EXECUTIVE TRAINING AND MENTAL CAPACITY: AN INVESTIGATION OF THE ROLE OF AROUSAL AND TEMPORAL EXECUTIVES IN FACILITATING PERFORMANCE.

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ABSTRACT

The present study forms part of a continual process of ongoing research based on the assumptions and principles of Pascual-Leone's neo-Piagetian Theory of Constructive Operators. Pascual-Leone proposes a model of development that has as its main postulate a quantitative parameter (*M*-power) which, together with other operators, is held to account for the qualitative logical-structural competencies characteristic of the epistemic subject at each successive Piagetian developmental stage. The present study was designed to assess, via the use of the Compound Stimulus Visual Information (CSVI) task, the role of executive processing on performance. The aim of the study was to ascertain the effect on performance if subjects are trained to use arousal executives and temporal executives that maximize the application of *M*-power and increase the number of times subjects attend and respond to the compound stimulus. All subjects (N=114) were Zulu-speaking children aged 11 (N=59) and 13 (N=55) years living in a township (Indaleni) adjacent to Richmond (Natal). Subjects in each of the two age groups were randomly assigned to three experimental groups (arousal-temporal; temporal-arousal; and control) in accord with the order in which they received executive training between the three CSVI tests administered.

The most striking feature of the results is the contrast between training, learning, and developmental effects. Niether the arousal nor temporal training appears to have effected performance although clear developmental effects were evident, with older subjects consistently performing at higher levels than younger subjects on the first look of the CSVI. This is not the case for repeated looks or for the second look of the first CSVI, for which older and younger subjects perform at the same level. However, for both first and repeated looks strong learning effects are evident across the three CSVI tests with performance improving from an initial underperformance to overperformance on the final CSVI. This suggests that subjects learn strategies that enable them to lower the task demands across looks. In investigating this possibility a comparison was made between the theoretically anticipated proportion of "new" and "repeat" responses and those actually obtained. This comparison clearly indicates the use of some strategy on the part of both 11 and 13 year-olds which significantly reduces the number of repeats made. This, in turn, effectively increases the *M*-power available for new responses on repeated exposure of the stimulus compound. This improved performance of subjects on repeated testing suggests that tasks cannot be made equivalent across subjects unless the subjects have the opportunity to engage in the task and thereby generate strategies appropriate to meet the task demands. Further, the self-generation of strategies and the marked degree of individual variation evident within the present study suggests that these must be investigated in the light of the interrelation between contextual/individual factors and postulated structural invarients such that a clearer understanding of the interaction between inter- and intra-individual processes becomes possiable.

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1.0 NEO-PIAGETIAN RESEARCH: CONTEXT AND OVERVIEW OF THE PRESENT STUDY.

Neo-Piagetian research continues to concern itself with the same problems that occupied Piaget during his career. That is it attempts, (a) to specify the age related cognitive competencies of the developing person; (b) to isolate the transition mechanisms that propel the cognitive system from one level of competence to the next, and; (c) to establish relations between competencies and mechanisms on the one hand and the context in which cognitive growth takes place on the other. In their attempts to investigate competencies and mechanisms neo-Piagetians, like Piaget, devise theory based tasks and formally model the performance of subjects on these. However, unlike Piaget, the tasks developed by neo-Piagetians are more closely linked to familiar contexts with the systematic control and isolation of variables in an attempt to highlight specific phenomena and derive causal links. (Sternberg, 1987, p507).

In the process of theory building and investigation, neo-Piagetians have utilized cross-cultural research as a testing ground. To date, relatively general stages and variable time differences in the acquisition of the related competencies have been found. These findings focus attention on the mechanisms of transition or, in Piagetian terms, the process of equilibration and the role of context in this process.

Although Piaget's theory provides a theoretical basis for distinguishing between context-specific learning and content free organismic equilibratory mechanisms, equilibration remains a global and descriptive construct despite its crucial theoretical role in the process of development. This feature of Piagetian theory was recognized by Pascual-Leone (1970) and his neo-Piagetian theory is an attempt to explicate equilibration. Pascual-Leone's Theory of Constructive Operators (1970, 1983, 1984; Pascual-Leone, Goodman, Ammon & Subelman, 1978; Pascual-Leone & Goodman, 1979) constitutes a model in which equilibration is seen in terms of a set of operators that together co-determine performance across stages of development and across kinds of situations or tasks. He refers to these operators as "silent" or "hidden" in the sense that they operate on content or experiential processes (i.e. schemes) and regulate which of these will determine performance. For example, when confronted with a typical Piagetian conservation experiment children at different ages focus on different aspects of the situation. It is this "silent choice" of representing a situation in a particular way that the Theory of Constructive Operators (TCO) attempts to explain in terms of a set of regulatory or constructive operators.

The present study forms part of a continual process of ongoing research based on the assumptions and principles of Pascual-Leone's Theory of Constructive Operators. As a cross-cultural study its focus is directed at exploring and explaining time differences in the acquisition of stage related competencies among disadvantaged Zulu speaking children.

In what follows, methodological issues surrounding neo-Piagetian cross-cultural research and the exposition of the requirements for a truly Constructive Rationalist theory are given in Chapter Two. In Chapter Three a brief overview of Pascual-Leone's Theory of Constructive Operators and its relation to the Piagetian stages of development is given. Following this is a functional description of his model of mental attention and its relation to the Compound Stimulus Visual Information (CSVI) task. (The CSVI being a theory based task developed by Pascual-Leone, as one means of verifying the central construct, *M*, of the TCO.) The chapter also includes an outline of the CSVI in terms of the Bose-Einstein Occupancy Model of

Combinational Analysis which yields age related theoretical distributions against which performance on the CSVI is compared. Finally, the chapter provides a review of some disparate finding in studies using the CSVI and contextualizes the present study in relation to these. Chapters Four and Five provide a description of the subjects, design and procedure used, as well as the results obtained in the present study. Chapters Six and Seven constitute an analysis of the results in terms of the principles and constructs of Pascual-Leone's Theory of Constructive Operators with particular emphasis being placed on the contrast between training, learning and developmental effects.

2.0 CROSS-CULTURAL DEVELOPMENTAL RESEARCH: METHODOLOGICAL ISSUES.

Piaget, in his attempts to discover and explain the normal sequence of human development, focused on commonalities in the application of norms that change with development and on the possibility and emergence of truly novel performances; that is, performances that cannot be the sole result of learning or of the performance-producing combinatorial possibilities of the learned repertoire of skills. To this end, Piaget recognized the necessity for a disassociation between intra-individual factors resulting in the spontaneous and internal development of the individual and inter-individual factors specific to a given society/culture. He stressed the importance of biological factors (maturation) in determining a degree of uniformity in development regardless of the social environments of individuals but at the same time recognized individual equilibratory factors (which depend upon environmental as well as on epigenetic[1] factors) as a source of variation. Similarly, Piaget recognized the fact that common socialization processes and differential cultural pressures exist which interact with the individual's equilibration processes in the course of development. As a result Piaget argued for the necessity of investigating, via cross-cultural research, the differential role of these factors in determining the course of human development (Piaget in Berry and Dassen, 1974).

However, in the cross-cultural application of Piagetian concepts and tests, the latter have generated a tangled controversy due to the fact that Western children appear to undergo a more rapid cognitive development than their non-Western peers. Participants in the controversy tend to fall into two groups: psychological universalists, who stress the subjective universality of human psychology, and the cultural relativists, who emphasize the objective cultural and environmental variables in psychological development. The psychological universalist position, which Piaget adopts, assumes that a general theory of cognition is possible, but it cannot adequately account for disparities in the developmental patterns of non-Western samples relative to that of western samples with the result that they run the risk of ethnocentrism (Buck-Morris, 1981).

Sensitive to this problem cultural relativists, such as the proponents of the Laboratory of Comparative Human Cognition or LCHC (1982), argue that performance must be viewed in the light of prior experience and similarity of context. For cultural relativists, context specific cognitive achievements form the basis of development and consequently cognition is seen to differ across cultures because different cultural conditions pose different kinds of problems.

> "cultural differences are merely the expressions of the many products that a universal mind can manufacture, given the wide variations in conditions of life, and culturally valid activities."
> (Cole and Scribner, 1974, p172)

This emphasis on situational determinants commits cultural relativists to a search for the "rules underlying the patterns of behavior that are seen in different situations" (ibid, p194). In this "search" the independent variable or situation is manipulated to assess its effect on behaviour; the dependent variable. Implicit in this method is a reactive view of human action. Mind and culture are seen as two separate systems/states which are causally related in a unidirectional way: culture determining mind.

In contrast Miller (1984), in accord with Vygotsky (1978), argues that human action is not reactive but that it is "both responsive to and generative of the world in which it occurs" (Miller, 1984, p6). In this view mind and culture cannot be separated as independent and dependent variables, but must be seen as a unitary system in which the processes of mind reproduce and transform culture and, at the same time, the processes of culture reproduce and transform mind. In this conceptualization, the interaction of mind and culture as the genesis of performance is emphasized. A developmental method is adopted in which the research problem is not how mind varies as a function of culture but, how the two simultaneously interact to generate each other in the process of their mutual transformation.

From this perspective, the task of cross-cultural psychology is no longer the discovery of differences between cultures (i.e the understanding of the performance of particular children) but the discovery of the transformations/processes underlying performance as it manifests itself within and across cultures (i.e the understanding of the longitudinal development of generalized competencies).

The emphasis on situational determinants by the cultural relativists operating within an experimental paradigm and the explication of general competencies by those adopting the developmental method are, however, not mutually exclusive pursuits. As Pascual-Leone and de Ribaupierre (1984) argue "the experimental method allows the building of models with respect to situational aspects, but does not give enough consideration to the subject as a significant source of variation. The psycho-genetic [developmental] method does not take into sufficient account situational variables, nor individual variables other than age, in order to clearly demonstrate the existence of stages in development." (Pascual-Leone and de Ribaupierre, 1984, p23) What is required for a truly constructive[2] Rationalist[3] theory is the use of both methods in explicating the role of contextual and/or individual variables in modulating structural invariants (ibid).

Pascual-Leone's (1970) neo-Piagetian Theory of Constructive Operators (TCO), in its attempt to explicate equilibration, differentiates, at an organismic level, between universal and differential constructs in the form of "silent operators" (See Chapter 3), which are conceptualized as anchored both in individuals and in situations, providing for interaction between subjects and situations. As such, the TCO recognizes the central role of culture as a generative mechanism and, at a meta-theoretical level, has the potential to account for the interaction of mind and culture in development. Secondly, in terms of its method the TCO is ideally suited for cross-cultural research and verification in that, the Compound Stimulus Visual Information (CSVI) task, one of the tests developed by Pascual-Leone (1970) as a means of verifying his central developmental concept *M* (See Chapter 3), controls for content learning. Subjects are taught nine stimulus-response associations which form the basis for all subsequent performance and this permits the use of the CSVI across cultures by ensuring that all subjects are familiar with the elements constituting the task. Thirdly, the CSVI avoids the problem of ethnocentrism because performance is compared to a mathematical theoretical distribution which is independent of any cultural reference point. Finally, the TCO has the potential to account for individual variation in addition to its explication of cognitive universals. Pascual-Leone (1970), through task analysis, specifies which operators are likely to be triggered by a given situation and which operators will lead to correct as opposed to incorrect performance. On the basis of these specifications then, predictions can be made with respect to the performance of different types of subjects on a range of tasks, given a common developmental level.

Given the fact that the TCO satisfies most of the criteria necessary for an adequate account of both similarities and differences in performance within and across cultures (See Dasen and de Ribaupierre, 1987), and the fact that it has the potential to overcome previous difficulties in the application and verification of Piagetian principles, the present study operates within the framework of Pascual-Leone's neo-Piagetian theory in its cross-cultural investigation of the role of executive processing on task performance by subjects of low socio-economic status. Before expanding on the present study, however, an exposition of Pascual-Leone's theory and the CSVI tasks will be given.

NOTES:

1 Interactions between the genotype and the physical environment during growth.

2 A theory can be defined as constructive if it creates theoretical structural models to simulate the genesis of performance. (Pascual-Leone and de Ribaupierre, 1984)

3 Rationalist models rest on at least three presuppositions:
- a) the organization of the subject's inner processes is so active that the organism can be referred to as a "metasubject"[3a].
- b) this organisation or metasubject is essentially the same for a given type of subjects.
- c) it also applies across types of situations.

3a The term "metasubjective" was introduced by Pascual-Leone (1976, 1983) to refer to the inner processual organisation whose functioning permits the subjects' experiences and performances; it represents the ever active and hidden psychological organism, ie., the processual invariants that cause subjective and objective experiences. The term is used to stress the difference between experiences or performances, on the one hand, and the dynamic organismic system which produces them, on the other hand. (Adapted from Pascual-Leone and de Ribaupierre, 1984)

3.0 PASCUAL-LEONE'S THEORY OF CONSTRUCTIVE OPERATORS: ITS MODEL AND MEASURE OF MENTAL ATTENTION.

3.1 OVERVIEW:

Most developmental theories are concerned with the emergence of truly novel performances, that is performances that cannot be the sole result of learning or of the performance-producing combinatorial possibilities of the learned repertoire of skills. One way of viewing developmental change is in terms of a progressive sequence of unlearning and creative learning, of breaking established connections between experience and performance and establishing truly new performances. Viewed in this light, it is clear that however necessary learning may be, additional organismic operators or psychological processes are required that produce truly novel performances and regulate the learning-unlearning creative process.

Piaget calls equilibration the set of psychological processes that regulate cognitive construction and reconstruction and thus generate truly novel performance in specific situations. Although Piaget's theory provides a theoretical basis for distinguishing between context-specific learning and content free organismic equilibratory mechanisms, equilibration remains a global and descriptive construct despite its crucial theoretical role in the process of development. This feature of Piagetian theory was recognized by Pascual-Leone (1970) and his neo-Piagetian theory is an attempt to explicate equilibration. Pascual-Leone (ibid) proposes a "performance model"[1] of development that has as its main postulate a quantitative parameter which, together with other "silent operators", is held to account for the qualitative logical-structural competencies characteristic of the epistemic subject at each successive Piagetian developmental stage. This quantitative parameter is proposed as the primary measure of Piaget's "field of centration"; its magnitude being the maximum number of activated schemes the metasubject[2] can coordinate at a given moment. Referred to as *M*-capacity (mental capacity) it is used as a label for the "intellectual processor" (Case, 1972) which accounts for equilibration or the functional constructivity of the organism in the generation of truly novel cognitive assertions and/or praxis.

3.2 THE THEORY OF CONSTRUCTIVE OPERATORS:

In its account of the functional constructivity of the organism, Pascual-Leone's (ibid) Theory of Constructive Operators (TCO) postulates a bilevel organization of systems in the metasubject to explain the dynamic choice amongst schemes (see section 2.2.2) which, on the basis of the Principle of Assimilatory praxis[3], takes place in any given situation.

According to the Principle of Bilevel Psychological Organization the metasubject may be conceptualized as being constituted by two strongly hierarchically organized, functionally and structurally different, but interacting systems (ibid). The first system being a repertoire of schemes and the second a set of basic factors and principles, which modify the activation weights of schemes in accordance with organismic requirements. (ibid)

3.2.1 SCHEMES:

Schemes may be conceptualized as an organized set of actions acquired through learning during interaction with the environment, which are transferable from one situation to the next in future interactions.

Pascual-Leone (1987) identifies two basic categories of schemes: executive schemes and action schemes. Executive schemes constitute the plan/control structures of the subject that monitor and control the strategic use of cognitive capacities within a given situation. Action schemes, by contrast, are those schemes (motor, perceptual, representational, conceptual etc.) that serve to implement the executive plan in question.

