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CULTURALLY INVARIANT PARAMETERS OF COGNITIVE FUNCTIONING

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The two research traditions indicated with the terms indigenous cognition and information processing models are much further apart than suggested by the simple conjunction "and" through which they are related in the title of this workshop. Studies of indigenous cognition tend to be focussed on products of human cognitive functioning, with a preference for those not readily found in Western cultures. The term information processing refers to psychological functions and mechanisms supposedly mediating between stimulus input and subject's responses.

In the former tradition differences between cultural groups are emphasised. Much evidence is available to the effect that the performance on various intellectual tasks is culture bound: In the Pacific region there are incredibly good navigators (Gladwin, 1970); and the Bushmen have exceptional skills in the tracking of game (Silberbauer, 1965). It can even be argued that the ability of Western educated subjects to readily solve simple syllogisms (when compared to subjects in populations without formal schooling) is another example of indigenous cognition. This implies that the term indigenous is not restricted to non-technological societies.

Even though the relation between culture and cognition is often recognized, a major problem in the study of indigenous cognition remains: the lack of psychological theories which integrate the evidence.

Integration is not a major issue in an information processing approach where the cross-cultural identity of key concepts, frequently referring to structural properties like forgetting rates and short term memory load, is typically postulated in the model. However, another problem occurs here, namely the interpretation of performance differences in terms of a theoretical model. Even for tasks with cognitively simple stimuli this is problematic, since in the actual performance of a task other variables than those postulated in the model often play a role and lead to cross-cultural differences.

In this chapter we shall elaborate on the contrast between universal processes in cognition and culture specific manifestations. The ultimate goal

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is to contribute to bridging the gap between the two research traditions. Bridges are built by starting from the banks and working towards the middle of the gap to be spanned. One cannot start in the middle. We would argue that high-level theories, such as the Triarchic Theory of Intelligence by Sternberg (1984) are premature, because proper foundations are still lacking. Despite (or because of?) the fact that the Dutch have a long experience with building on waterlogged surfaces with a low carrying capacity, we have betrayed our cultural heritage and started our construction efforts from the more rock-like structures of information processing, rather than from the bank with the soft soil of cultural products. This preference is reflected in the title of the paper.

Cultural Products of Cognition

The highlights of research on indigenous cognition are observations showing that unschooled and "primitive" people can do things which are not readily understood and achieved by Westerners. As such it has helped to shake prevailing notions about the intellectual superiority of people in the industrialised world. However, special feats as mentioned in the introduction are fairly rare and the main finding lies in the remarkable discrepancies in performance across tasks (compared to Western scores) found in studies in which a variety of such tasks is administered. An example are the discrepancies found by Reuning and his associates in their research among the Bushmen (Reuning and Wortley, 1973). Their subjects obtained top scores on the Squares Detection Test, where squares have to be formed by connecting quadruples of dots in an array in which there is no apparent order at first sight. In contrast, an Embedded Figures Test presented great difficulties to the Bushmen, even though from the correct solution of some extremely easy items it could be concluded that the task was understood. The possibility that the low scores of the Bushmen are due to some method artefact is reinforced by recent findings from Richter and Griesel (personal communication).

Two traditions can be distinguished in the analysis of indigenous cognitive performance, as it emerges from observations of local behavior and scores on ability tests. In the first, emphasis is placed on the cultural context in which a particular behaviour occurs. Perhaps the most clear-cut empirical study has been reported by Serpell (1979). His subjects were children from Zambia and Great Britain who were asked to reproduce certain patterns by using pencil and paper as one medium, and flexible iron wire as another medium of expression. Serpell chose these two media because English children frequently practice drawing, but rarely use wire for the purpose of representation, while wire modelling is a popular pastime for

Zambian children. The Zambian children did better in wire modelling than their English age mates, but gained lower scores for their drawings.

The most extensive body of research in the contextual tradition we owe to Cole and his colleagues. We shall assume that their studies of cognition among the Kpelle (Cole, Gay, Glick and Sharp, 1971), and literacy as found among the Vai (Cole and Scribner, 1981), need no further mentioning here.

Serpell (1985) very explicitly points to the immediate influence of the environment. He objects to the suggestion by Jahoda (1980, p. 129), "that behaviour is a joint function of individual psychological processes and eco-culture," because a reference to the concrete situation is absent. In the school of Cole, the thesis of specificity and contextualism may not be upheld so strongly, but any difference with Serpell appears to be a matter of degree rather than of principle.

In the contextualist outlook, generalisation of results is limited to narrow classes of situations, or to domains with a similar task structure as experienced by the subject. Any possible explanation of cultural differences in performance on tasks which require different solution strategies falls, outside the scope of a contextual explanation. There is a minimal recognition of cultural factors which affect the cognitive apparatus of the person, or of differences between cultural groups in cognitive strategies which are applicable over a wide domain of situations.

