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Effects of mediated learning experience on Raven's matrices scores of African and non-African university students in South Africa

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Abstract

Rushton and Skuy [Intelligence 28 (2000) 1.] found that White university psychology students in South Africa averaged between one and two standard deviations higher than African students on Raven's Standard Progressive Matrices. This new study was carried out to determine whether Feuerstein's Mediated Learning Experience would improve the scores of the African students. The sample comprised 70 African and 28 non-African first year psychology students. Subjects were given the Raven's on two occasions and, in-between, randomly constituted experimental groups were exposed to mediated learning experience. Both the African and non-African groups improved over the baseline on the Raven's compared to the control groups, with significantly greater improvement for the African group.

Keywords: Mediated learning experience; Intelligence; University students; African; South Africa

1. Introduction

Lower mean test scores are routinely obtained in South African Black samples relative to Euro-American samples and test norms. For example, Owen (1992) gave Raven's Standard

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Progressive Matrices (SPM) without time limits to 1056 White and 1093 African 14-year-olds, which yielded a mean African IQ equivalent of 72, compared to 100 for Whites, using the percentile equivalents for the standardization data. A study by Skuy, Schutte, Fridjhon, and O'Carroll (2001) found scores one to two standard deviations below American norms in 154 African secondary school students in Soweto, Johannesburg, on a variety of tests including the Wechsler Intelligence Scale for Children-Revised (WISC-R), the Rey Auditory Verbal Learning Test, the Stroop Color Word Test, the Wisconsin Card Sorting Test, the Bender Gestalt Visual Motor Integration Test, the Rey–Osterreith Complex Figure Test, the Trail Making Test, the Spatial Memory Task, and various Drawing Tasks. On the WISC-R, the African students were 1.81 standard deviations below American norms.

The low mean score of Africans is also found in university samples. In one study, Grieve and Viljoen (2000) gave the Raven's Matrices to 30 African students in 4th year law and commerce at the University of Venda in South Africa's rural Northern Province. At this historically disadvantaged "African" university, the students averaged a score of 37 out of 60 on the Raven's. By the standards of 1993 US normative sample (Raven, Court, & Raven, 1990, p. 98), this placed them at the 7th percentile with an IQ equivalent of 78. A study by Rushton and Skuy (2000) gave untimed Raven's to three hundred nine 17- to-23-year-old first-year students at the University of the Witwatersrand. The 173 African students solved an average of 44 of the 60 problems, whereas the 136 White students solved an average of 54 of the 60 problems. By the standard of the 1993 US normative sample, the African students scored at the 14th percentile and the White students scored at the 61st percentile, yielding IQ equivalents of 84 and 104, respectively. Rushton and Skuy reviewed much of the literature.

Over the past few years, South Africa has witnessed massive changes in political, social, and economic arenas leading to a greater focus on human rights and equal opportunities for all. Consequently, this has created much debate around the notion of intelligence and the usefulness and validity of traditional assessment techniques in the South African context. The traditional view of intelligence as a stable, fixed entity has been challenged by the idea of intelligence as capable of being developed and improved. As a result of this, more active and dynamic models of assessing intelligence have been developed. One such model that has received growing attention over the past few years is the Learning Propensity Assessment Device (LPAD, or Learning Potential Assessment Device, as it was originally called) developed by Feuerstein (1979).

The LPAD is based on the premise that intelligence is a function of one's past experience and that structural changes occur in cognitive functioning as a result of new experiences. Low IQ scores in individuals are said to be the result of experiential disadvantages and the consequent underdevelopment of certain cognitive structures (Jensen & Feuerstein, 1987). Feuerstein's approach to raising intelligence test scores has at its core the mediated learning experience in which the mediator helps a subject to create and expand his or her experience to previously inaccessible areas (Jensen & Feuerstein, 1987).