Within the TCO, schemes are seen to have a releasing component (rc) and an effecting component (ec)[4]. The *rc* of any scheme represents the set of potential cues or conditions which govern that scheme's activation while the *ec* consists of all the physiological or behavioural effects which result once that scheme has been released. In the activation of schemes, however, some may be incompatible in that their effecting components cannot occur simultaneously. In this case, compatible schemes summate and only that group of compatible schemes with the greatest activation weight is released in performance (Chapman, 1981). This means that the subject's performance is likely to be determined by several distinct but compatible schemes. This Pascual-Leone refers to as the Principle of Schematic Overdetermination of Performance (Pascual-Leone, 1970).

Further, the repeated co-activation of compatible schemes, as described above, is seen to result in the structural integration of the *rc* and *ec* of individual schemes in the formation of a single superscheme which is then activated and released as a unit in subsequent performance (see *L*-operator, below). Similarly, such superschemes may form constellations of superschemes referred to as compound superschemes (ibid). It is these schemes, superschemes and compound superschemes which upon activation and application, are used by the metasubject to modify and/or further its ongoing behavior.

3.2.2 METACONSTRUCTS:

The metaconstructs constitute the second system in the Bilevel Psychological Organization of the metasubject. These constructs are referred to as "silent operators" and they constitute a set of basic factors and principles which, unlike schemes, are situation or content free (ibid) . The choice between schemes in any situation is determined by these metaconstructs or silent operators which function by *boosting* or weighting relevant schemes and inhibiting or *de-boosting* the application of others. The TCO postulates seven such silent operators in its account of human constructivity; the most relevant, in terms of the present study, being the *M*, *I*, *C* and *L* operators.

The M-operator may be conceptualized as a capacity for mental energy (Pascual-Leone, 1987). It functions via the mobilization and random allocation of mental energy *(M)* by executive schemes, in the boosting of activated, task-relevant action schemes (ibid).

The I-operator, on the other hand, is the subject's capacity to actively inhibit or interrupt the activation of task-irrelevant action schemes that could interfere in the production of appropriate performance (ibid).

From a developmental perspective it is these two capacities that are seen to have a certain power which develops with age (maturation) and which explains (together with the *C* and *L*-operator, see below) the emergence of Piaget's stages of cognitive growth. This developmental pattern appears in Table 1. The table shows the measure of *M*-capacity ie., *M*-power, in terms of the maximum number of schemes a child can boost at a given moment. This is symbolized by the sum $e + k$ where e is a constant representing the capacity used to sustain executive functions. Pascual-Leone (1970) proposes that this capacity develops during the sensory motor period and remains constant thereafter. The k component, which increases by one unit every second year, corresponds to a growth in the subject's capacity to boost relevant schemes.

Table 1:
Predicted maximum M-power values as a function of age, and their correspondence to the Piagetian substage sequence.

M-power (e + k)	**Piagetian substage**	**Normative chronological age**
e + 1	Low preoperations	3, 4
e + 2	High preoperations	5, 6
e + 3	Low concrete operations	7, 8
e + 4	High concrete operations	9, 10
e + 5	Substage introductory to formal operations	11, 12
e + 6	Low formal operations	13, 14
e + 7	High formal operations	15- adults

Within each of the stages in Table 1, Pascual-Leone recognizes that any subject may, while possessing a particular *M*-capacity, function using only part of that reserve in a given situation. To account for this Pascual-Leone distinguishes between structural *M*-capacity *(Ms)* and functional *M*-capacity *(Mf)*. Structural *M*-capacity refers to the maximum potential capacity available to the subject while functional *M*-capacity refers to the capacity that the subject actually uses at any given moment. A multiplicity of factors may result in the *Mf* being less than the subject's *Ms* in any task situation. These include the following:

(a) The subject possessing poor arousal executives, that is executives such as "this task is easy/difficult", which permit the allocation of an appropriate M-capacity to meet task demands. Here the subject may not "realize" that the task has a high M-demand and so may not mobilize his/her full M-capacity, or s/he may regard more difficult tasks as too difficult and again not mobilize his/her full M-capacity (ie. The subject gives up too soon.)

(b) The subject possessing poor temporal executives, that is executives such as "you need to look again, this task is difficult", which permit the re-allocation of M-capacity in an attempt to meet task demands. Here the subject fails to realize that the task has a high M-demand, with the result that an inappropriate executive scheme representing the task as easy is activated and dominates at the evaluation point resulting in the underperformance of the subject.

(c) The subject being fatigued giving rise to the under-utilization of M regardless of the M-demand of the task.

(d) The subject being field-dependent rather than field-independent. Pascual-Leone recognizes, and has found (1970), that performance on measures of M-power is influenced by the cognitive style of the subject. Field-independent subjects appear to use their full structural *M*-capacity and are able to disembed the individual cues of a test stimulus. In contrast, field-dependent subjects do not use their full *M*-capacity and are unable to overcome the embedded context of the cues in a test situation. The result is that they underperform relative to that expected for their developmental stage. It is for this reason that Pascual-Leone regards most tests of *M*-power as a reliable measure of *M* only for field-independent subjects.

The L and C -operators: Although structural changes in cognitive growth may be attributed to the growth of *M*-power, the *M*-operator is not sufficient to explain development. Without suitable learning in situations demanding high *M* arousal, children will function below their maximum potential. The TCO posits two types of learning: *C* (content) learning and *L* (logical or structural) learning. *C* and *L*-learning account for the differentiation of schemes through experience, and the corresponding operators formalize the increase in assimilatory power that a scheme derives as a result of its differentiation.

C-learning, or content learning, occurs as the result of empirical experience and involves an increase in the activation weight of a scheme by the incorporation of previously non-schematized properties into that scheme's *rc* or *ec*, or the assimulation of the *rc* and *ec* of a functionally related subordinate scheme.

L-learning, or logical structural learning, functions to increase the saliency of groups of schemes that are co-activated in performance and gives rise to networks of structures representing the relations of co-activation. There are two types of *L*-learning; *LC*-learning and *LM*-learning. If external conditions result in the repeated co-activation of a group of schemes then *LC*-learning takes place giving rise to context specific structures representing the relations of co-activation. Alternatively, *LM* structures representing the relations of co-activation may be formed in the application of *L* to a group of schemes which, regardless of differences in the context of activation, are simultaneously and repeatedly boosted by *M*.

The important point is that the *L* and *C*-operators, conceptualized as a weight or power, may facilitate or inhibit development depending on the nature of the situation and of the silent operators that together co-determine performance. In this regard, the relation between the *M*, *L* and *C*-operators is of particular importance as it is by means of *M* that it is possible to attend to new non-salient aspects of a situation and to override the effects of previous learning.

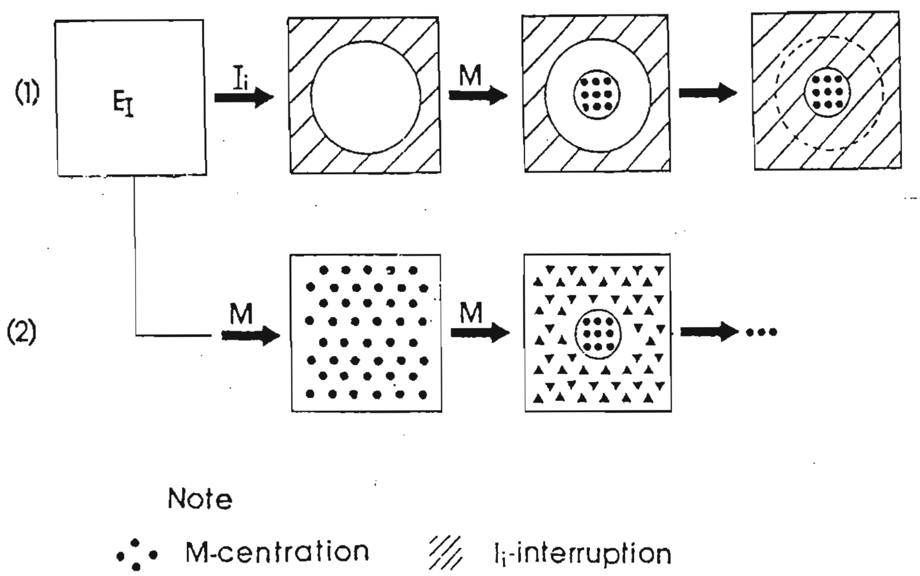
3.3 A FUNCTIONAL DESCRIPTION OF PASCUAL-LEONE'S MODEL OF MENTAL ATTENTION:

Pascual-Leone (1987) argues that an understanding of the cognitive developmental stages and the principles of intellectual development is dependent upon an understanding and conceptualization of the subject's general-purpose mental attentional mechanisms. It is these capacities which causally explain the production of truly novel performance as well as the adaptive plasticity demonstrated in the ability to modify existing functional structures as a result of experience. What follows is a descriptive account of Pascual-Leone's model which illustrates two strategies of mental attention that subjects could use in different situations.

Figure 1 symbolizes the interplay of *M* and *I*-capacities as they work together to cause the activation of structures relevant to the task at hand. Section (1) represents the case of a misleading situation that contains cues inducing the subject to apply task-irrelevant structures, while section (2) represents a situation where no active inhibition is necessary as the subject recognizes the relevant content from the outset. The squares symbolize the subject's repertoire of activated schemes and E_1 stands for the currently dominant executive structures.

Section (1): In a misleading situation the appropriate strategy for the subject to employ would be to inhibit (*I*-interupt) those schemes which, in accord with the current executive, are clearly inappropriate to the task at hand [represented by *Ii*]. After interruption the subject has a more focused "beam" of attention [symbolized by the circle] as irrelevant schemes will cease to be activated [indicated by the hatched region of the square]. At this point the subject uses his/her *M*-capacity to boost, with mental attentional energy, schemes appropriate to the task situation. Since the subject's *M*-capacity is limited, and allocation is random, it is likely that not all the remaining schemes will be boosted. Thus the *I*-operator is used again to inhibit those schemes not boosted by *M* [illustrated in the last square of section 1]. The result is a focused beam of mental attention which consists of a set of task relevant schemes which co-determine performance.

FIGURE 1:
The interplay of *M* and *I* -capacities under misleading (section 1) and facilitating (section 2) conditions.



[Adapted from Pascual-Leone, 1987, p553]

Section (2): In a facilitating situation, where all the activated schemes are potentially useful in terms of the task executives, *I*-interuption is not required. Thus, the subject uses his/her *M*-capacity to boost the activated schemes. From one to *k* schemes can receive mental attentional energy, depending on how this comes to be distributed across the schemes (allocation is random). The result is a set of *M*-boosted, task-relevant schemes which determine performance [indicated by the inner circle in the second square]. This occurs when the subject knows, and attends to, the relevant items in the situation from the outset.

In the above, each application of M is considered an attending act *(A)* and the responses made constitute the operating process *(O)*. At this point the subject may evaluate *(E)* his/her performance. This involves attending to E_1 and a scheme representing the just completed *A-O* activity. In applying M to these schemes, if the subject's M-capacity remains unsaturated, a further *A-O-E* process may be initiated in an attempt to satisfy task demands and/or goals. *A-O-E* cycles may continue as long as M remains unsaturated at the point of evaluation.

The M-operator, as described, constitutes a processing resource (mental attentional energy); its capacity determining the number of schemes that can be attended to and co-ordinated in a single attentional act *(A)* and the number of attending acts possible in a given situation. As such it forms the basis for the transformation of stimulus information (eg. Perceptual information) in the production of appropriate behavioural responses. It thus becomes possible, via the control and structuring of the stimulus information, to empirically verify the amount and extent of M-operator processing. In this regard several test procedures, including the Figural Intersections Test (FIT) and the Compound Stimulus Visual Information (CSVI) task, have been developed as measures of M-capacity.

3.4 THE COMPOUND STIMULUS VISUAL INFORMATION (CSVI) TASK.

3.4.1 OVERVIEW:

The outline of the second possible strategy given above represents the assumed *A-O-E* process used by subjects on Pascual-Leone's Compound Stimulus Visual Information (CSVI) task. The CSVI was developed as a means of isolating the effect of *M* in a given situation and, consequently, of providing an empirical measure of the parameter k ($Mp = e + k$) across subjects of different ages and developmental stages. In accord with the TCO, *M* is assumed to operate upon schemes existing in the subject's repertoire. Performance will thus depend upon the content of this repertoire in addition to the subject's actual *M*-power. Thus, in measuring *M*-power using the CSVI subjects are trained to acquire a repertoire of simple schemes and are then tested for *M*-capacity by determining their ability to integrate these in response to compound visual stimuli. As subjects are taught the information necessary for task performance before they are tested, the responses actually produced reflect the extent of the subject's *M*-capacity and executive schemes only.

To date three versions of the Compound Stimulus Visual Information task have been developed; the Free Response procedure; the Delayed Response procedure; and the Tachistoscopic procedure. The major difference between the versions is the number of times subjects are able to look and respond to the compound stimuli. In the standard Free Response procedure the compound stimulus is presented for 5 seconds and subjects can begin responding upon presentation, and continue even when the stimulus is removed. In this procedure no control exists for the (temporal) executives employed by the subjects. Pascual-Leone (1970) has verified that the number of times subjects will attend (look and respond) to the stimulus is a function of the age related k parameter that determines the *M*-power of the subject ($Mp = e + k$). For example, 11 year-olds with an *M*-power of $e + 5$ will attend five times. However, Pascual-Leone (1970) and Globerson (1976) point out that field-dependent subjects frequently allocate to the task a measure of *M*-capacity inferior to their structural reserve. For this reason the standard Free Response procedure necessitates a methodological control for the pre-selection of field independent subjects only.

In contrast, the Delayed Response procedure provides a limited control for temporal executives in that the subject may respond only after the 5 second presentation of the compound stimuli. Here it is assumed that subjects make two attending acts, one in the presence of the stimuli and the second using the afterimage as a source of stimulus information. As a result of this limit on the number of attending acts possible, the Delayed Response procedure provides a control for the effects of field dependence-independence.

In the Tachistoscopic presentation, the subject is limited to a single observation (followed by a mask) of the stimulus on each 120 milisecond exposure. The strength of this procedure is that it permits a degree of differentiation between *M* and executive strategies. Since the subject has to request the repeated exposure of the stimulus, it is possible to empirically monitor the number of times s/he actually looks and responds thus providing a control for temporal executive efficiency. Further, since performance on the first tachistoscopic presentation is determined solely by the strength of the learned executive strategies (arousal executives) that mobilize *M* within specific centrations or across several centrations, the difference between *Ms* and *Mf* on the first look can be used as an indication of the d/efficiency of these executives.

3.4.2. OUTLINE OF STAGES:

The CSVI consists of three stages. In the first stage, all subjects learn a set of nine S-R pairs using a paired associate learning procedure. These associations constitute the basic knowledge units or schemes upon which test performance is based. Each S-R unit consists of a simple visual cue (e.g., square, red) and a corresponding motor response (e.g., clap-hands, stand-up) [See Figure 2, Chapter 4].

The second stage consists of a pre-test designed to ensure that the nine associations have been learned correctly. Four blocks of 10 slides are used and each slide contains one instance of each learned stimulus cue. Only subjects who pass the pre-test proceed to the next stage. Subjects who do not reach criterion (usually 40/40) are re-trained until the criterion is met. In this way, all subjects are equally familiar with the task content before testing of *M*-power commences.