The contextual orientation has effectively undermined the notion that broad psychological dispositions and strategies ranging over the entire cognitive domain, or at least major parts thereof, are the antecedents of cross-cultural differences as measured by standard intelligence tests. However, culture (with or without the situation concept as an intermediate step) is an unspecified variable. Explanatory concepts are invoked, but at a high level of abstraction; e.g., adaptation to the environment. We shall come back to this point later on. Here it may be noted that virtually no state of affairs is incompatible with a contextual explanation. It can be argued that Serpell, in his study, made a testable prediction, but the *a priori* probability of this being confirmed is very high as soon as large cultural differences in overall intelligence can be ruled out. Thus, the explanatory value of such context variables is marginal. The question is how to proceed once the empirical reality of contextual influences has been accepted. As far as we can see reference to situational task demands is necessary, but not enough. There is a need for theories explaining the effects of context variables on the structural and functional properties of cognitive processes in the individual.

The second tradition is characterised by the search for universal characteristics underlying the diversity in performance. Taking up the metaphor from the introduction, this tradition amounts to driving piles in the

soft soil of the observables to find the firm ground of shared psychological functions. There is a fairly long tradition of cross-cultural factor analytic research on the structural properties of intelligence. Evidence of some early studies allegedly pointed to cognitive simplicity, particularly of Bantu speaking populations (e.g., Murray, 1956). The interpretation was challenged on analytic as well as empirical grounds (e.g., Grant and Schepers, 1969). However, this does not mean that structural identity has been established.

A major review of the available evidence from factor-analytic studies has been reported by Irvine (1979). He included 91 published factor analyses based on cross-cultural data. More than 60 different factor descriptions emerged, which he classified into 6 categories. According to Irvine, the results show an increase in factorial complexity with higher levels of education. He also argues that there are interrelationships between factors which suggest a higher-order cohesiveness which is identified with information processing capacity. The fact that correlations are far from perfect is attributed to "task-related requirements and also strategies for coping with these that are not so much limiting as differentiating" (cf. Irvine, 1979, p. 316).

Although we realise that a brief reference cannot do justice to many finer points, our objection is that the similarities which Irvine mentioned, do not justify claims about structural identity. The jump to information processing is too sudden and too large. Irvine listed the presence or absence of a factor in his 6 factor categories for 63 analyses. He based his listing on the information of the original authors and his own impressions, but had no objective criteria for his classification (i.e., psychometric). There was no factor recorded in 175 out of the possible 378 cases, that is 46%. Of course, the number and variety of tests in the original studies is the most likely reason for the absence of a factor in many instances. However, this does not mean that one may assume that each absent factor would have been present in a more extended battery.

In addition, we would like to raise a methodological point. It has been repeatedly stressed in the cross-cultural literature that any comparison requires a standard of comparison which is invariant across the groups to be compared (e.g., Eckensberger, 1979). In exploratory factor analysis, the first goal is to establish whether or not factors are sufficiently similar to accept them as referring to identical psychological characteristics. Unfortunately, more restraint than sometimes practiced is needed (cf. Bijnen, van der Net and Poortinga, 1986). There is still another problem, namely the interpretation of quantitative differences on scales, which measure corresponding factors. As we have argued before (Poortinga, 1975, 1983), similarity of correlation coefficients (the basis for factor

identity) is an insufficient condition for unbiased comparison of performance levels.

In summary, analyses of indigenous cognitive products, including standard Western ability tests, have shown that large contextual, culture-specific effects can be traced in the behavioural repertoire of subjects. There is empirical evidence that the structure of intelligence, as established by factor analysis, reveals similarities across all cultures, but identical scales which allow for a precise comparison have not been derived and, we presume, cannot be derived from an analysis focussing on behavioural products.

Invariance of Process

When one starts to build the bridge between indigenous cognition and information processing from the other end, cultural invariance can be introduced as a theoretical postulate. Empirical research is then needed to establish the validity of the implied theoretical claim. We shall distinguish postulates at three levels, conceptual, theoretical and, in the next section, the operational level.

At the conceptual level one finds abstract notions such as intelligence, adaptation and the capacity to learn from experience. We have nothing against this type of notion in scientific communication. In fact, the term cognitive process is used here in this sense. However, a far more precise meaning is required in explanatory investigations.

Let us go back to the concept of adaptation. Biologists have pointed out that it is difficult to conclude that adaptation has occurred in a particular instance, unless the environmental demands to which a species has adapted can somehow be specified. Reference to successful adaptation has the danger of becoming circular, unless the environmental factors to which organisms have adapted can be specified independently of the adaptation process (e.g., Lewontin, 1978). A certain anatomic or behavioural feature can come about in many ways, also as the accidental by-product of some ongoing evolutionary process. If adaptation is invoked *a posteriori*, the mechanisms of evolutionary change have to be traced through what Lewontin calls engineering analysis. In the behavioural sciences we speak about a process of experimental validation in the course of which erroneous explanations can be identified. In psychology, adaptation is not much more than a metaphor which lacks clear empirical referents. Obviously, what is needed are more precise and refutable concepts and theories.