Empirical evidence supports the utility of Feuerstein's model to improving test performance, with students in crosscultural studies. In a study of 113 teenage Bedouin boys given a 3-month enrichment program, a significant improvement showed in posttest scores, which approached the average scores of Israeli children who had initially tested higher (Rand &

Kaniel, 1987). In a study of illiterate Ethiopian children newly arrived in Israel, compared with Israeli-borne children, a short phase of intensive mediation resulted in much improved test scores in the Ethiopians (Tzuriel & Kaufman, 1999).

Several studies have found the usefulness of Feuerstein's LPAD in South Africa. Skuy and Shmukler (1987) found that test scores improved in an experimental study with 60 Indian and 60 Colored students. Improvement was more evident among the Coloreds who, in historical South Africa, were more educationally deprived than the Indians. The Colored community comprises people of mixed race who, in the *apartheid* era, were classified as a separate group, distinct from the African cultural group but who, like them, occupied a sociopolitically disadvantaged status in the society. Shochet (1992) examined the use of dynamic assessment for determining university admission for disadvantaged undergraduates. Given their disadvantaged schooling meant that their scholastic marks were not accurately reflecting their abilities, Shochet found an increase in performance after the mediation, which he interpreted as indicating the usefulness of this technique.

The LPAD therefore may offer an attractive solution to assessment, as well as help meet the students' educational needs. The present research therefore seeks to investigate the effects of mediation in improving performance on nonverbal intelligence tests such as Raven's Standard Progressive Matrices (Raven, Court, & Raven, 1996). The Raven's Test was chosen in order to follow up on Rushton and Skuy's (2000) study of the test performance of African and White university students. This study had shown that White students averaged about two standard deviations higher than the African students on this test of nonverbal intelligence. We considered the possibility that this study underestimated the true test performance of Black African students. Thus, we decided to repeat the study with the additional component of mediation from Feuerstein's model to see if this would improve the scores of the African students.

2. Method

2.1. Sample

Most of the students in the population from which the sample was drawn had recently passed public matriculation (high school) examinations and were accepted into the psychology course either on the basis of their matriculation grades or an entrance examination provided by the university. The latter was a particularly important basis on which to select African students, given the inadequacy of the segregated township schools, which most of them had attended. While apartheid was officially discarded in 1994, most African students in the sample had been exposed to the discriminatory policies, poorly qualified teachers, sparsely equipped and funded schools, and generally poor quality of education characterizing the segregated African education system (Hartshorne, 1992). Further, while a concerted effort is now being made to achieve integration and equity in the society and in education, the schools in the townships, inhabited almost entirely by Africans, are still beset by many of the same problems as before, as reflected in their exceptionally poor matriculation results in recent years.

Ninety-eight first year university students aged 17–29 (mean age = 20; 28 males, 70 females) in psychology volunteered to participate in the study. They were 70 African students (23 males, 47 females) and 28 non-African (4 males; 24 females) students (20 White, 6 Indian, 2 Colored). The mean age of the African group was 20.5, and it was 19.5 years for the non-African group. Although there were approximately equal numbers of African ($n = 475$) and non-African ($n = 400$) students in the psychology class, the fact that students were offered a small payment as incentive for participation in the study attracted more African students due to the relative incentive value for the Africans.

Subjects were randomly assigned to the experimental ($n = 55$) and control groups ($n = 43$) with each group consisting of students of varying levels of academic achievement. Final (end of the academic year) psychology examination marks were recorded.

3. Procedure

Students volunteered after hearing a brief outline of the study during their usual class time. As usual with dynamic assessment on the LPAD, the students underwent pre- and posttest phases where they completed the measure according to the standard instructions, with a group intervention in-between. The study focused on improving scores on the Raven's Standard Progressive Matrices (Raven's), using the Set Variations II of the LPAD as the mediation task.

The testing procedure was as follows.

Day 1: Raven's pretest for the whole sample in one group.