The test consists of presenting subjects with compound stimuli (e.g., red square) constituted by the simple stimuli they have previously learned, to which they must respond with the corresponding motor responses (e.g., clap-hands and stand-up). Each of the 42 randomly presented compounds contain from two to eight simple stimuli. The critical feature of the CSVI is that learning or previous experience is controlled as all subjects who participate in the task have acquired the information (nine S-R units) necessary for test performance. As described earlier, the TCO predicts a specific *M* for each Piagetian developmental stage. Performance on the third stage of the CSVI then should reflect the *k* values predicted by the theory for each age group.

3.4.3 TASK ANALYSIS:

In the outline of Figure 1; section (2) given previously, the facilitating situation described has the effect of limiting the role of silent operators, other than *M*, in the production of an appropriate response. As such, it provides the context for the isolation and verification of the quantitative *k* estimates characteristic of each successive Piagetian developmental stage. The third stage of the CSVI constitutes such a facilitating situation.

As a result of learning, each of the nine S-R units are represented by separate schemes; initially an S-scheme and a R-scheme and the *L*-structure assigning the S to its R. Together the nine pairs of learned schemes constitute the subject's repertoire of schemes. Upon presentation of the compound stimuli, schemes are activated from this repertoire by the cues available in the stimuli. It is assumed that the schemes activated correspond in a one-to-one fashion to the compound stimuli and that the corresponding schemes to all the cues presented are activated and activated equally. These schemes then constitute the subject's field of activation. Since all the schemes activated are task relevant, the M-power of the subject now randomly boosts the schemes within this field in accordance with the subject's k capacity. From one to k schemes can receive mental attentional energy, depending on how this comes to be distributed across the schemes (allocation is random). The result is a set of M-boosted, task-relevant schemes which co-determine performance. As stated earlier, if the subject's M-capacity remains unsaturated at the point of evaluation, a further *A-O-E* process may be initiated.

Based on these assumptions and the predicted k capacity of the subject, the theoretical probabilities of subjects' producing a number *(x)* of relevant responses for a stimulus class *(Sn)* can be calculated using the Bose-Einstein statistic.

3.4.4 THE BOSE-EINSTEIN OCCUPANCY MODEL:

The analysis of the CSVI given above, can also be interpreted in terms of the Bose-Einstein Occupancy Model of Combinational Analysis. Occupancy models of combinational analysis deal with the outcomes (probabilities) generated by randomly throwing a number *(k)* of balls into a number *(n)* of cells and they establish how many cells will be filled by at least one ball after having thrown *k* balls. The balls in the model represent the *k* units of *M*-power and the cells represent the stimulus cues or schemes activated by the task. The number *(x)* of different responses produced by a subject corresponds to the number of cells filled by at least one ball at the end of the task. The point is that it is possible to compute theoretical predictions (probability distributions) against which the empirical data can be compared. According to the Bose-Einstein *(BE)* model, the probability that exactly *x* cells are filled with at least one ball when *n* is the number of cells available and *k* the number of balls thrown is:

$$\mathrm{Pr}(x) = \frac{\left[\frac{n}{n-x}\right]\left[\frac{k-1}{x-1}\right]}{\frac{n+k-1}{k}}$$

In terms of the CSVI, the Bose-Einstein distribution may be used to compute the probability that x number of responses are produced when n is the number of cues in the stimulus compound and k the number of units of M-power available to a subject. The important point to note is that whereas the parameter n is a function of the task (number of elements in the stimulus compound), the parameter k is theoretically derived from the TCO. Although k is a function of age, its value in the CSVI task will also depend on the number of times subjects attend (look and respond) to the compound stimulus or, in terms of the Bose-Einstein model, the number of times the set of balls is thrown into the cells. This is an important methodological consideration for cross-cultural research because it is possible to attribute performance differences either to the subjects' M-capacity or to the number of times subjects attend to the compound stimulus. For example, the performance of 13 year-olds with a predicted k of 6 who attend once, is equivalent to 6 balls in the Bose-Einstein model; for 7 year-olds with a predicted k of 3 who attend twice, the number of balls in the Bose-Einstein distribution is $3 \times 2 = 6$.

Different versions of the CSVI-BE may be used, in conjunction with the different versions of the CSVI itself, to avoid confounding the effects of M-capacity and the number of attending acts. In the free-response version, the assumption is that field-independent subjects look and respond *k* times yielding a value of k^2 in the Bose-Einstein model (Pascual-Leone, 1970). In the delayed response version, the assumption is that the number of attending acts is limited to two; one in the presence of the stimulus and one using the afterimage as a source of stimulus information. This yields a $2k$ value in the model. The tachistoscopic version enables the number of looks to be determined empirically and the first look provides a relatively pure measure of *M*-power.

By substituting the age related *k* values derived from the TCO into the adjusted Bose-Einstein formula (See Pascual-Leone, 1970 for details of adjustment), it is possible to compute for each stimulus class *(Sn)*, where *n* is the number of cues in the compound stimulus, the probability that one to *n* number of responses will be produced by subjects of a given age. Against these theoretical probabilities, the empirical probabilities based on the actual number of responses produced by the subjects can be computed. If there is a close correspondence between the obtained empirical and theoretical distributions, it may be concluded that the theoretical model provides a good explanation of the phenomenon in question, in particular for the systematic improvements with age. (See appendix A for worked example)

3.5. REVIEW OF SOME DISPARATE FINDINGS IN STUDIES USING THE CSVI.

The empirical evidence supporting the quantitative predictions reflecting the universal developmental construct *M* of the TCO has been impressive (Pascual-Leone and Smith, 1969; Pascual-Leone, 1970; DeAvila, Havassay and Pascual-Leone, 1976; Pascual-Leone and Goodman, 1979; Goodman, 1979; Case, 1979; M.S. Miller, 1980; Globerson, 1981; Parkinson, 1985; Juckes, 1985/1986; and R. Miller, Pascual-Leone, Campbell and Juckes, 1989.)

Two studies using the Tachistoscopic version of the CSVI have not found the predicted increase in *M*-power across age. In both studies, however, field-independent subjects were not pre-selected. Miller (1980) tested high and low SES Canadian children aged 9-10 years and 11-12 years. Although the high SES subjects performed at the predicted levels, the low SES 11-12 year-olds performed at the same level as the younger 9-10 year-olds. Juckes (1987) reported similar findings for Zulu-speaking township children. In his sample, 11 and 13 year-olds performed at the same level as the 9 year-olds. Juckes also reported that the mean number of looks (attending acts) for both age groups was 1.6. In both studies, the underperformance of the older subjects is attributed to executive processing deficiencies (arousal and temporal executives) that mobilize the application of *M*-power in a given task rather than to different *M*-capacity for children from different backgrounds. Following on Juckes' work, a pilot study was conducted (Andrew, 1987) in which subjects tested by Juckes were trained, using a different task, to identify objects presented tachistoscopically. These subjects were then tested on the CSVI and they performed at the predicted level. These tentative findings provided the impetus for the present study

The present study was designed to assess the role of executive processing on CSVI performance by extending the initial training to include not only familiarity with the task content but also with the task-relevant executives. The aim of the study was to ascertain the effect on performance if subjects are trained to use arousal executives and temporal executives that maximize the application of *M*-power and increase the number of times subjects attend and respond to the stimulus.

NOTES:

1 A performance model constitutes a machine-like, psychological model capable of generating the type of competencies described within any purely descriptive/ normative "competence model".

2 A term used to stress the importance of the active cognitive processing of the subject.

3 The principle that in any given situation schemes, under minimal conditions of satisfaction, rush to apply their particular organized set of actions to that situation.

4 Some schemes have an added terminal component (tc).

4.0. METHOD

4.1. SUBJECTS:

All the subjects (N=114) were Zulu-speaking children aged 11 (N=59) and 13 (N=55) years living in a township (Indaleni) adjacent to Richmond (Natal). Conditions of life in Indaleni are harsh for the vast majority of inhabitants and in comparison with their white middle-class peers the children of Indaleni are severely disadvantaged. The subjects in each age group were randomly assigned to three experimental groups (see design below). For each age group, the sample sizes, mean ages and age range, sex, and educational level are provided in table 2.

Table 2:

Mean age and age range, number of subjects (N), sex (F,M), and school grade for each experimental group.

		Mean	Age				Grade				
Age	Group	Age	Range	N	F	M	2	3	4	5	6
11	AT[a]	11:4	11:2-11:8	19	6	13	11	5	3	0	0
	TA[b]	11:4	11:0-11:9	20	9	11	0	7	4	6	3
	C[c]	11:4	11:0-11:7	20	11	9	0	15	0	0	5
13	AT	13:2	13:0-13:7	19	7	12	1	9	2	4	3
	TA	13:3	13:0-13:7	18	9	9	0	3	2	7	6
	C	13:4	13:0-13:7	18	8	10	0	3	11	0	4

[a]AT=Arousal followed by Temporal Training
[b]TA=Temporal followed by Arousal Training [c]C=Control

From table 2, it is evident that 24% (14) of the 11 year-olds were in grades 5 or 6, the age appropriate grade-level for this age; none of the 13 year-olds were in grades 7 or 8 and more than 50% were in grades 3 and 4.

4.2. CSVI: TRAINING AND TESTING:

The tachistoscopic version of the CSVI was used. The instructions and procedures for training were based on those adopted by Goodman (1979). Only a summary of the training procedure is provided (For a detailed description see Goodman, 1979, pp.397-400). The training was conducted in Zulu by the research assistants (See Appendix B for English instructions and Zulu translation).

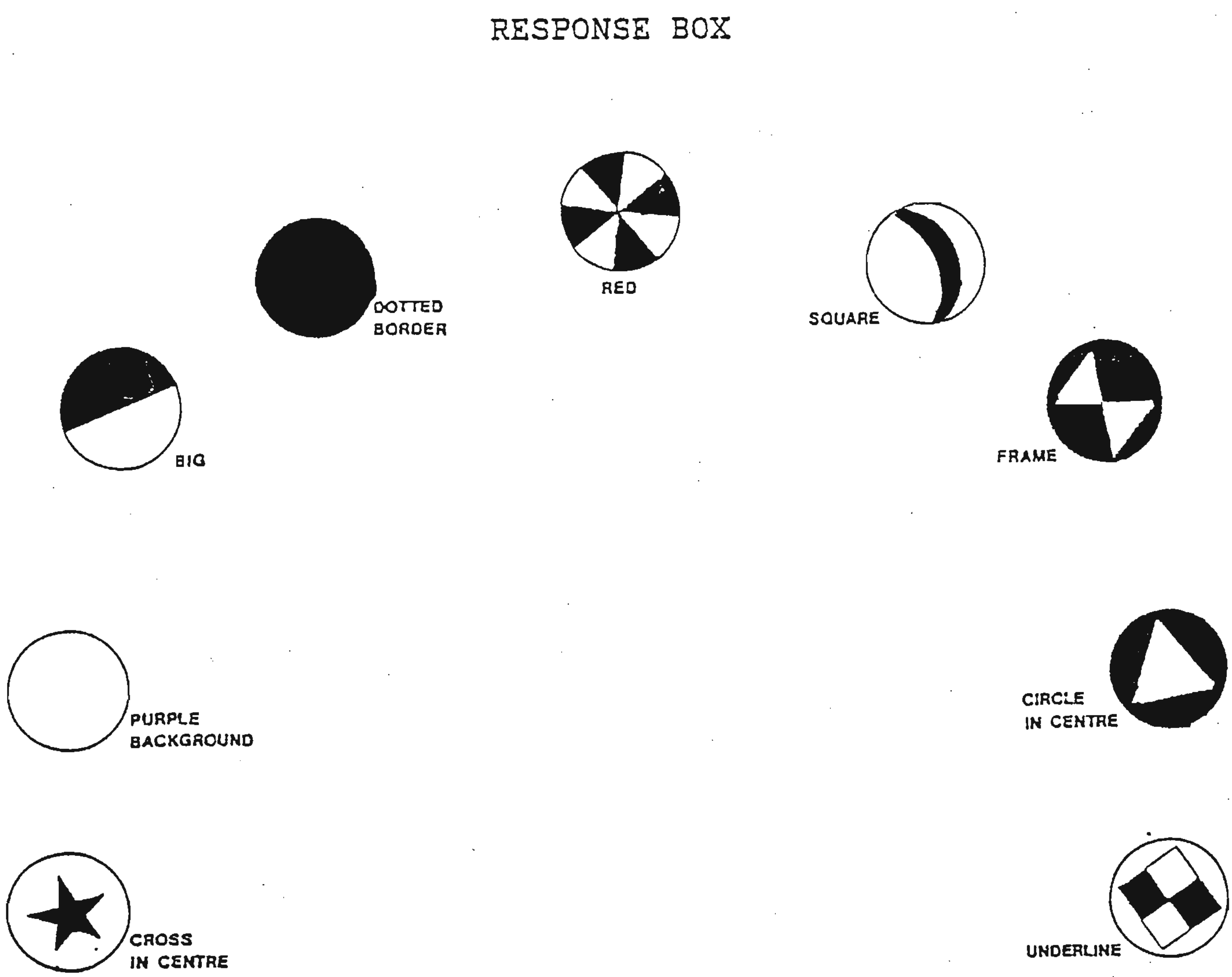
After introducing the nine S-R pairs, subjects are trained using cards that contain only one stimulus cue. Subjects were trained in groups of six on a Friday. After training was completed, the subjects were tested on the nine S-R pairs. Four blocks of 10 cards were used and each card contained one instance of each learned stimulus cue. The cards were randomized within each block. Subjects that did not meet the criterion of 40 out of 40 correct responses were re-trained until the criterion was reached. Testing on the CSVI commenced the following Monday after a short warm-up session. Testing was conducted in Zulu by a female research assistant.

Testing on the CSVI involves presenting subjects with compound stimuli ranging from 2 to 8 stimulus cues (i.e., stimulus classes). Subjects are informed that they will receive cards with more than one stimulus cue and that they should produce all the relevant responses. Six blocks of seven cards are used for testing. Each block contains one instance of each stimulus class (from 2 to 8 compound cues) and each block is randomized for order of presentation of the stimulus classes. The compound stimulus is exposed for 120 milliseconds followed by a mask and the subjects respond immediately.

In the present study, in place of motor responses such as 'clap-hands', subjects were required to press buttons on a response display box similar to that used by Pascual-Leone and Goodman (1979), and Parkinson (1975a). The configuration of buttons with their distinctive patterns and associated stimuli are illustrated in Figure 2. Although Figure 2 also contains the names (e.g., purple background, big) of the cues presented to the subjects by means of display cards, these do not appear on the actual response box. The box is constructed such that

FIGURE 2:

The configuration of buttons and associated stimuli on the response box as used in the present study.



when a button is pressed a corresponding light is activated on a recording panel enabling subjects' responses to be recorded and subsequently scored.

4.3. AROUSAL AND TEMPORAL EXECUTIVE TRAINING:

The Executive Training (ET) procedures utilize a set of slides which contain eight common objects and/or animals (See Figure 3). These slides are presented tachistoscopically and, depending upon the particular ET condition, subjects receive monetary rewards for correct responses. Two different procedures were used to train for arousal (ET-A) and temporal executives (ET-T).