At the theoretical level postulates are formulated in a way that leaves them more open to empirical scrutiny. The theories which exist differ considerably in level of abstraction. A good example of a theory postulating rather high level processes, that can be operationalised in fairly diverse

ways, is that of Piaget. There is a considerable amount of cross-cultural research in his tradition, with emphasis on the question, whether or not the three main stages in the development of cognitive operations are invariant across cultures (Dasen, 1977; Dasen and Heron, 1980). In the sensory-motor stage, cross-cultural differences have been observed, but they are small and often controversial, as shown for instance by the discussions on the so-called precocity of African children (Warren, 1972; Super, 1981).

For the stage of concrete operations, performance differences are much larger, although the underlying constructs, (the "operations") have been identified in all cultures studied. Evidence on differences in the rate of development is somewhat equivocal, since the concrete operational stage is not homogeneous over task domains. It is not clear to what extent this lack of homogeneity is caused by context variables. Another important consideration with respect to the cross-cultural study of concrete operations is the distinction between performance and competence, based on the finding that older children with poor scores can benefit greatly from even a little training (e.g., Dasen, Ngini and Lavallee, 1979). In sum, we think that cultural invariance of the concrete operational stage can be justifiably claimed, but that it is still unclear in what way cultural factors modulate concrete operations.

For the stage of formal operational thinking, the evidence on cultural invariance is more ambiguous. Piaget's original tasks generally cannot be solved by illiterate subjects. Piaget has given three possible explanations, (i) the quality of environmental stimulation, (ii) formal reasoning in a cognitive specialisation of particular cultures, and (iii) specialisation with respect to the domains in which formal reasoning is applied (Piaget, 1982). The last, contextual, alternative was seen as the most likely by Piaget. The surprisingly poor performance of Western students on certain kinds of simple logical problems (Wason and Johnson-Laird, 1972) and observational studies which have shown evidence of formal argument among illiterate peoples, for example in judicial courts (Hutchins, 1980), have added credit to this argument. In addition, the recent criticisms on the homogeneity of stages as conceived by Piaget have added momentum to a contextual interpretation of differences.

On the other hand, we cannot escape the impression that opinions are coloured by equalitarian preconceptions. It seems fairly well established that so-called postconventional moral reasoning, in the sense of Kohlberg, is not found in illiterate societies, at least not with the usual interview methods (Snarey, 1985). This does not demonstrate a lower sense of morality. Turiel (1983) has shown the need to distinguish, even at preschool age, between reactions of children to violation of a moral principle and to the breach of a rule of convention, or social rule. Formal education, and the

consequent facility for verbalisation, may well be the cause behind cross-cultural differences in cognitive, as well as moral, reasoning. However, verbalisation refers to cognitive processes in an individual, rather than to a situational variable. In general, if differences are consistent over such a wide domain that it encompasses logical, as well as moral reasoning, the contextual argument amounts to an overgeneralisation.

In view of the difficulties pointed out, it may be worthwhile to look at the prospects of low level theories, in which the inferential distance between concepts and operationalisations is small. To escape the contextual effects which have emerged in other approaches, there is little scope for theories which require stimuli at a high level of cognitive complexity. More promising are theories which, for the operationalisation in assessment instruments, only need cognitively simple stimuli. Recently there has been an increase in such approaches. We can mention the work by Hunt (e.g., Hunt 1982; Lansman, Donaldson, Hunt and Yantis, 1982) emphasising the role of basic processes of attention and information processing in the assessment of intelligence, the analysis of evoked responses in electrophysiological brain activity promoted by Eysenck and his associates (Eysenck, 1982; Hendrickson and Hendrickson, 1980) and, last but not least, the analysis of reaction time parameters which was revived by Jensen (e.g., 1982). Some of these paradigms have been used for studying intergroup differences, but almost exclusively within cultures (e.g., Vernon and Jensen, 1984; Jensen, 1985; Vernon, Nador and Kantor, 1985). Cross-cultural studies in which simple stimuli were taken as a starting point for analysis of cognitive processes have been reported by Verster (1983) and by Irvine and Reuning (1981).

We shall not elaborate on these theories and the few relevant cross-cultural investigations here, but rather indicate how, in our opinion, one can try to avoid context effects, if one takes this kind of model as a starting point for the analysis of cross-cultural differences in cognition.

