negotiation. Research in the spirit of the prospectus here outlined could play a vital role in achieving consensus.

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