4.3.1. ET-A:

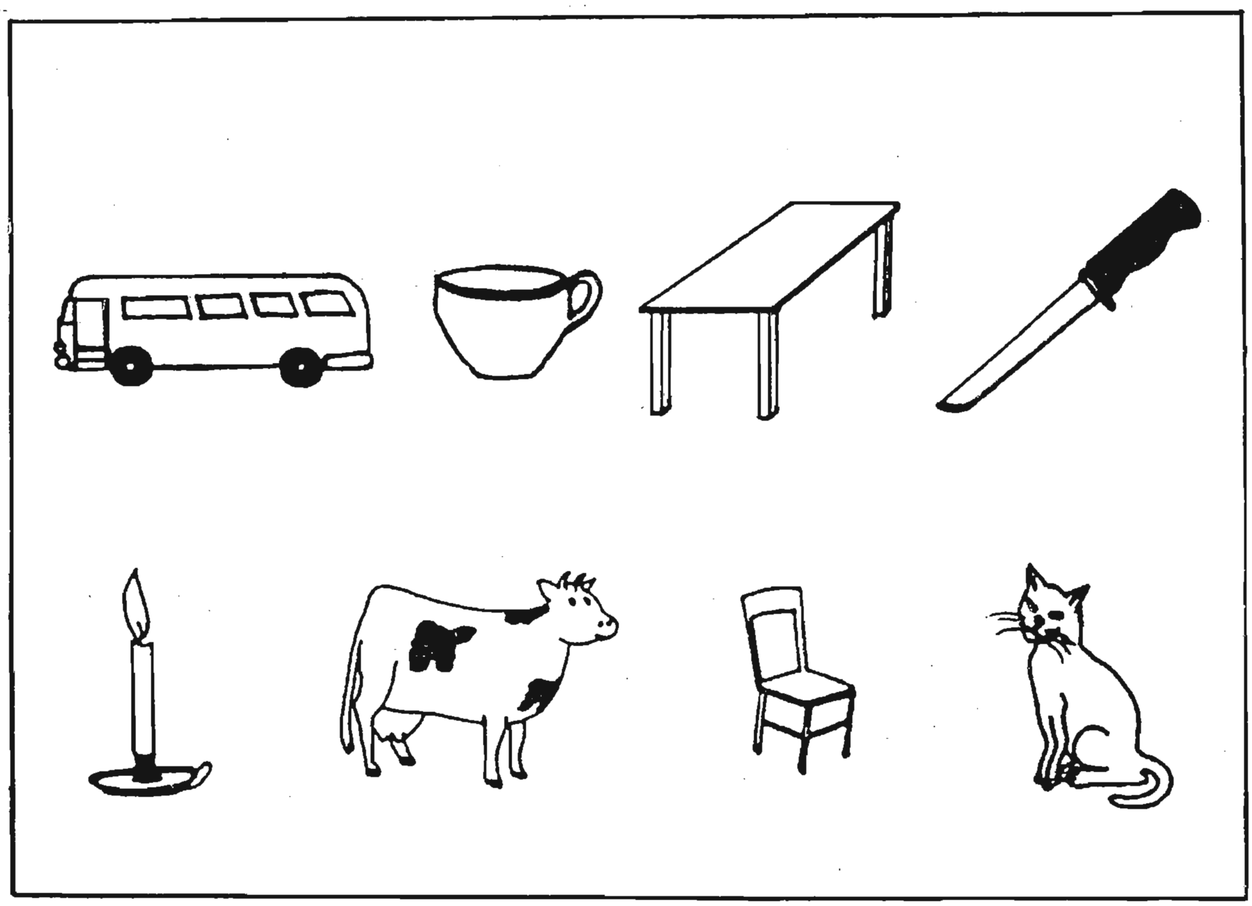
Four sets of 10 slides in each set are used. The first set is presented with a single exposure of 1 second per slide and thereafter the exposure time is halved for each successive set reaching 125 milliseconds on the fourth set. Subjects are required to identify the eight objects/animals present in the slides. To encourage efficient arousal executive use, for each correct response subjects receive 1, 2, 3, and 4 cents for the first, second, third, and fourth sets of slides, respectively. Thus subjects stand to gain 80 cents for the first set and 320 cents for the fourth set.

4.3.2. ET-T:

Twenty-eight slides are each exposed for 1 second. However, subjects may select any number of exposures for each slide. For each slide, subjects are provided with response sheets containing from 2 to 8 pictures of objects/animals and are simply required to indicate whether the objects/animals on the response sheet are included in the presented slide. Subjects are rewarded with 10 cents for correct identification and no reward is received for incorrect identification. The reward system is intended to encourage efficient temporal executive use as more items on the response sheet or slide require more exposures of the slide to ensure success.

FIGURE 3:

Example of an executive training card containing eight object/animal combinations.



4.4. DESIGN AND PROCEDURE:

Subjects in each of the two age groups were randomly assigned to three experimental groups. After initial training and testing on the CSVI (CSVI-1), one group (AT) received arousal executive training and another group (TA) temporal executive training before being tested again on the CSVI (CSVI-2). The third group (C) served as a control and received no training but was retested after the same time interval on the CSVI. After this second testing on the CSVI, subjects that had previously received arousal executive training were given temporal training and visa-versa while the control group continued to receive no training. Following training all the subjects were retested a third time on the CSVI (CSVI-3). The design is illustrated in table 3.

Table 3:

Experimental design and procedure.

FRIDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
AT[a]					
CSVI TRAIN	CSVI-1 TEST	ET[d]-A	CSVI-2 TEST	ET-T	CSVI-3 TEST
TA[b]					
CSVI TRAIN	CSVI-1 TEST	ET-T	CSVI-2 TEST	ET-A	CSVI-3 TEST
C[c]					
CSVI TRAIN	CSVI-1 TEST	NIL	CSVI-2 TEST	NIL	CSVI-3 TEST

[a]AT=Arousal followed by Temporal Training
[b]TA=Temporal followed by Arousal Training
[c]C=Control [d]Executive training

3.5. SCORING:

For each stimulus presentation a subject can produce from 1 to *n* correct responses for any stimulus class n. The stimulus classes (*Sn*) are constituted by compound stimuli having 2, 3, 4, 5, 6, 7, and 8 stimulus cues (S^2, S^3, S^4, S^5, S^6, S^7, S^8,). If, for example, a compound stimulus with 6 cues is presented (S^6), a subject may produce from one to six responses.

The number of correct responses produced represents a subject's score for that particular stimulus. Only correct responses are scored, and no-response instances are excluded from the analysis. From these values mean scores and variances are calculated for each stimulus class and the total task. The proportion of correct responses for each stimulus class is calculated by dividing the mean score by the stimulus class value. For example, a mean score of 2.4 for stimulus class 4 yields a proportion of .6 correct responses. The proportional distributions of correct responses are compared with theoretical Bose-Einstein distributions.

5.0 RESULTS

5.1 OVERVIEW

The standard analysis of the CSVI in terms of the Bose-Eienstein model of combinatorial statistics involves the calculation of the empirical proportion of correct responses per stimulus class and the comparison of these to the theoretically predicted proportions calculated on the basis of an assumed *M*-capacity. The analysis of the present findings yielded somewhat anomalous results with subjects improving from underperformance to overperformance with repeated testing. In an attempt to understand these findings a secondary analysis of the results was carried out which yielded a theoretically valid interpretation of the seemingly anomalous findings. In the presentation of these findings the results of the standard Bose-Einstein analysis are given in the first section, headed Primary Analysis, while the section headed Secondary Analysis contains the theory based analysis and explanation of this overperformance.

5.2 PRIMARY ANALYSIS

The empirical distributions (proportion of correct responses) for each age, CSVI test, experimental group, and the two training groups combined (AT+TA), are given in table 4 for the first look and in table 5 for repeated looks. The mean looks per stimulus class are also given in table 5.

For the first look, the Kolmogorov-Smirnov two-sample test (see Appendix C) does not yield any significant differences for the 11 year-olds between the distributions for the AT and TA training groups on any of the three CSVI tests. Similarly, no significant differences are obtained when the two training groups are combined and compared with the control group on any of the CSVI tests. The results are the same for the 13 year-olds with one exception. On the first CSVI test, the TA group performs significantly better than the AT group but on the second and third CSVI tests no significant differences obtain.

Table 4:

First look: Distributions of correct responses for each age, CSVI test, experimental group, and the two training groups combined

			Stimulus class						
Age	**CSVI**	**Group**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
11 Yrs									
	1								
		AT[a]	.83	.67	.56	.47	.44	.42	.41
		TA[b]	.78	.66	.58	.51	.47	.42	.38
		C[c]	.78	.64	.55	.49	.44	.42	.39
		AT+TA	.80	.67	.57	.49	.46	.42	.39
	2								
		AT	.87	.74	.64	.52	.48	.50	.43
		TA	.90	.73	.67	.57	.55	.49	.48
		C	.83	.77	.65	.60	.51	.49	.48
		AT+TA	.88	.74	.65	.55	.52	.49	.46
	3								
		AT	.91	.78	.72	.60	.56	.53	.49
		TA	.93	.76	.67	.60	.56	.51	.49
		C	.85	.75	.70	.60	.58	.51	.52
		AT+TA	.92	.77	.69	.59	.56	.52	.49
13 Yrs									
	1								
		AT	.76	.63	.56	.50	.49	.47	.45
		TA	.82	.74	.63	.60	.50	.48	.46
		C	.83	.71	.57	.52	.48	.45	.43
		AT+TA	.79	.68	.59	.55	.50	.48	.45
	2								
		AT	.90	.77	.70	.57	.58	.57	.49
		TA	.89	.80	.71	.62	.59	.52	.50
		C	.86	.74	.63	.62	.59	.54	.53
		AT+TA	.90	.78	.70	.60	.59	.54	.49
	3								
		AT	.95	.81	.71	.65	.59	.56	.55
		TA	.96	.82	.75	.67	.63	.57	.56
		C	.90	.81	.73	.64	.62	.58	.54
		AT+TA	.95	.81	.73	.66	.61	.57	.55

[a]AT=Arousal followed by Temporal Training
[b]TA=Temporal followed by Arousal Training
[c]C=Control

Table 5:

Repeated looks: Mean looks per stimulus class and distributions of correct responses for each age, CSVI test, experimental group, and the two training groups combined

				Stimulus class						
Age	CSVI	Group	Looks	2	3	4	5	6	7	8
11 Yrs										
	1	AT[a]	1.89	.94	.88	.79	.72	.70	.67	.62
		TA[b]	2.12	.89	.83	.84	.78	.73	.70	.69
		C[c]	1.93	.89	.81	.77	.73	.67	.67	.63
		AT+TA	2.00	.91	.85	.82	.75	.71	.69	.66
	2	AT	1.85	.96	.91	.87	.78	.74	.72	.67
		TA	2.10	.96	.86	.87	.81	.79	.74	.75
		C	1.74	.90	.86	.82	.81	.74	.73	.72
		AT+TA	1.98	.96	.88	.87	.80	.77	.73	.71
	3	AT	1.77	.97	.92	.88	.81	.79	.77	.71
		TA	2.04	.98	.86	.87	.82	.81	.78	.75
		C	1.77	.91	.90	.85	.81	.78	.74	.76
		AT+TA	1.91	.97	.89	.87	.81	.80	.77	.73
13 Yrs										
	1	AT	1.81	.93	.80	.74	.67	.66	.65	.60
		TA	1.98	.93	.86	.80	.76	.70	.68	.64
		C	1.82	.93	.84	.78	.70	.67	.64	.60
		AT+TA	1.89	.93	.83	.77	.71	.68	.66	.62
	2	AT	1.63	.96	.88	.84	.77	.75	.74	.66
		TA	2.13	.96	.90	.86	.84	.79	.75	.71
		C	1.75	.92	.85	.80	.74	.73	.69	.68
		AT+TA	1.88	.96	.89	.85	.80	.77	.74	.68
	3	AT	1.57	.95	.89	.84	.80	.76	.76	.74
		TA	1.98	.98	.90	.89	.83	.78	.75	.77
		C	1.68	.94	.91	.87	.79	.78	.73	.72
		AT+TA	1.78	.97	.89	.87	.81	.77	.75	.75

[a]AT=Arousal followed by Temporal Training
[b]TA=Temporal followed by Arousal Training
[c]C=Control

For repeated looks, no significant differences are obtained (on the Kolmogorov-Smirnov two sample test) for 11 or 13 year-olds between the two training groups or between the combined training groups and the control groups on any of the CSVI tests (See Appendix C). The mean looks per stimulus class are higher for 11 than 13 year-olds for each experimental group and declines over the three CSVI tests for both ages, with the exception of the TA groups. For these groups, there is very little change over the three tests and 13 year-old subjects look more on the second CSVI test than on the first or third test.

For the first look, the combined distributions for the three experimental groups for 11 and 13 year-olds are given in table 6. The Bose-Einstein theoretical distributions for *k* values (number of balls) of 4, 5, 6 and 7 that according to the TCO are appropriate for 9, 11, 13 and 15 year-olds, respectively, are also provided in table 6. These data are presented graphically in figures 4, 5, and 6.

Table 6:

First look: Combined distributions of correct scores for 11 and 13 year-olds and theoretical distributions for k values of 4, 5, 6, and 7

			Stimulus class						
Age	**CSVI**	**k**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
11 Yrs									
	1		.79	.66	.56	.49	.45	.42	.39
	2		.87	.75	.65	.56	.51	.49	.47
	3		.90	.76	.69	.60	.56	.52	.50
13 Yrs									
	1		.80	.69	.59	.54	.49	.47	.44
	2		.89	.77	.68	.61	.59	.54	.50
	3		.93	.81	.73	.65	.61	.57	.55
		4	.80	.67	.57	.50	.45	.42	.39
		5	.83	.71	.63	.56	.48	.43	.42
		6	.86	.75	.67	.60	.55	.50	.46
		7	.88	.78	.70	.64	.58	.54	.50

FIGURE 4:
First look; combined empirical distributions for the three experimental groups for 11 year-olds and corresponding theoretical distributions

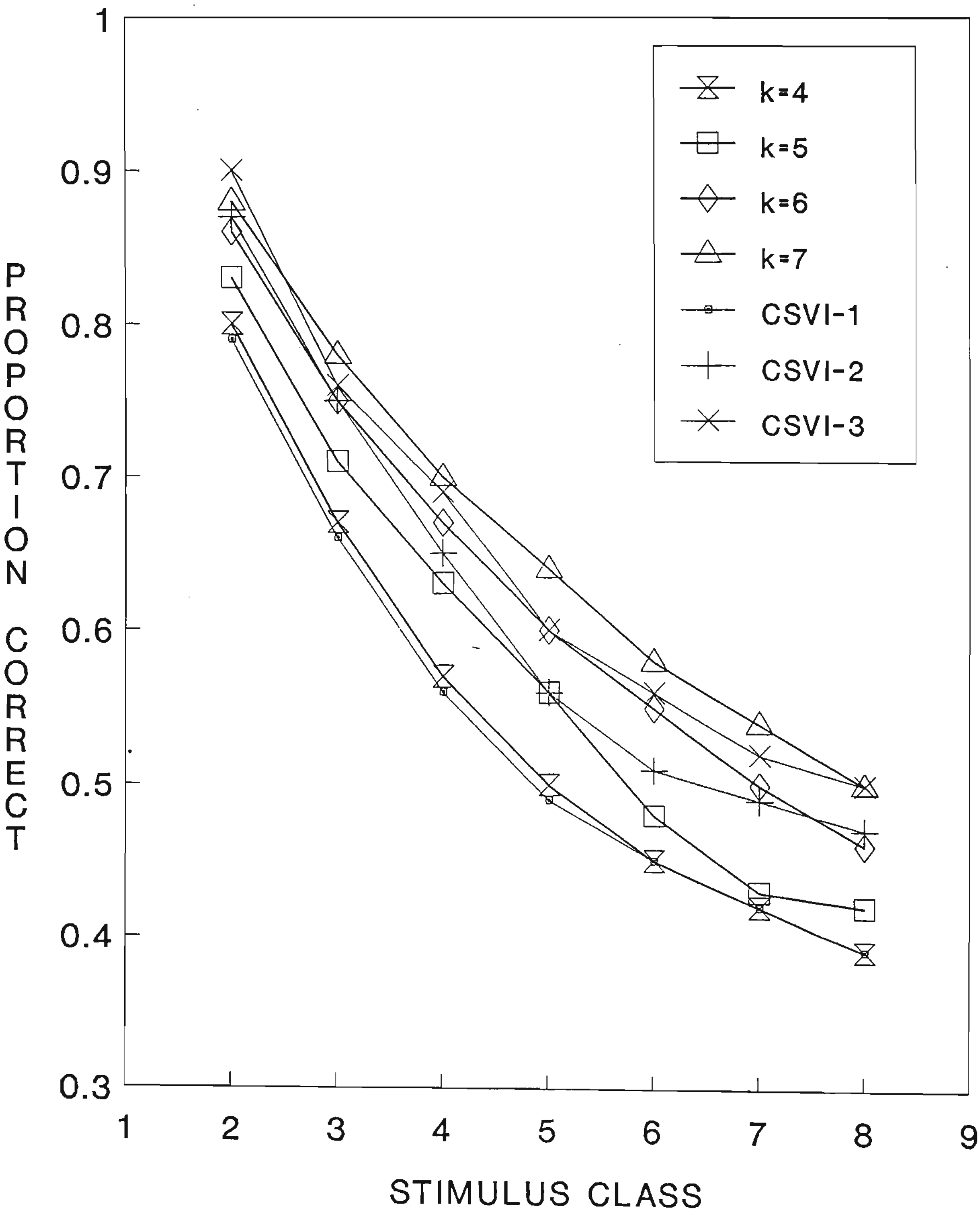


FIGURE 5:
First look; combined empirical distributions for the three experimental groups for 13 year-olds and corresponding theoretical distributions