Invariance of Parameters

Crucial in this enterprise is the answer to the question: "what evidence is needed for a satisfactory demonstration of cross-cultural invariance of a psychological concept?" The cross-cultural researcher faces a serious dilemma, as it is virtually impossible to prove that an observed difference cannot be attributed to measurement artefacts, as well as to the domain or ability measured (van de Vijver and Poortinga, 1985; Poortinga and van de Vijver, in press). In other words, the decision whether an observed difference is valid, or due to the cultural inequivalence of the measurement procedure is usually, to a greater or lesser extent, arbitrary. This is equally true for cognitively simple stimuli as for the more complex

items used in traditional ability tests. The dilemma occurs whenever a measurement procedure cannot be assumed *a priori* to be equally representative of the behavioural domain or construct under scrutiny (cf. Poortinga and Malpass, 1986). It may be noted that the replication of a cross-cultural difference over stimuli, or over items, does not necessarily mean that the results are valid. Many sources of bias are common to all stimuli in a task; these cannot be detected by methods which are based on the assumption that a substantial proportion of the stimuli is unbiased, as happens in item bias analysis (van de Vijver and Poortinga, 1982, 1985).

If differences are likely to be observed and if they are difficult to interpret, either as valid or as due to method inequivalence, the suggestion seems rather obvious that one should try to follow the alternative strategy of finding *no* differences. More details about the rationale are given in a preliminary report (Poortinga, 1986). Later on we shall show that invariance can be defined at different levels. For the time being we shall assume the most stringent requirement, viz. that any parameter postulated in a model has an identical value in representative samples from the populations concerned. To illustrate the feasibility of this approach we shall present some empirical data from two projects. One was done some 15 years ago, the other has been completed more recently.

The first study was reported by Poortinga (1971). It was inspired by the traditional information transmission theory, prominent in the late sixties. The aim was to test the notion, among others suggested by Biesheuvel (1943), that Africans have relatively greater perceptual proficiency in the auditory modality than in the visual modality when compared with Europeans. Forty Black and 40 White South African students were administered a brightness and a loudness judgement task with 8 stimuli each, approximately equally spaced in terms of (subjective) scale distance. There were 3 sessions; the rate of learning was initially high, but had become very low in both samples during the third session. The distributions of the erroneous responses over the stimuli during the second half of the third session are presented in Figure 1.

Identity of the underlying psychological processes can be reasonably inferred from the similarity in the distributions of errors in the two cultural groups. Uncertainty remains as to whether the somewhat larger number of errors in the Black sample is process-linked, and a valid indication of differences in information transmission capacity, or that it has to be considered as due to unwanted factors, such as the relative unfamiliarity of the Black students with the experimental setting, or a lower motivation to do well on the task. In our opinion, the data contain nothing to decide this issue, despite the fact that we are dealing with a fairly elementary psychophysical task. Although we shall return to this point, it may be noted

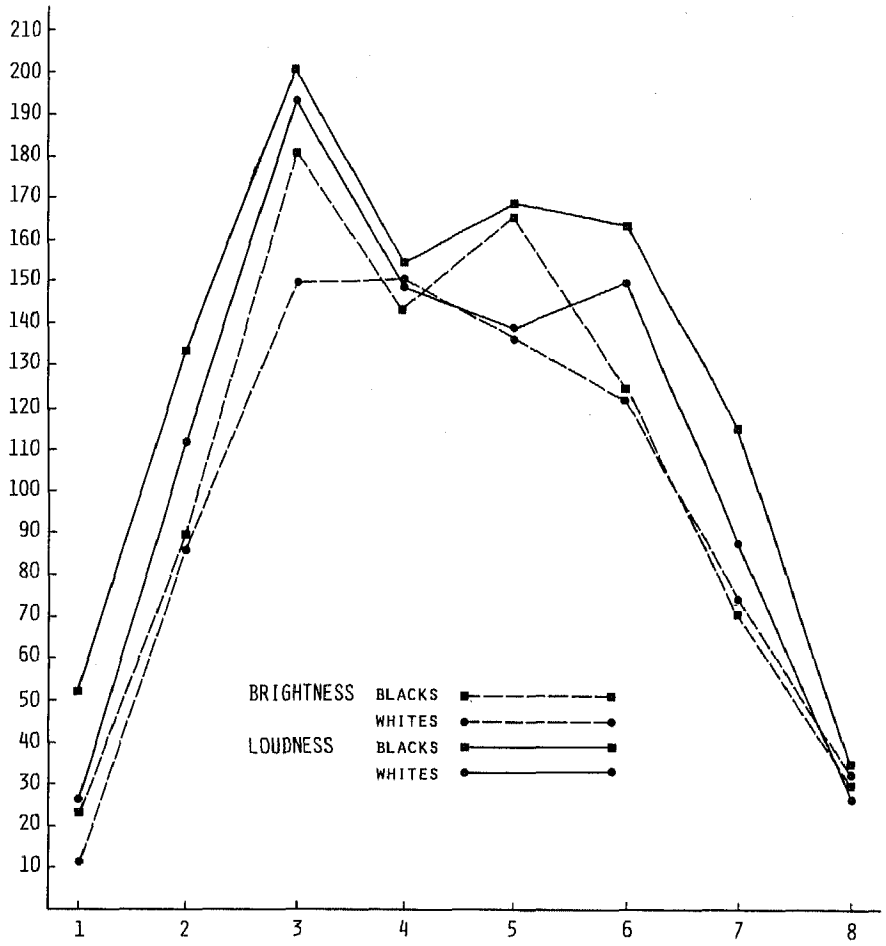

Figure 1. Distribution of errors over the stimuli in a loudness and a brightness judgement task with Black and White South African students (after Poortinga, 1971).

here that the hypothesis, stated in terms of relative performance on the two tasks, could be meaningfully tested under the assumption that such variables as mentioned would equally affect the scores on both tasks.