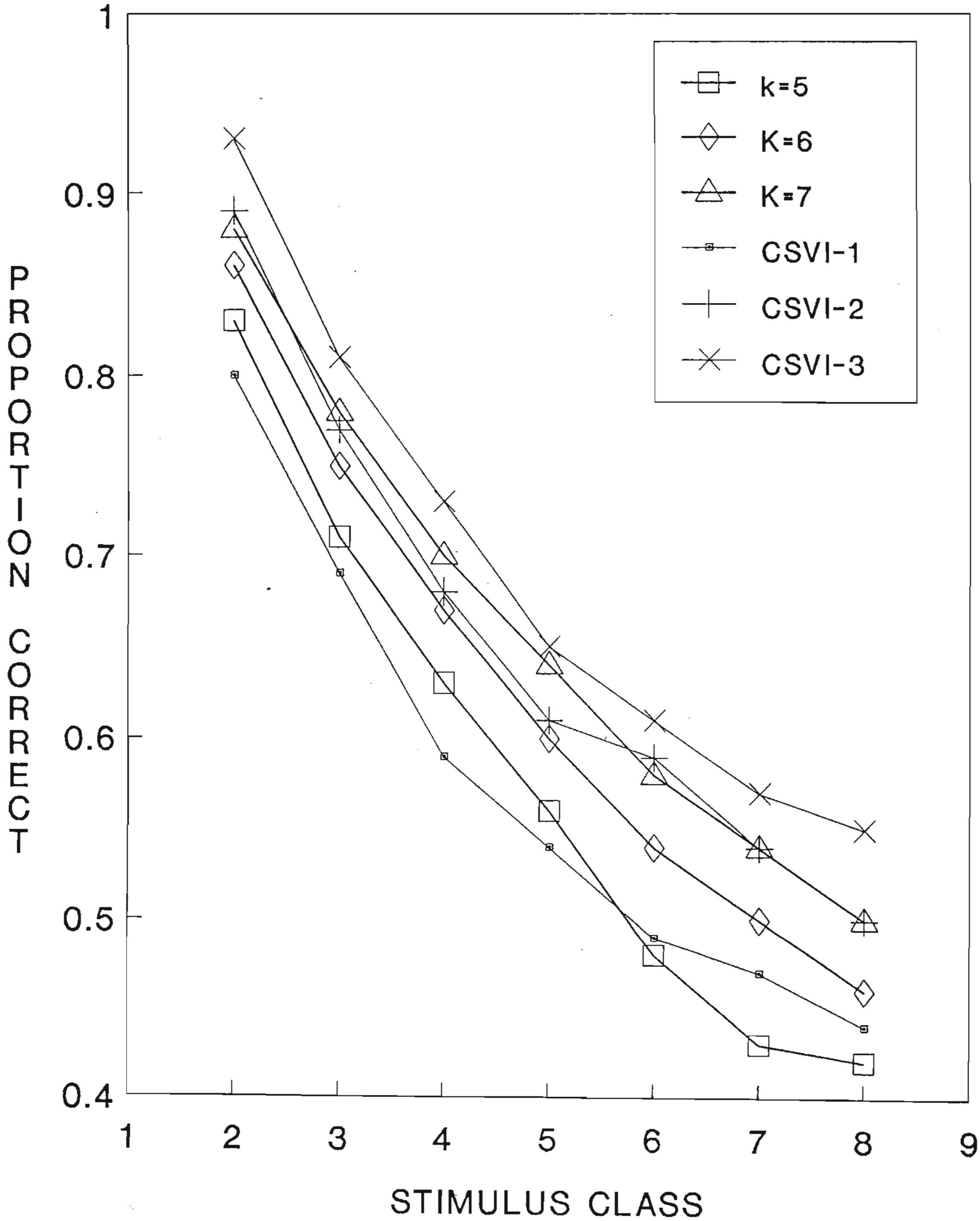
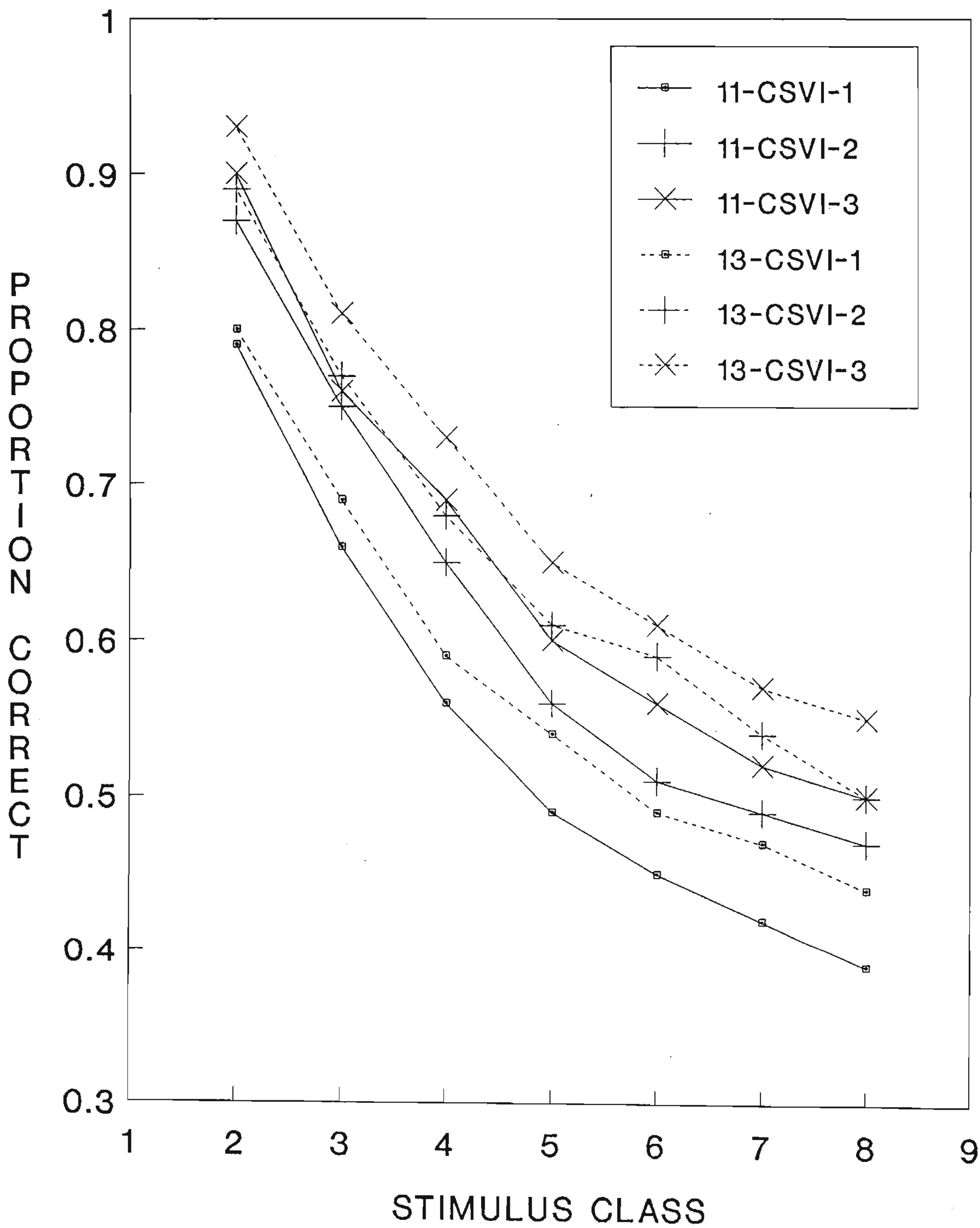


FIGURE 6:
First look; empirical distributions for 11 and 13 year-olds combined.



Task performance improves steadily across the three CSVI tests for both age groups. In each of the three training conditions subjects underperform on the first test, relative to theoretical predictions. Performance for the 11 year-olds corresponds closely to the theoretical distribution predicted for 9 years (k = 4) and for the 13 year-olds corresponds to that predicted for 11 years (k = 5). On the second CSVI, subjects in both age-groups overperform; 11 year-olds approaching the level predicted for 13 years (k = 6); 13 year-olds approaching the level predicted for 15 years (k = 7). On the third CSVI both age groups continue to improve.

For repeated looks, the mean looks per stimulus class and the combined distributions for for the three experimental groups for 11 and 13 year-olds are given in table 7. The Bose-Einstein theoretical distributions for 12, 16 and 20 balls, are also provided in table 7. There are no significant differences on the Kolmogorov-Smirnov two sample test between the distributions of the 11 and 13 year-olds on any of the CSVI tests (See Appendix C). The combined distributions for both age groups and the theoretical distributions are presented in figure 7. Performance improves steadily across the three CSVI tests. The mean looks per stimulus class are higher for 11 than 13 year-olds and for both ages decline over the three CSVI tests.

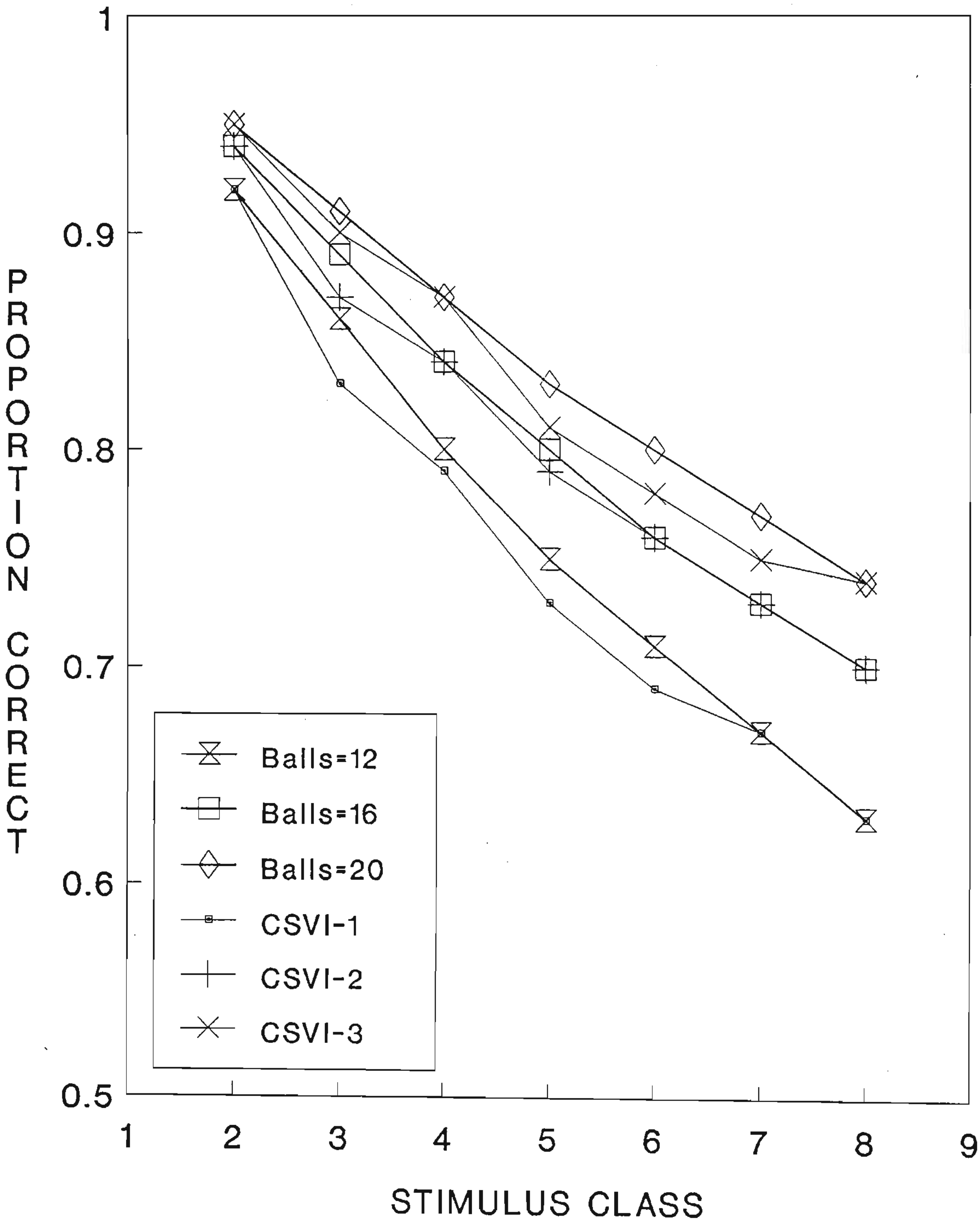
Table 7:

Repeated looks: Mean looks per stimulus class, combined distributions of correct scores for 11 and 13 year-olds and theoretical distributions corresponding to balls in the Bose-Einstein model

				Stimulus class						
Age	**CSVI**	**Looks**	**Balls**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
11 Yrs										
	1	1.99	(12)	.91	.84	.80	.74	.70	.68	.65
	2	1.90	(16)	.94	.87	.85	.80	.76	.73	.71
	3	1.86	(20)	.95	.90	.86	.81	.79	.76	.74
13 Yrs										
	1	1.87	(12)	.93	.83	.77	.71	.68	.66	.61
	2	1.82	(16)	.95	.87	.83	.78	.76	.73	.68
	3	1.75	(20)	.96	.90	.87	.80	.78	.74	.74
			12	.92	.86	.80	.75	.71	.67	.63
			16	.94	.89	.84	.80	.76	.73	.70
			20	.95	.91	.87	.83	.80	.77	.74

Note The number of balls in brackets indicate the fit between the empirical distributions and the theoretical distribution for that number of balls.

FIGURE 7:
Repeated looks; empirical distributions for 11 and 13 year-olds combined and corresponding theoretical distributions.



The analysis of performance on the CSVI using the Bose-Einstein model has, until now, focused upon the combined performance of subjects of the same age. In the process it is probable that the general underperformance found on the first look of the first CSVI masks the target performance of at least some individuals of that age group. As a result, the individual variability within age groups for both 11 and 13 year-olds on the first look of the first CSVI was calculated and is presented in table 8. The table indicates the percentage of subjects within each age group who perform below, at, or above the theoretically anticipated age appropriate level. These percentages indicate that, despite an overall underperformance for both ages on the first look analysis of the first CSVI, a large proportion of subjects within the respective samples actually perform in accord with theoretical predictions.

Table 8:

First look, first CSVI: Individual variability within age-groups.

Age-group:	11 yrs.	13 yrs.
Under-performance:	54.2%	70.6%
Target-performance:	18.7%	11.8%
Over-performance:	27.1%	23.6%

5.3 SECONDARY ANALYSIS

The results of the primary analysis indicate an initial underperformance on the first look of the first CSVI but overperformance on the repeated looks measure of the *first* and subsequent CSVI tests. The initial underperformance on the first look of the first CSVI was anticipated by the present study on the basis of the performance of subjects drawn from the same population in the study conducted by Juckes (1987). However the subsequent overperformance of the subjects on the repeated looks measure of the *first* and subsequent CSVI's was not anticipated. Theoretically the repeated looks measure of the CSVI should yield k estimates approximating that obtained on the first look. In an attempt to explain this improved performance across looks, an analysis of the second look as a first look was made. If, as is the case, subjects underperform on the first look of the first CSVI but overperform on the repeated looks measure then the basis for the improvement must lie in the performance of subjects between looks. Thus an analysis of the second look as a first look should provide the basis for a comparison of the subjects performance between the first and subsequent exposures of the stimuli.

For the second look of the first CSVI (analyzed as a first look), the combined distributions for the three experimental groups for 11 and 13 year-olds, as well as the Bose-Einstein theoretical distributions for 3 and 4 balls are given in table 9.

Table 9:

Second look, first CSVI: Combined distributions of correct scores for 11 and 13 year-olds and theoretical distributions corresponding to balls in the Bose-Einstein model

				Stimulus class						
Age	**Looks**	**Balls**	**k**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
11 Yrs	0.81	(3.2)	4	.57	.49	.47	.46	.41	.42	.40
13 Yrs	0.82	(3.2)	4	.68	.51	.47	.44	.43	.38	.36
		3		.75	.60	.52	.43	.38	.34	.30
		4		.80	.67	.57	.50	.45	.42	.39

Note

1. The number of balls in brackets indicate the fit between the empirical distributions and the theoretical distribution for that number of balls.

2. The k value indicated is derived in the division of the number of balls by the number of looks made.

The results indicate that, on subsequent exposure of the compound stimulus cards, both the 11 and 13 year-olds display a k of 4. In other words the 11 year-olds continue to display a k equivalent to that displayed on the first look, while the 13 year-olds function with a reduced k. This suggests that the overperformance displayed on the repeated measure is the result of some strategy which reduces the M-demand of the task between exposures of the stimulus compound. One such strategy would be to reduce the number of repeats between looks. The Bose-Einstein occupancy model, in its generation of the theoretical distributions, anticipates a percentage of responses to be repeated between looks. In terms of performance this means that the k available for the production of new responses is reduced with repeated exposures. Thus if subjects developed a strategy that significantly reduced the number of repeats made on subsequent exposures, subjects could satisfy task demands with a k below that theoretically necessary to do so. In investigating this possibility the theoretically anticipated proportion of "new" and "repeat" responses on the second look of the first CSVI for both 11 and 13 year-olds was derived from the Bose-Eienstein theoretical distributions (See Appendix D for derivation). This indicated that for subjects functioning with a k of 4 on the first look of the CSVI one would anticipate that of all the responses made on subsequent exposures of a stimulus compound 30.2% would be new responses and 69.8% would be repeats. Similarly for subjects functioning with a *k* of 5 on the first look of the CSVI, 31.8% of all responses would be new responses and 68.2% would be repeats. These theoretically anticipated proportions are presented in table 10 along with the empirical proportion of new and repeat responses actually obtained by the 11 and 13 year-olds respectively. A comparison of the theoretical and empirical proportions indicates that both 11 and 13 year-olds produce significantly more new responses on the second look of the first CSVI than that theoretically anticipated given the *k* capacity evident on the first look of the first CSVI. Of all the responses made by the 11 year-olds 59% were new responses and only 41% were repeats. Similarly, 45.4% of the responses made by 13 year-olds were new responses and only 54.6% were repeats.

Table 10:

Second look, First CSVI: Theoretical and empirical proportion repeats and new responses.

Theoretical:	11 yrs. 2k=8	13 yrs. 2k=10
Total task:	2.454	2.617
New:		
Mean:	.741	.817
Prop:	.302	.318
% :	30.2	31.8
Repeats:		
Mean:	1.713	1.800
Prop:	.698	.682
% :	69.8	68.2

Empirical:	Control	Arousal	Temporal	Combined
11 yrs.				
Total:	84	85	79	82.6
New:				
Mean:	46.1	48.8	51.4	48.7
Prop:	.548	.573	.651	.590
% :	54.8	57.3	65.1	59
Repeat:				
Mean:	37.9	36.4	27.6	33.9
Prop:	.452	.427	.349	.410
% :	45.2	42.7	34.9	41.0
13 yrs.				
Total:	70	84	74	76.2
New:				
Mean:	36.9	32.0	35.1	34.6
Prop:	.524	.380	.475	.454
% :	52.4	38.0	47.5	45.4
Repeat:				
Mean:	33.6	52.3	38.8	41.6
Prop:	.476	.620	.525	.546
% :	47.6	62.0	52.5	54.6

6.0 DISCUSSION

The primary aim of the present study was to investigate the effect on performance if subjects are trained to use arousal and temporal executives that maximize the application of *M*-power and increase the number of times subjects attend and respond to the stimulus. As is evident from the primary analysis however, training does not appear to effect performance. For the first look, no significant differences were evident between the various experimental groups indicating that the training, in particular arousal training, was not effective. Similarly for repeated looks, there are no training, in particular temporal training, effects.

The results for the first look however, do indicate clear developmental effects across the three CSVI tests with older subjects consistently performing at higher levels than younger subjects. Further, the analysis of the first look of the first CSVI indicates an initial underperformance for subjects of both age groups with 11 year-olds displaying a k equivalent to that expected of 9 year-olds and 13 year-olds a k equivalent to that expected of 11 year-olds. These results confirm previous findings of underperformance with children drawn from the same schools (Juckes, 1987; Andrew, 1987) and at the same time point to the problem of time differences in the acquisition of stage related competencies often evident in Piagetian and neo-Piagetian cross-cultural research.

It would seem evident that the non-Western (disadvantaged) subjects of this study do not display the same rate of cognitive development as their Western (advantaged) peers. However two factors are important in this regard. Firstly, the analysis of performance on the CSVI using the Bose-Einstein statistic focuses on the combined performance of subjects of the same age. In this process the general underperformance found on the first look of the CSVI masks the target performance of a significant number of individuals within each age group. In the present study, 54.2% of the 11 year-olds underperformed but a significant 45.8% either performed at the predicted age appropriate level or overperformed. A similar trend is evident in the individual analysis of the performance of the 13 year-olds, with 35.4 % performing at or above the age appropriate level. Thus, despite an overall underperformance for both age groups, a large proportion of subjects actually perform in accord with age related theoretical predictions. Secondly, the underperformance displayed by the subjects occurred only on the first look of the first

CSVI. Performance on the repeated looks measure of the first and subsequent CSVI's demonstrates a continued improvement to the point where performance yields distributions that are well above those predicted by a strategy free probabilistic model.

Taken together these findings indicate the danger of generalized comparisons which are made on the basis of manifest performance and highlights the necessity for a more thorough investigation into the role of intra-individual and inter-individual factors in determining performance. Related to this is the problem of task equivalence in cross-cultural research. Even a test such as the CSVI, in which subjects are pretrained and equally familiar with the task content, does not entirely remove the problem of task equivalence across subjects with different learning experiences.

The importance of the effect of appropriate learning experiences is demonstrated in the present study where subjects move from underperformance to overperformance with repeated exposure to the task. The initial underperformance obtained in the present study was anticipated on the basis of the performance of subjects drawn from the same population in a previous study conducted by Juckes (1987). However, the subsequent overperformance after repeated exposure to the task was not anticipated. Theoretically the repeated looks measure of the CSVI should yield *k* estimates approximating those obtained on the first look. In terms of the Bose-Einstein distribution, the appropriate number of balls for two looks is twice *k* (2*k*). The obtained empirical findings yield distributions that fit 12, 16 and 20 ball models for the first, second and third CSVI tests. This would require *k* values of 6, 8 and 10 and these are higher than those actually obtained in the present study and in other studies using different versions of the CSVI.

In an attempt to investigate this improved performance across looks an analysis of the second look as a first look was made. If, as is the case, subjects underperform on the first look of the first CSVI but overperform on the repeated looks measure of the CSVI then the source of the improvement must lie in the praxis of subjects between looks. An analysis of the second look as a first look thus provides the basis for a comparison of performance between the first and subsequent exposures of the stimulus compounds.

This analysis indicates that on subsequent exposures of the stimulus compounds 11 year-olds continue to display a *k* equivalent to that used on the first look, while 13 year-olds function with a reduced *k*. This suggests that the overperformance displayed on the repeated look measure is the result of some strategy which reduces the *M*-demand of the task between exposures of the stimulus compounds. In investigating this possibility the theoretically anticipated proportion of "new" and "repeat" responses between exposures was derived from the Bose-Einstein theoretical distributions (See Appendix D for derivation). This indicated that 11 year-olds made almost twice as many new responses than that anticipated by a strategy free probabilistic model while the 13 year-olds made 1.5 times as many new responses than that anticipated. This clearly indicates the use of some strategy on the part of both the 11 and 13 year-olds which significantly reduces the number of repeats made and which, in turn, effectively increases the k available for new responses on repeated exposure of the stimulus compounds. Further, the fact that the 11 year-olds displayed the more effective employment of this strategy explains why, despite the use of a lower k on the first look of first CSVI, they perform at a level equivalent to that of the 13 year-olds on the repeated measure of the CSVI.

This finding not only offers an explanation of the improved performance between the first and repeated looks measure of the first CSVI but also explains the improved performance across tests despite a decrease in the mean number of looks made. Further, it explains why performance levels for repeated looks are well above those predicted by a strategy free probabilistic model.

In general the results, on the repeated measure of the CSVI, confirm previous findings obtained with Zulu-speaking township children on another test of *M*-capacity, the Figural Intersection Test or FIT (Miller et al, 1989; Bentley et al, 1989). The trend in the present study from underperformance to overperformance, is the same as that obtained for the FIT. An important difference between the CSVI and the FIT is that no pretest training is provided for the FIT. The fact that performance on the FIT improves with repeated testing in the absence of any training between test sessions, suggests that subjects are able to learn from the situation itself and to construct more efficient means of executing the task. The results of the present study provide direct confirmation of this interpretation. Deliberate attempts at training did not effect performance and, consequently, it appears that subjects draw on some learning resource or internal mechanism that allows them to produce more efficient task relevant executives. Moreover, the results of the present study suggest that subjects are also able to generate strategies that reduce the *M*-demand of the task.

This suggests that children need to be encouraged and given the opportunity to discover solutions to previously difficult tasks rather than be trained to meet task demands. As Pascual-Leone (1974) argues, children must not be viewed as passive, empty vessels to be filled with knowledge but rather should be seen as active, independent problem-solving discoverers of the world. In this way they can develop problem solving abilities to deal with conflict situations and reduce task demands on their own accord.

7.0 OVERVIEW AND CONCLUSION

As is evident from the results, deliberate attempts to train subjects in efficient executive strategies did not provide the expected improvement in performance. Instead, it was the individual self-generation of strategies appropriate to the task situation which gave rise to an improvement in the manifest performance of subjects over the three CSVI tests. What this means is that, through praxis, subjects were able to draw on some learning resource or internal mechanism that allowed them to produce task relevant executives and/or strategies.

This raises the issue of task equivalence in cross-cultural research using the CSVI. It is well established that a lack of familiarity with test materials and content, and for that matter testing as such, will result in poor performance (See Glick, 1975; Greenfield, 1974 and Price-Williams, 1975). With regard to the CSVI, the results of the present study demonstrate the fact that familiarity with task content is not sufficient to ensure task equivalence as the ability to integrate information in response to the compound stimuli is dependent upon task appropriate strategies in addition to ones available *M*-capacity.

Consequently, the use of the CSVI as a measure of *M*-power must be modified to ensure task equivalence. As demonstrated, subjects develop appropriate strategies by engaging in the task, the implication being that future use of the CSVI in cross-cultural research must permit subjects the opportunity to engage in the task before performance can be held to reflect the true *M*-capacity of subjects.

Further, the individual variation evident in the performance of subjects in the present study, highlights the danger of using the CSVI as a "group test" where the combined mean performance of subjects is used as the sole measure of their *M*-capacity. Clearly, the fact that performance is dependent upon the use of task appropriate strategies in addition to *M*-capacity necessitates an analysis of individual performance with repeated exposure to the task so as to differentiate between those subjects already possessing task appropriate strategies, and those who do or do not develop these in the process of engaging in the task. Related to this is the need for the investigation and explanation of these differences in future research.

In this regard, the results of the present study, together with those obtained by Juckes (1987), seem to provide very clear evidence of an initial overall underperformance on the first look of the first CSVI.

Taken in isolation these findings accord well with the accumulation of performance differences reported in the field of cross-cultural psychology (See Dasen, 1977 and Dasen & Heron, 1981) and suggests that these are the result of differences in the environmental/cultural conditions of subjects. However, the present findings also indicate differences in the performance of subjects of the same age and social/cultural environment. The individual analysis of the first look of the first CSVI yielded three distinct levels of performance and this cannot be explained in terms of inter-individual factors alone. Further, the fact that subjects overperformed as a result of the self generation of appropriate executives/strategies with repeated exposure to the task seems to indicate that the initial manifest performance differences are the result of the novelty of the task rather than a "deficiency" on the part of the subjects. If this is the case then the subsequent overperformance must be understood and explained in terms of intra-individual factors in addition to inter-individual factors. Without recourse to any universal, maturational or constructive factors one would be hard pressed to explain the variation and constructive ability evident in the individual performance of these subjects. This is the problem facing cultural relativists.

The argument that performance is a function of specific kinds of learning in situations that are culturally determined at best may produce descriptive theoretical statements and at worst does not advance much beyond common or correlational sense (Miller et al, 1989). The difficulty with this approach is that it cannot explain how successful performance is generated in unfamiliar or novel situations. In contrast, it is the primary goal of what has been referred to as "central processor" theories (See LCHC, 1982) to address this very issue. To this end, the understanding of the mechanisms of intelligent performance, irrespective of the nature of the performance, is sought in the belief that the psychological processes that govern performance are invariant across cultures. The strength of this approach is demonstrated in the present study in that the seemingly anomalous overperformance of subjects with repeated testing was explained in terms of the theoretically based concepts of cognitive capacities and strategies and validated by the empirical analysis of the responses of subjects in the *process* of the generation of successful performance on an unfamiliar task.

The implication for cross-cultural research is that attention should be directed less at performance criteria and more at the processes, both universal and individual, that generate performance such that a clearer understanding of the relation between inter- and intra-individual processes becomes possible.

In this regard, future research should focus on exploring the differential role of individual equilbratory factors as a source of variation. The individual performance differences evident on the first look of the first CSVI in the present study highlight the fact that not all subjects of the same age demonstrate the same initial executive strength. As executives are learned strategies, the environmental conditions and social experiences of these subjects should be investigated in an attempt to understand these differences. Related to this is the possibility that individuals may differ in their potential to generate appropriate strategies in the context of a novel situation. In the present study, deliberate attempts to train subjects in the use of appropriate strategies failed. Consequently, the improvement demonstrated by these subjects was the result of their ability to learn from the situation itself and to generate problem solving strategies. This ability needs to be investigated in a design which permits repeated exposure to the task. In this way, individual improvement may highlight differences in the ability of subjects to adapt to novel situations. As Piaget argued, the problem facing developmental psychology is not to explain the familiar but how we proceed from the familiar to the unfamiliar; that is spontaneous construction in the face of novelty.