The second study (Poortinga, 1986) formed part of a larger investigation on the cultural invariance of a basic personality variable, namely interindividual differences in the relative impact of stimuli of higher

and lower intensity. This dimension, which in the Russian literature is known as the strength of the nervous system (Nebylitsyn, 1972), has been related to arousability and extraversion-introversion (cf. Mangan, 1982).

The study was conducted in India and the Netherlands. The Dutch subjects consisted of samples of university students and military conscripts. In India, the subjects were university students and members of a tribal group (the Juang), partly still in transition from hunting and gathering to a settled agricultural existence. The evoked potentials in the EEG to "loud" and "soft" bursts of white noise (25 msec. duration, 8dB intensity difference) were registered in two sessions. The subjects were asked not to do anything with the louder stimuli, but to count the softer stimuli and to press a button each time they had counted 5 of these sounds.[1] The traces averaged over stimuli and subjects per sample (each trace is based on the results of at least 28 subjects) are presented in Figure 2.

The averaging over subjects has suppressed the smaller high frequency components of the wave form, but the major peaks have become more prominent. The first point to be noted is the strong similarities between the four samples, also in respect of the differences between the louder and the softer stimuli. It is beyond doubt that the procedure has elicited the same processes in all four cultural groups. Nevertheless, the Indian and Dutch samples differ in two respects. The first major peak (N100) has a significantly higher latency and a higher amplitude in the Indian samples. The parameter values of this peak are to a large extent determined by the physical characteristics (notably intensity) of the stimulus, even though individual differences exist. These two parameters tend to be positively correlated. Long latency in auditory (unlike in visual) evoked potentials has been associated with high IQ. A more traditional explanation for the high amplitude is a high level of arousal or attention (Callaway, 1975). This appears to be rather plausible in the present study, since significant differences were found between the two cultures on each of four measures of activation (or anxiety) in the experimental situation (Poortinga, 1986). The cross-cultural differences would then be a consequence of the general principle that, at least up to a point, the effective impact of stimuli is stronger in the more activated individual.

The second noteworthy difference is with the peak at 220 msec., which has about the same amplitude in all four samples for the louder stimuli, but is clearly less pronounced in the Indian samples for the softer stimuli. The difference was not homogeneous across subjects within cultures, only the proportion of subjects with a low or absent peak differed between samples. This component is associated with endogenous, subjective aspects of decision making. It appears that the recognition of the stimulus as a signal or as a no-signal event (Simson, Vaughan and Ritter,

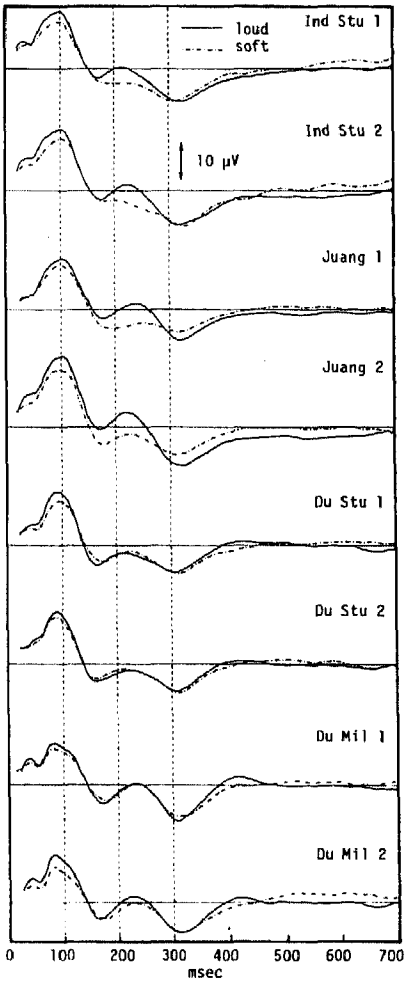

Figure 2. Averaged Evoked Potential curves in two sessions for short bursts of noise of which the softer stimuli had to be counted. The four groups of subjects are Indian and Dutch university students, Dutch military conscripts and members of the Juang group in India.

1976, 1977), was not equal across groups under the conditions of the experiment.

There can be little doubt that in this experiment, the question whether the same processes are tapped should be answered affirmatively. However, some of the parameters in terms of which the evoked potentials can be described, have (statistically significantly) different values across cultures. We believe that this will almost invariably be the case, when tasks are administered in cultures which are wide apart. Consequently, the interpretation of the differences found on any parameter remains problematic.