REFERENCES

Andrew, D.J. (1987) *Executive training and mental capacity amongst Zulu speaking children: a preliminary investigation.* Unpublished Honours Thesis, University of Natal, Durban.

Bentley, A., Kvalsvig, J. & Miller, R. (1989) The cognitive consequences of poverty: a Neo-Piagetian study with Zulu children. *Applied Cognitive Psychology.* (In Press)

Buck-Morris, S. (1981) Socio-economic bias in Piaget's theory and its implications for cross-cultural studies. In S. Modgil & C. Modgil (Eds.) *Jean Piaget: Consensus and Controversy.* London: Holt, Rinehart and Winston.

Campbell, C.M. (1985) *Learning and development: an investigation of a neo-Piagetian theory of cognitive growth.* Unpublished Masters Thesis, University of Natal, Durban.

Case, R. & Serlin, R. (1979) A new processing model for predicting performance on Pascual-Leone's test of M-space. *Cognitive Psychology*, 11, 308-326.

Case, R. (1972) Validation of a neo-Piagetian mental capacity construct. *Journal of Experimental Child Psychology.* 14, 287-302.

Chapman, M (1981) Pascual-Leone's theory of constructive operators: An introduction. *Human Development*, 24, 144-155.

Cole, M. & Scribner, S. (1974) *Culture and Thought: A Psychological Introduction.* New York: John Wiley and Sons, Inc.

Dasen, P.R. (1977) *Piagetian psychology: Cross-cultural contributions.* New York: Gardner Press.

Dasen, P.R. & Heron, A. (1981) Cross-cultural tests of Piaget's theory. In Triandis, H.C. & Heron, A. (Eds.) *Handbook of cross-cultural psychology. Vol. 4.* Boston: Allyn & Bacon.

Dasen, P.R. & de Ribaupierre, A. (1987) Neo-Piagetian theories: cross-cultural and differential perspectives. *International Journal of Psychology,* 22, 793-832.

DeAvila, E.A., Havassay, B., & Pascual-Leone, J. (1976) *Mexican-American schoolchildren: a neo-Piagetian analysis.* Washington, DC: Georgetown University press.

Demetriou, A. (1987) *Preface to the International Journal of Psychology*, 22, 501-505. (1987)

Glick, J. (1975) Cognitive development in cross-cultural perspective. In Horowitz, F. et al (Eds.) *Review of child development research. Vol. 4.* Chicago: University of Chicago Press.

Globerson, T. (1976) *Field-independence, information processing capacity, and mental effort.* Unpublished Doctoral dissertation, University of California, Berkley.

Globerson, T. (1981) *Mental capacity and cognitive functioning: a developmental and comparative study.* Paper presented at the Society for Research in Child Development Biennial Convention, Boston.

Goodman, D.R. (1979) *Stage transitions and the developmental trace of cognitive operators: an investigation of a neo-Piagetian theory of cognitive growth.* Unpublished Doctoral dissertation, York University, Toronto.

Greenfield, P.M. (1976) Cross-cultural research and Piagetian theory: paradox and progress. In Riegal, K.F. & Meacham, J.A. (Eds.) *the developing person in a changing world. Vol. 1.* Chicago: Aldine.

Juckes, T.J. (1985) *An investigation of the M-operator of the neo-Piagetian theory of constructive operators in Zulu speaking children.* Unpublished Honours Thesis. University of Natal, Durban.

Juckes, T.J. (1987) *Mental capacity and executive strategies among Zulu speaking children.* Unpublished Masters Thesis. University of Natal: Durban.

Laboratory of Comparative Human Cognition (1982). In R.J. Sternberg (Ed.), *Handbook of human intelligence* (pp. 642-719). Cambridge, Mass: Cambridge University Press.

Miller, M.S. (1980) *Executive schemes vs mental capacity in predicting intelligence and underperformance among lower socioeconomic status groups.* Unpublished Doctoral Dissertation. York University, Toronto.

Miller, R. & Craig, A. (1985) Cognitive development and social change: Theoretical issues. In Langunes, I. & Poortinga, Y *From a different perspective: studies of behavior across cultures.* Seventh international conference of the International Association For Cross-cultural Psychology.

Miller, R. (1984) *Reflections of mind and culture.* (Inaugural lecture) Pietermaritzburg, University of Natal Press.

Miller, R., Pascual-Leone, J., Campbell, C. & Juckes, T. (1989) *Learning and development: a neo-Piagetian cross-cultural analysis.* International Journal of Psychology, 24, p293-313.

Parkinson, G.M. (1975a) *The CSVI: a measure of the quantitative construct M.* Unpublished manuscript, York University, Toronto.

Parkinson, G.M. (1975b) *The limits of learning: a quantitative investigation of intelligence.* Unpublished Doctoral dissertation, York University, Toronto.

Pascual-Leone, J & Goodman, D (1978) Intelligence and experience: a Neo-Piagetian approach. *Instructional Science,* 8, 301-367.

Pascual-Leone, J. & de Ribaupierre, A. (1984) For an integration of methods in cognitive psychology: experimental psychology, genetic psychology and psychometrics. *L'Annee Psychologique,* 84, 227-250

Pascual-Leone, J. & Smith, J. (1969) The encoding and decoding of symbols by children: a neo-Piagetian model. *Journal of Experimental Child Psychology,* 8, 328-355.

Pascual-Leone, J. (1970) A mathematical model for the transition rule in Piaget's developmental stages. *Acta Psychologica,* 32, 301-345.

Pascual-Leone, J. (1974) *A neo-Piagetian process-structural model of Witkin's psychological differentiation.* Paper prepared for the symposium on Cross-Cultural Psychology, Kingston.

Pascual-Leone, J. (1983) Growing into human maturity: Towards a metasubjective theory of adulthood stages. In P.B. Baltes & O.G. Brim (Eds.), *Life-span development and behavior* (Vol 5). New York: Academic Press.

Pascual-Leone, J. (1984) Attention, dialectic, and mental effort: Towards an organismic theory of life stages. In M.L. Commons, F.A. Richards, & C. Armon (Eds.), *Beyond Formal Operations: late adolescence and adult cognitive development.* New York: Praeger.

Pascual-Leone, J. (1987) Organismic processes for neo-Piagetian theories: a dialectical causal account of cognitive development. *International Journal of Psychology,* 22, 531 -570.

Pascual-Leone, J., Goodman, D., Ammon, P. & Subelman, I. (1978) Piagetian theory and neo-Piagetian analyses as psychological guides in education. In J.M. Gallagher & J.A. Easley (Eds.), *Knowledge and development,* Vol. 2. New York: Plenum Publishing Corporation.

Piaget, J (1974) Need and significance of cross-cultural studies in genetic psychology. In J.W. Berry & P.P. Dassen (Eds.) *Culture and cognition: readings in cross-cultural psychology.* London: Metheum & Co. Ltd.

Price-Williams, D.R. (1975) *Explorations in cross-cultural psychology. Vol. 3.* San Francisco: Chandler & Sharp.

Sternberg, R.J (1987) A day at developmental downs: Sportscast for race #2- Neo-Piagetian theories of cognitive growth. *International Journal of Psychology* , 22, 507 -529.

Vygotsky, L.S. (1978) *Mind in society: the development of higher psychological processes.* London: Harvard University Press.

APPENDIX A

THE BOSE-EINSTEIN (THEORETICAL) DISTRIBUTION: A WORKED EXAMPLE.

FORMULA FOR THE CALCULATION OF THE EMPIRICAL RECALL PROPORTIONS: FOR EACH STIMULUS CLASS AND FOR THE TOTAL TASK.

THE BOSE-EINSTEIN (THEORETICAL) DISTRIBUTION: A WORKED EXAMPLE.

(1) The Bose-Einstein statistic:

$$Pr\ (x) = \frac{\left[\frac{n}{n - x}\right] \quad \left[\frac{k - 1}{x - 1}\right]}{\frac{n + k - 1}{k}}$$

(2) Expanding (1)
[See Pascual-Leone, 1970 for details of expansion.]

$$Pr\ (x) = \frac{\left[\frac{n'}{(n - x)'x'}\right] \quad \left[\frac{(k - 1)'}{(x - 1)'(k - x)'}\right]}{\frac{(n + k - 1)'}{k'\ (n - 1)'}}$$

(3) If: k = 5 [The subjects theoretical M-capacity]
n = 3 [The response class (theoretical) or actual number of responses (empirical)]
x = 3 [The number of compound stimuli (cues)]

Then:

$$Pr\ (x) = \frac{\left[\frac{3'}{(3 - 3)'\ 3'}\right] \quad \left[\frac{(5 - 1)'}{(3 - 1)'\ (5 - 3)'}\right]}{\frac{(3 + 5 - 1)'}{5'\ (3 - 1)'}}$$

$$Pr\ (x) = \frac{\left[\frac{3'}{1'\ 3'}\right] \quad \left[\frac{4'}{2'\ 2'}\right]}{\frac{7'}{5'\ 2'}}$$

$$Pr\ (x) = 0.286$$

FORMULA FOR THE CALCULATION OF THE EMPIRICAL RECALL PROPORTIONS: FOR EACH STIMULUS CLASS AND FOR THE TOTAL TASK.

$$E(x) = \frac{\dfrac{1(R1) + 2(R2) + \ldots n(Rn)}{R1 + R2 + \ldots Rn}}{Sn}$$

Where: R1 = Frequency of single responses.
R2 = Frequency of double responses.
Rn = Frequency of n responses.
and Sn = The number of compound stimuli.

APPENDIX B:

ENGLISH INSTRUCTIONS; ET-A, ET-T AND CSVI-TACH.

ZULU INSTRUCTIONS; ET-A, ET-T AND CSVI-TACH.

ENGLISH INSTRUCTIONS:

ET-A:

We are going to play a game today which is broken down into a number of stages. In each stage you will be shown slides with eight objects in them. What I want you to do is to look at the slide and once it has gone off, mark all the objects that you saw. You can show me which objects you saw in the slide by putting a cross through that object on the paper in front of you. Remember that each slide has eight objects in it so you can have up to eight crosses on your page. Now to make the game more exciting I am going to pay you for each object you get right. In the first stage of the game I will give you one cent (1c) for every object that you get right. So if you get five of the objects in the slide you will get 5c, if you get six right you get 6c and so on. In the other stages I will pay you more because the game gets more difficult.

I am now going to show you the first slide. Watch carefully because the slide is only going to be flashed for a very short time. First look at the slide and when it has gone off you can start putting your crosses through the objects on the paper in front of you. Are you ready? Here is the first slide.

(Flash slide for 1 second)

(Allow unlimited response time)

(Reward child with 1C per correct identification)

(Continue as above for first 10 slides)

Stage two: instruct as above but reward with two cents (2c) per correct response and decrease duration of exposure to 0.5 seconds (500 ms.).

Stage three: instruct as above but reward with three cents (3c) per correct response and decrease exposure to 0.25 seconds (250 ms.).

Stage four: instruct as above but reward with four cents (4c) per correct response and decrease exposure to 0.125 seconds (125 ms.).

ET-T:

We are going to play a game today which involves looking for groups of objects in the slides which we are going to show you. On the paper in front of you, you will see some objects and two squares one marked "yes" and the other "no". What you have to do in this game is to tell me, by putting a cross under the "yes" or "no", if all the objects on the page in front of you are actually in the slide or not.

What you need to do then is look at the objects on the page in front of you, remember them, then look at the slide and see if they are all in that slide. If all the objects on the paper are in the slide then you put a cross in the square marked "yes". If the objects on the paper are not in the slide then put a cross in the square marked "no".

Remember that you can only mark "yes" if **ALL** the objects on the paper are in the slide. If even one object on the paper is **NOT** in the slide then you must put a cross under "no". This is a difficult game so to make it easier you can look at each slide as many times as you like before you make up your mind where to put your cross. I will also give you ten cents (10c) for every answer you get right.

Are you ready to begin the game? Look at the objects on the first page, now tell me if all those objects are in the slide or not.

(Allow child to view slide as many times as s/he wishes)

(Duration per exposure 1 second)

(Record the number of looks made)

(Reward child with 10C if response is correct)

(Indicate where error was made if response is incorrect)

(Continue to next slide)

CSVI-TACH:

INTRODUCTION: Today we are going to learn a code to send messages. When you have a code you can send special messages by making certain signals. I will be sending you messages on this screen here and you will let me know that you have received them by making the signals which I will teach you. Before we can send any messages, we must first learn the code.

TRAINING: Here is the first message in the code. It is a square shape. Every time you see a square shape you press the button that looks like this.....[Point to 'zebra-stripe' button on display box. Get child to press this button]

Now what about this one? [Point to top right figure] Respond with either: "yes, that is right, there is no message here", or "No, you don't know anything for that one. The only message you know is the square shape. There is no message here."

How about this one? [Point to bottom right figure] Respond as above. Is there a message here? [Point to bottom left] Respond as above.

[Proceed to next card] Now we have a new message. This time it is the colour red. [Instruct as above]

[Repeat this procedure for each of the nine associations.]

<u>PRETEST:</u> You have learned the new code well. Now we must learn how to get messages. We will practice that now. I am going to show you some slides, your job is to look for the messages that you have just learnt and when you see one you must press the button for that message. If you do not see a message then you must tell me. After you have seen the message and pushed the button we will go on to the next message.

(Exposure 0.125 seconds {125 ms.})

(Mark each response)

(Children must get all 40 correct to proceed to next stage)

<u>TEST:</u> From now on there will be more than one message in each slide. Your job is to push the buttons for all the messages that you see. Because there is more that one message in each slide you can look at each slide as many times as you need to. If you want to look at a slide again then just tell me, otherwise tell me that you want the next slide. Are you ready for the first slide? Here is the first slide.

(Exposure 0.125 seconds {125 ms.})

(Allow child to view slide and respond, then force two looks or more on the first three slides. Encourage the child all the while. After the first three slides the child must not be assisted.)

ZULU INSTRUCTIONS:

ET-A:

Sizodlala umdlalo namhlanje onezigaba eziningi. Esigabeeni ngasinye nizokhonjiswa izithombe ezinezinto eziyisishiya galombili. Engifuna nikweze ukubuka esithombeni bese kuthi uma sesidlulile, nibhale zonke izinto enizibnile. Ningangikhombisa izinto enizibonile ngokuthi nibhale isiphambano kuleyonto ephepheni elingaphambi kwenu. Khumbulani ukuthi isithombe ngasinye sinezinto eziyisishiyagalombili, okusho ukuthi ungaba neziphambano ezingu - 8 ekhasini lakho. Manje ukuze ngenze lomdlalo ujabulise ngizonikhokhela uma nisho into okuyiyonayona. Esigabeni sokugala ngizoninika isenti (1c) kuyo yonke into eniyithole kahle okusho ukuthi uma uthole izinto eziyisihlanu kahle uzothola u-5c, uma uthole eziyisithupha, uzothola u-6c njalonjalo. Kwezinye izigaba ngizonikhokhela kakhulu ngoba umdlala uya ngokuya uba nzima. Sengizonikhombisa isithombe sokugala-ke manje. Bhekisisami ngoba isithombe sizovezwa isikhathi isincane kakhulu. Qalani ngokubuka isithombe besi kuthi uma sesidlulile seningagala-ke ukubhala iziphambano ezintweni enizibonile ephepheni eliphambi kweni.

Senilungile? Nasi isithombe sokugala.