Manipulating Constraints on Parameter Invariance

The strategy, to use tasks in which the culture specific meaning of stimuli is reduced, has not met with success in the sense that culturally invariant parameters as defined above have been identified. Nor do we believe that they can be identified. Nevertheless, we are of the opinion that the search for invariant parameters is a worthwhile goal. In this section we shall discuss two techniques which can help in this effort. The first amounts to formulating research questions in such a way that the requirements for parameter identity can be relaxed. The second technique amounts to the construction of variables from which unwanted sources of variance are eliminated through experimental and statistical manipulation.

The conditions for invariance can be relaxed if the design of a study does not require comparison of absolute levels of performance across groups. Rather frequently one finds hypotheses formulated in such a way that relative differences can be compared. This can be done, especially when under otherwise equal experimental conditions, stimuli are presented which differ only in one aspect. The study on auditory and visual information transmission, of which some results were given in Figure 1, is an example. The response procedure was kept constant, as well as the instructions and various other sources of variance; only the nature of the stimuli differed. In terms of the hypothesis, relative intercultural differences between the auditory and the visual task were tested. In the present example, only two tasks were used. When more measurements are taken a pattern of results can be studied. The constraints can be further relaxed, if quantitative cross-cultural differences (absolute or relative) are not of interest. For example, to answer the question whether a model is valid across cultures, we only need to know whether a cognitive process can be described in terms of the same set of parameters, independent of their quantitative values in the various cultures." For some further suggestions we would like to refer to a recent chapter by Malpass and Poortinga (1986).

The second technique is the construction of invariant parameters through statistical and experimental manipulation. First, it should be mentioned that a particular outlook on culture as a psychological variable is

presupposed. It is implied that culture, as a source of variance, can be controlled or eliminated. This orientation has received impetus from recent articles by Segall (1983, 1984), who has argued that cross-cultural psychology can do without the culture concept. In his opinion, we start with some dependent variable on which interesting cross-cultural differences are observed. From there we have to start looking for an independent variable which can explain this difference. Culture acquires, in this view, the status of an unspecified variable, which has to be replaced by more specific explanatory variables. This leads to the paradox that a cross-cultural difference has been satisfactorily dealt with when there is no difference left to be explained in terms of culture (cf. van de Vijver and Poortinga, in press; Poortinga and van de Vijver, in press).

In our approach, context variables are introduced into the design of a study, not because they have cultural relevance, but to eliminate cultural differences. Imagine an analysis of variance model or a linear regression model with culture as a factor. A full explanation of a cross-cultural difference on the dependent variable has been given if the variance on the factor, culture, can be reduced to zero. Variance which can be explained in terms of a context variable can be eliminated when that variable is entered into the analysis, e.g., as a covariate in the analysis of variance.

We are not only dealing here with a methodological issue. The approach will work only if psychological variables can be defined which are independent of culture, i.e., truly universal. The term culturally invariant obtains its full meaning here. "Culturally invariant", or "universal", are psychological processes and functions which are not differentially affected by cultural variation. We do believe that such processes and functions exist, but that there are no procedures to measure them directly. This would require culture-free measurement. However, our own results, of which a few examples have been given here, indicate that a high degree of similarity of results is observed, provided well structured studies, based on cognitively simple tasks, are used.

Apart from the two techniques mentioned to reduce constraints on invariance, researchers can control sources of variance through instruction of the subjects and through training. One should make subjects familiar with the kind of problems they will have to solve, as well as with the stimulus materials. No difference in cognitive functioning can be inferred, if it cannot be replicated over time and over (theoretically relevant) stimulus conditions. In the experiments discussed in the previous section, stability over stimulus conditions has not been investigated, and they do not lend themselves to quantitative comparison of performance levels across cultures. For the evoked potentials experiment the effect of some specific situational reaction (arousal or anxiety) could be made plausible (Poortinga, 1986).

Conclusion

The invariance or universality of parameters can neither be inferred from observational data and ability test scores, nor be demonstrated on the basis of experiments with information processing models. However, we would submit that with the latter approach one can get closer to the point where no differences between cultures are found. Earlier in this paper we made a reference to experimental validation as a means to reconstruct, post hoc, the effects of antecedent variables. For this kind of analysis, the parameters used to describe a cognitive process have to be precisely known.

We are not convinced that there are substantial cognitive differences beyond conventions operating in specific domains of knowledge. However, the way to find out is to establish first the invariant aspects of cognitive functioning. Only thereafter can we attempt to understand the differences in indigenous cognition. These differences begin where invariance starts to break down. How cross-cultural differences will emerge we cannot say. One possibility is that the behavioural repertoire in a culture can be understood as a set of overlearned assemblies of concatenations of elementary processes. Although this might not complete the bridge which we mentioned in the introduction, it would narrow the gap still to be closed, if the validity of some such model could be established. For the time being we can only point to a few small experimental steps, but in view of the evidence that cultural invariance of cognitive processes cannot be deductively inferred from cross-cultural data, it can only be established through experimental analysis.

Notes

1 The Indian tribal subjects counted up to four, because of the apparent lack of a word for "five" in their language. The task was communicated successfully; only one subject committed more than an occasional error. The trials over which the subjects pressed the button were eliminated.

REFERENCES

Biesheuvel, S. (1943). African intelligence. Johannesburg: South African Institute of Race Relations.

Bijnen, E.J., van der Net, T.Z.J. & Poortinga, Y.H. (1986). On cross-cultural comparative studies with the Eysenck Personality Questionnaire. Journal of Cross-Cultural Psychology, 17, 3-16.

Callaway, E. (1975). Brain electrical potentials and individual psychological differences. New York: Grune and Stratton.

Cole, M., Gay, J., Glick, J.A. & Sharp, D.W. (1971). The cultural context of learning and thinking. New York: Basic Books.

Cole, M. & Scribner, S. (1981). The psychology of literacy. Cambridge, Mass.: Harvard University Press.

Dasen, P.R. (1977). Are cognitive processes universal? A contribution to cross-cultural Piagetian psychology. In N. Warren (Ed.), Studies in cross-cultural psychology (Vol. 1, pp. 155-201). London: Academic Press.

Dasen, P.R. & Heron, A. (1980). Cross-cultural tests of Piaget's theory. In H.C. Triandis & A. Heron (Eds.), Handbook of cross-cultural psychology (Vol. 4, pp. 295-341). Boston: Allyn and Bacon.

Dasen, P.R., Ngini, L. & Lavallee, M. (1979). Cross-cultural training studies of concrete operations. In L. Eckensberger, W. Lonner & Y.H. Poortinga (Eds.), Cross-cultural contributions to psychology (pp. 94-104). Lisse: Swets & Zeitlinger.

Eckensberger, L.H. (1979). A metamethodological evaluation of psychological theories from a cross-cultural perspective. In L. Eckensberger, W. Lonner & Y.H. Poortinga (Eds.), Cross-cultural contributions to psychology (pp. 255-275). Lisse: Swets & Zeitlinger.

Eysenck, H.J. (1982). The psychophysiology of intelligence. In C.D. Spielberger & J.N. Butcher (Eds.), Advances in personality assessment (Vol. 1, pp. 1-37). Hillsdale: Erlbaum.

Gladwin, T. (1970). East is a big bird. Cambridge, Mass.: Harvard University Press.

Grant, G.V. & Schepers, J.M. (1969). An exploratory factor analysis of five new cognitive tests for use with African mine workers. Psychologia Africana, 12, 181-192.

Hendrickson, A.E. & Hendrickson, D.E. (1980). The biological basis of individual differences in intelligence. Personality and Individual Differences, 1, 3-33.

Hunt, E. (1982). Towards new ways of assessing intelligence. Intelligence, 6, 231-240.

Hutchins, E. (1980). Culture and inference: A Trobriand case study. Cambridge, Mass.: Harvard University Press.

Irvine, S.H. (1979). The place of factor analysis in cross-cultural methodology and its contribution to cognitive theory. In L. Eckensberger, W. Lonner & Y.H. Poortinga (Eds.)., Cross-cultural contributions to psychology (pp. 300-341). Lisse: Swets & Zeitlinger.

Irvine, S.H. & Reuning, H. (1981). "Perceptual speed" and cognitive controls. Journal of Cross-Cultural Psychology, 12, 425-444.

Jahoda, G. (1980). Theoretical and systematic approaches to cross-cultural psychology. In H.C. Triandis & W.W. Lambert (Eds.), Handbook of cross-cultural psychology (Vol. 1, pp. 69-141). Boston: Allyn & Bacon.

Jensen, A.R. (1982). Reaction time and psychometric g. In H.J. Eysenck (Eds.), A model for intelligence. Berlin: Springer Verlag.

Jensen, A.R. (1985). The nature of the black-white difference on various psychometric tests: Spearman's hypothesis. The Behavioral and Brain Sciences, 8, 193-263.

Lansman, M., Donaldson, G., Hunt, E. & Yantis, S. (1982). Ability factors and cognitive processes. Intelligence, 6, 347-386.

Lewontin, R.C. (1978). Adaptation. Scientific American, 239, 157-169.

Malpass, R.S. & Poortinga, Y.H. (1986). Strategies for design and analysis. In W.J. Lonner & J.W. Berry (Eds.), Field methods in cross-cultural research. Beverly Hills: Sage.

Mangan, G.L. (1982). The biology of human behavior: East-West models of temperament and personality. Oxford: Pergamon.

Murray, C.O. (1956). The structure of African intelligence. M.A. thesis. Durban: University of Natal.