(Veza isithombe umzuzwana owodwa 1 second)

(Ungabakaleli isikhathi sokubhala iziphambano)

(Klomelisa umntwana ngesenti kuko konke akutholile)

(Okubeka njengaphezulu ezithambeni zokugala eziyishumi)

Isigaba sesibili: luleka njengasekuqaleni kodwa ubaklomelise ngamasenti amabili (2c) uma bephendule kahle, futhi isikhathi sokuvezwa kwesithombe usehlisele ku 0.5 seconds (usigamu somzuzwana) (500ms.)

Isigaba sesithathu: luleka njengasekugaleni kodwa ubanike amasenti amathathu, futhi isithombe usiveze isikhathi esingango 0.25 seconds. (250ms.)

Isigaba sesine: luleka njengakugala kodwa ubanike amasenti amane (4c) uma bephendule kahle bese isikhathi sokuvezwa kwesithombe usehlisele ku 0.125 seconds (125ms.)

ET-T:

Namthlange sizodlala undlala lapho nizobuka amaqoqo ezinto ezithombini esizonikhombisa zona. Ephepheni elingaphambi kwakho, uzubona idlazana lezinto nezikwele ezinbili esisodwa sibhalwe ukuthi "yebo" kanti esinye sibhalwe ukuti "oha". Okufanele nikwenze ukungitshela, ngokubhala isiphambano ngaphansi kwa "yebo" noma "qha", uma zonke izinto ekhasini eliphambi kwakho ngempela zikhona noma azikho. Okufanele ukwenze-ke ukubuka lezinto ekhasim eliphambi kwakho, uzikhumbule, bese ubuka esithombeni ubona uma zikhona zonke kulesosithombe. Uma zonke izinto ezisephepheni zikhona esithombeni bhala isiphambano esikweleni esibhaleve u-"yebo". Uma izinto ezisephepheni zingekho esithombeni, bhala isiphambano ezinkweleni esibalwe "qha". Khumbula ukuthi ungamubhala kuphela u-"yebo" uma ZONKE izinto ezisephepheni zikhona esithombeni. Noma kungeyodwa into esephephani engekho esithombeni, kufanele ubhale isiphambano ku-"oha". Lona ngumdlala obukumi, kodwa ukuze ube lula ungabuka esithombeni izikhathi ezininzi ngokuthanda kwakho ngaphambi kokuba ubhale isiphambano. Ngizoninika amasenti alishumi (10^c) kuyo yonke impendulo etholwe kahle.

Senilungile ukuqala umdlalo? Bukani izinto ekhasini lokuqala, manje ngitsheleni ukuthi zonke lezinto zikhona esithombeni noma qha.

(Bukisa umnitwana isithombe izikhathi ezinthandwa nguye)

(Isikhathi sombukiso ngamunye umzuzwaana owodwa [1 second])

(Bhala ukuthi ubuke kangaki esithombeni)

(Nika umntwana u-10C uma ethole kahle)

(Bhala ukuthi iphutha likuphi uma impendulo kungeyona)

(Qhubekela esithombeni sesibili)

CSVI-TACH

ISINGENISO: namthlanje sizofunda indlela yokudlulisa imiyonlezo. Uma unendlela yokudlulisa umyalezo ungadlulisa imiyalezo ebalulekile ngokwenza izinkomba ezithile. Ngizonidluisela imiyalezo kulesibuko kanti nina nizongitshela ukuthi niyitholile lemiyalezo ngokwenza izinkomba engizonifundisa zona. Ngaphambi kokudlulisa imiyalezo, kufandele siqale sifunde indlela yokudlulisa yona imiyalezo.

UKUZILOLONGA: nangu umyalezo wokuqala. Uyisikwele njalo uma ubona isikwele ubocindezela inkinbho ebukeka njengalokhu.... [khomba inkinobho enemigqa ye-zebra ebhokisini lombukiso. Cindezelisa ingane lekinobho]

Manje imjani lomyalezo? [khomba okuphezulu ngasesandleni sokudla] Phendulani ngokuthi "yebo, kuyiqiniso, awukho umyelezo lapha" noma "cha, anazi lutho ngalokho. Umyalezo eniwaziyo kuphela owesikwele. Awukho umyalezo lapha".

Kunjani ngalowa? [khomba kokuphansi ngasesandleni sokudla] Phendulani njengaphezulu.

Ukhona umyalezo lapha? [khomba phansi ngasesandleni sobunscele] phendulani njengaphezulu.

[qhubekela kwelinye ikhadi] manje sinawo umyalezo omusha. Manje sekungumbala obomvu. [luleka njengakuqala]

[Phindaphinda lenqubo koyo yonke imiyalezo eyisishiyagalolunye]

ISANDULELO SESIVINYO: nifunde kahle indlela yokudluisa imiyalezo. Manje kufandele sifunda ukuthola imiyalezo. Sizokufunda lokho manje. Ngizonikhombisa isithombe ezimbalwa, owena umsebenzi ukubheka imiyalezo lena enisanda kuyifunda, uma niwubona nicindezele inkinobho yalowomyalezo. Uma ningaboni myalezo kufanele ningitshele. Emva kokubona umyalezo macindezela nenkinobho ningawuthola omunye umyalezo ngokucindezela lenkinobho ebomuv. Uma nicindezela lekimobho ebomvu kufanele nibheke omunye umyalezo ngoba uzofika ngokushesha okukhulu. [ukuvezwa ngu-125 ms.]

(Bhala impendulo ngayinye)

(Abawtwana kufonele bathole wonke u-40 kakle ukuze baqhubekele esigabeni esilandelayo)

ISIVIVINYO: kusukela manje kuzoba khona imiyalezo engaphezu kowodwa embukisweni ngamunge. Umsebenzi wenu ukucindezela izinkinobho kuyo yonke imiyalezo eniyibonayo. Ngoba kunemiyalezo emningi emubukisiweni ngamunye ninagabuka izikhati eziningi ngokuthanda kwenu. Uma nifuna ukubuka okwesibihi kufanele ucindezele lenkinobho ebomuv. Njabo uma ucindezela inkinobho ebomuv uzobona umyalezo futhi kodwa okubukhunyana ukuthola imiyalezo eminingi emibukisweni emincane. Seniwulungele umbukiso wokuqala? Nango-ke owokugala.

(Ukuvezwa ngu-125 ms.)

(Vumela umntwana ukubuka bese siyaphendula, bese uqikelele ukuthi abuke kabili noma ngaphezulu emibukisweni yokugala emithathu. Khuthaza umntwana ngayo yonke indlela. Emva kwemibukiso yokugala emithathu umntwana akufanele asizwe)

APPENDIX C

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA ON THE FIRST LOOK MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA COMBINED AND THE CONTROL GROUP ON THE FIRST LOOK MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA ON THE REPEATED LOOKS MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA COMBINED AND THE CONTROL GROUP ON THE REPEATED LOOKS MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA ON THE FIRST LOOK MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

			STIMULUS CLASS						
AGE	CSVI	GROUP	2	3	4	5	6	7	8
11	1	AT	.83	1.50	2.06	2.53	2.97	3.39	3.8
		TA	.78	1.44	2.02	2.53	3.00	3.42	3.8
		Diff=	.05	0.06	0.04	0.00	0.03	0.03	0.0
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.06; p > 0.05: N.S.				
	2	AT	.87	1.61	2.25	2.77	3.25	3.75	4.18
		TA	.90	1.63	2.30	2.87	3.42	3.91	4.39
		Diff=	.03	.02	0.05	0.10	0.17	0.16	0.21
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.21; p > 0.05: N.S.				
	3	AT	.91	1.69	2.41	3.01	3.57	4.10	4.59
		TA	.93	1.69	2.36	2.96	3.52	4.03	4.52
		Diff=	.02	0.00	0.05	0.05	0.05	0.07	0.07
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.07; p > 0.05: N.S.				
13	1	AT	.76	1.39	1.95	2.45	2.94	3.41	3.86
		TA	.82	1.56	2.19	2.79	3.29	3.77	4.23
		Diff=	.06	0.17	0.24	0.34	0.35	0.36	0.37
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.37; p < 0.05: SIG.				
	2	AT	.90	1.67	2.37	2.94	3.52	4.09	4.58
		TA	.89	1.69	2.40	3.02	3.61	4.13	4.63
		Diff=	.01	0.02	0.03	0.08	0.09	0.04	0.05
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.09; p > 0.05: N.S.				
	3	AT	.95	1.76	2.47	3.12	3.71	4.27	4.82
		TA	.96	1.78	2.53	3.20	3.83	4.40	4.96
		Diff=	.01	0.02	0.06	0.08	0.12	0.13	0.14
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.14; p > 0.05: N.S.				

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA COMBINED AND THE CONTROL GROUP ON THE FIRST LOOK MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

			STIMULUS CLASS						
AGE	CSVI	GROUP	2	3	4	5	6	7	8
11	1	AT+TA	.80	1.47	2.04	2.53	2.99	3.41	3.80
		C	.78	1.42	1.97	2.46	2.90	3.32	3.71
		Diff=	.02	0.05	0.07	0.07	0.09	0.09	0.09
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.09; p > 0.05: N.S.				
	2	AT+TA	.88	1.62	2.27	2.82	3.34	3.83	4.29
		C	.83	1.60	2.25	2.85	3.36	3.85	4.33
		Diff=	.05	0.02	0.02	0.03	0.02	0.02	0.04
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.04; p > 0.05: N.S.				
	3	AT+TA	.92	1.69	2.38	2.97	3.53	4.05	4.54
		C	.85	1.60	2.30	2.90	3.48	3.99	4.51
		Diff=	.07	0.09	0.08	0.07	0.05	0.06	0.03
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.09; p > 0.05: N.S.				
13	1	AT+TA	.79	1.47	2.06	2.61	3.11	3.59	4.04
		C	.83	1.54	2.11	2.63	3.11	3.56	3.99
		Diff=	.04	0.07	0.05	0.02	0.00	0.03	0.05
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.07; p > 0.05: N.S.				
	2	AT+TA	.90	1.68	2.38	2.98	3.57	4.11	4.60
		C	.86	1.60	2.23	2.85	3.44	3.98	4.51
		Diff=	.04	0.08	0.15	0.13	0.13	0.13	0.09
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.15; p > 0.05: N.S.				
	3	AT+TA	.95	1.76	2.49	3.15	3.76	4.33	4.88
		C	.90	1.71	2.44	3.08	3.70	4.28	4.82
		Diff=	.05	0.05	0.05	0.07	0.06	0.05	0.06
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.07; p > 0.05: N.S.				

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA ON THE REPEATED LOOKS MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

			STIMULUS CLASS						
AGE	**CSVI**	**GROUP**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
11	1	AT	.94	1.82	2.61	3.33	4.03	4.70	5.32
		TA	.89	1.72	2.56	3.34	4.07	4.77	5.46
		Diff=	.05	0.10	0.05	0.01	0.04	0.07	0.14
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.14; p > 0.05: N.S.				
	2	AT	.96	1.87	2.74	3.52	4.26	4.98	5.65
		TA	.96	1.82	2.69	3.50	4.29	5.03	5.78
		Diff=	.00	0.05	0.05	0.02	0.03	0.05	0.13
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.13; p > 0.05: N.S.				
	3	AT	.97	1.89	2.77	3.58	4.37	5.14	5.85
		TA	.98	1.84	2.71	3.53	4.34	5.12	5.87
		Diff=	.01	0.05	0.06	0.05	0.03	0.02	0.02
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.06; p > 0.05: N.S.				
13	1	AT	.93	1.73	2.47	3.14	3.80	4.45	5.05
		TA	.93	1.79	2.59	3.35	4.05	4.73	5.37
		Diff=	.00	0.06	0.12	0.21	0.25	0.28	0.32
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.32; p < 0.05: SIG.				
	2	AT	.96	1.84	2.68	3.45	4.20	4.94	5.60
		TA	.96	1.86	2.72	3.56	4.35	5.10	5.81
		Diff=	.00	0.02	0.04	0.11	0.15	0.16	0.21
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.21; p > 0.05: N.S.				
	3	AT	.95	1.84	2.68	3.48	4.24	5.00	5.74
		TA	.98	1.88	2.77	3.60	4.38	5.13	5.90
		Diff=	.03	0.04	0.09	0.12	0.14	0.13	0.16
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.16; p > 0.05: N.S.				

DIFFERENCE IN THE CUMULATIVE EMPIRICAL PROPORTION OF CORRECT RESPONSES FOR EXPERIMENTAL GROUPS AT AND TA COMBINED AND THE CONTROL GROUP ON THE REPEATED LOOKS MEASURE OF THE CSVI: 11 AND 13 YEAR-OLDS.

					STIMULUS CLASS				
AGE	CSVI	GROUP	2	3	4	5	6	7	8
11	1	AT+TA	.91	1.76	2.58	3.33	4.04	4.73	5.39
		C	.89	1.70	2.47	3.20	3.87	4.54	5.17
		Diff=	.03	0.06	0.11	0.13	0.17	0.19	0.23
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.23; p > 0.05: N.S.				
	2	AT+TA	.96	1.84	2.71	3.51	4.28	5.01	5.72
		C	.90	1.76	2.58	3.39	4.13	4.86	5.58
		Diff=	.06	0.08	0.13	0.12	0.15	0.15	0.14
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.15; p > 0.05: N.S.				
	3	AT+TA	.97	1.86	2.73	3.54	4.34	5.11	5.84
		C	.91	1.81	2.66	3.47	4.25	4.99	5.75
		Diff=	.06	0.05	0.07	0.07	0.09	0.12	0.09
		Kolmogorov-Smirnov:			n = 20, D-max. = 0.12; p > 0.05: N.S.				
13	1	AT+TA	.93	1.76	2.53	3.24	3.92	4.58	5.20
		C	.93	1.77	2.55	3.25	3.92	4.56	5.16
		Diff=	.00	0.01	0.02	0.01	0.00	0.02	0.04
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.04; p > 0.05: N.S.				
	2	AT+TA	.96	1.87	2.67	3.50	4.27	5.01	5.69
		C	.92	1.77	2.57	3.31	4.04	4.73	5.41
		Diff=	.04	0.08	0.13	0.19	0.23	0.28	0.28
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.28; p > 0.05: N.S.				
	3	AT+TA	.97	1.86	2.73	3.54	4.31	5.06	5.81
		C	.94	1.85	2.72	3.51	4.29	5.02	5.74
		Diff=	.03	0.01	0.01	0.03	0.02	0.04	0.07
		Kolmogorov-Smirnov:			n = 19, D-max. = 0.07; p > 0.05: N.S.				

APPENDIX C

DERIVATION OF THE THEORETICAL "NEW" AND "REPEAT" PROPORTIONS

DERIVATION OF THEORETICALLY ANTICIPATED "NEW" RESPONSES BETWEEN LOOKS:

Total task score for *a(k)* - Total task score for *k*
= New responses on subsequent looks

Thus if 2(k) = 8

Then new responses on the second look (See Table 10):
= 3.195 - 2.454
= 0.741

Converting this to a proportion:

$$\frac{0.741}{2.454} = 0.302$$

DERIVATION OF THEORETICALLY ANTICIPATED "REPEAT" RESPONSES BETWEEN LOOKS:

Total task score for *2k* - Total task score for *a(k)*
= Repeat responses on subsequent looks

Thus if 2(k) = 8

Then repeat responses on the second look (See Table 10)
= 2(2.454) - 3.195
= 1.713

Converting this to a proportion:

$$\frac{1.713}{2.454} = 0.698$$

NOTE: *The less the number of repeat responses between looks the greater the number of correct responses possible. The greater the number of repeat responses between looks the less the number of correct responses possible.*