Nebylitsyn, V.D. (1972). Fundamental properties of the human nervous system. New York: Plenum Press.

Piaget, J. (1982). Intellectual evolution from adolescence to adulthood. Human Development, 15, 1-12.

Poortinga, Y.H. (1971). Cross-cultural comparison of maximum performance tests, Pyschologia Africana Monograph Supplement, 6.

Poortinga, Y.H. (1975). Limitations on intercultural comparison of psychological data. Nederlands Tijdschrift voor de Psychologie, 30, 23-39.

Poortinga, Y.H. (1983). Psychometric approaches to intergroup comparison: The problem of equivalence. In S.H. Irvine & J.W. Berry (Eds.), Human assessment and cultural factors (pp. 237-257). New York: Plenum.

Poortinga, Y.H. (1986). Psychic unity versus cultural variation: An exploratory study of some basic personality variables in India and The Netherlands. Report. Tilburg University, Tilburg.

Poortinga, Y.H. & Malpass, R.S. (1986). Making inferences from cross-cultural data. In W.J. Lonner & J.W. Berry (Eds.), Field methods in cross-cultural research. Beverly Hills: Sage.

Poortinga, Y.H. & van de Vijver, F.J.R. (in press). Explaining cross-cultural differences: Bias analysis and beyond. Journal of Cross-Cultural Psychology.

Reuning, H. & Wortley, W. (1973). Psychological studies of the Bushmen. Psychologia Africana Monograph Supplement, No. 7.

Segall, M.H. (1983). On the search for the independent variable in cross-cultural psychology. In S.H. Irvine & J.W. Berry (Eds.), Human assessment and cultural factors (pp. 127-138). New York: Plenum.

Segall, M.H. (1984). More than we need to know about culture, but are afraid not to ask. Journal of Cross-Cultural Psychology, 15, 153-162.

Serpell, R., (1979). How specific are perceptual skills? British Journal of Psychology, 70, 365-380.

Serpell, R. (1985). Hoe specifiek zijn de psychologische factoren die ten grondslag liggen aan inter-culturele verschillen in gedrag? [How specific are the psychological factors underlying inter-cultural differences in behavior?] In J.M.H. van de Koppel (Ed.), Verkenningen in de cross-culturele psychologie (pp. 7-35). Lisse: Swets and Zeitlinger.

Silberbauer, G.B. (1965). Bushman Survey. Report submitted to the government of Bechuanaland. Mafeking: Bechuanaland Government Press.

Simson, R., Vaughan, H. & Ritter, W. (1976). The scalp topography of potentials associated with missing visual or auditory stimuli. Electroencephalography and Clinical Neurophysiology, 40, 33-42.

Simson, R., Vaughan, H. & Ritter, W. (1977). The scalp topography of potentials in auditory and visual discrimination tasks. Electroencephalography and Clinical Neurophysiology, 42, 528-535.

Snarey, J.R. (1985). Cross-cultural universality of social-moral development: A critical review of Kohlbergian research. Psychological Bulletin, 97, 202-232.

Sternberg, R.J. (1984). Toward a triarchic theory of human intelligence. The Behavioral and Brain Sciences, 7, 269-315.

Super, C.M. (1981). Behavioral development in infancy. In R. L. Munroe, R.H. Munroe & B.B. Whiting (Eds.), Handbook of cross-cultural human development (pp. 181-270). New York: Garland Press.

Turiel, E. (1983). The development of social knowledge: Morality and convention. Cambridge: Cambridge University Press.

van de Vijver, F.J.R. & Poortinga, Y.H. (1982). Cross-cultural generalization and universality. Journal of Cross-Cultural Psychology, 13, 387-408.

van de Vijver, F.J.R. & Poortinga, Y.H. (1985). A comment on McCauley and Colberg's conception of cross-cultural transportability of tests. Journal of Educational Measurement, 22, 157-161.

van de Vijver, F.J.R. & Poortinga, Y.H. (in press). Testing across cultures. In R.N. Hambleton & J.N. Zaal (Eds.), Handbook of testing. Amsterdam: North Holland.

Vernon, P.A. & Jensen, A.R. (1984). Individual and group differences in intelligence and speed of information-processing. Personality and Individual Differences, 5, 411-423.

Vernon, P.A., Nador, S. & Kantor, L. (1985). Group differences in intelligence and speed of information-processing. Intelligence, 9, 137-148.

Verster, J.M. (1983). The structure, organization, and correlates of cognitive speed and accuracy: A cross-cultural study using computerised tests. In S.H. Irvine & J.W. Berry (Eds.), Human assessment and cultural factors (pp. 275-292). New York: Plenum.

Warren, N. (1972). African infant precocity. Psychological Bulletin, 78, 353-367.

Wason, P.C. & Johnson-Laird, P.N. (1972). Psychology of reasoning: Structure and content. Cambridge, Mass.: Harvard University Press.