Day 8: Mediation training for 3 h on the Variations II of the LPAD. For the mediation, the experimental group was divided into four subgroups consisting of approximately 15 subjects each. Three psychologists who have had previous experience with dynamic assessment and the LPAD conducted the mediation with the assistance of six postgraduate psychology students.

Day 18: Raven's posttest for the whole sample to determine degree of transfer of learning from the Variations.

Day 20: Administration of the Representational Stencil Design Test (Stencils) to determine any further transfer of performance of the skills obtained through mediation. This also consisted of a pretest, a 2-h mediation and posttest. However, here, everything happened in 1 day and the whole group was given mediation. Therefore, there was no assignment of subjects to experimental and control conditions.

4. Measures and intervention

The LPAD consists of 14 exercises, many of which can be used for both individual and group administration. Each exercise contains an initial task for the purpose of mediation. Subsequent tasks increase in complexity and novelty and aim to assist the learner to achieve mastery over the task. Mediation provides the basis for the relationship between the examiner and the learner, which is the vehicle by which cognitive modifiability is achieved (Feuerstein, Haywood, Hoffman, & Jensen, 1983). The purpose of mediation is to assist the learner to

develop appropriate cognitive strategies and functions needed for the successful completion of the task.

Raven's Progressive Matrices consists of 60 items (divided into five sets of 12 items) designed to measure the ability to form comparisons, to reason by analogy, and to organize spatial information into related wholes. At first, the items are simple and become progressively more complex, requiring higher levels of cognitive reasoning. Each item is scored pass or fail with the maximum score of 60. Both the validity and internal consistency of the Raven's is high. In Rushton and Skuy's (2000) study of university students in South Africa, alpha coefficients ranged from 0.73 to 0.92 for Black and White, males and females.

Although the Raven's Test has been popular for crosscultural studies, Feuerstein (1979) states that it underestimates performance in culturally deprived learners. While these students demonstrate success on initial items, they tend to fail on later, more complex items. Performance on Raven's has been improved through mediation (Tzuriel & Feuerstein, 1992; Tzuriel & Kaufman, 1999).

The Set Variations II of the LPAD consists of five sets of items, which comprise variations of Sets C, D, and E of the Raven's Test. As on the Raven's, the subject is shown a series of designs and has to supply a missing part selected from a number of alternatives. According to Feuerstein (1979), this tests increasingly complex cognitive operations including analogies, permutations, and logical multiplication.

Each set of variations contains a learning task, for the purpose of initial mediation, and a series of progressively difficult variations to apply the skills learned. Mediation involves discussing with groups how to define the problem to be solved, how to focus on the task, how to set rules, how to regulate problem-solving behavior and identify the correct sequence of logical steps to solve the task. Mediation also involves helping the subject to develop appropriate concepts, verbal tools, and insights in relation to the task. The group is then asked to complete the initial task and continue with the variations that follow. Individual mediation is then undertaken while the group is attempting to complete these items. Fig. 1 illustrates the relationship between the Raven's and Set Variations II.

As the figure shows, Subset A of Set Variations II is based on Item C7 of the Raven's. With the help of mediation, the subject is required to complete the first variation (A) by selecting one of the eight given alternatives. Further, progressively more difficult variations follow, each with its own set of alternatives from which a correct answer must be chosen. While the broad principles that need to be applied in the Raven's are replicated in the Variations, the content of each variation varies from the Raven's and from the other variations in the subset. Thus, mediated learning involves more than simply teaching the test content. Rather, it involves more metacomponential training to promote use of general rules and strategies in analogy and related problem solving (Feuerstein, 1979; Laughon, 1990). Accordingly, assessment of performance on the Raven's, following mediation on the Variations, can be seen as an assessment of generalization or transfer of learning, albeit near transfer.

The Representational Stencil Design Test (Stencils) is one of the tests recommended for assessment of learning potential. Feuerstein et al. (1983) describe this test as measuring the capacity to learn a complex task, to use representational strategies, and to integrate information and problem-solving behavior. It is a perceptual test consisting of 20 tasks that

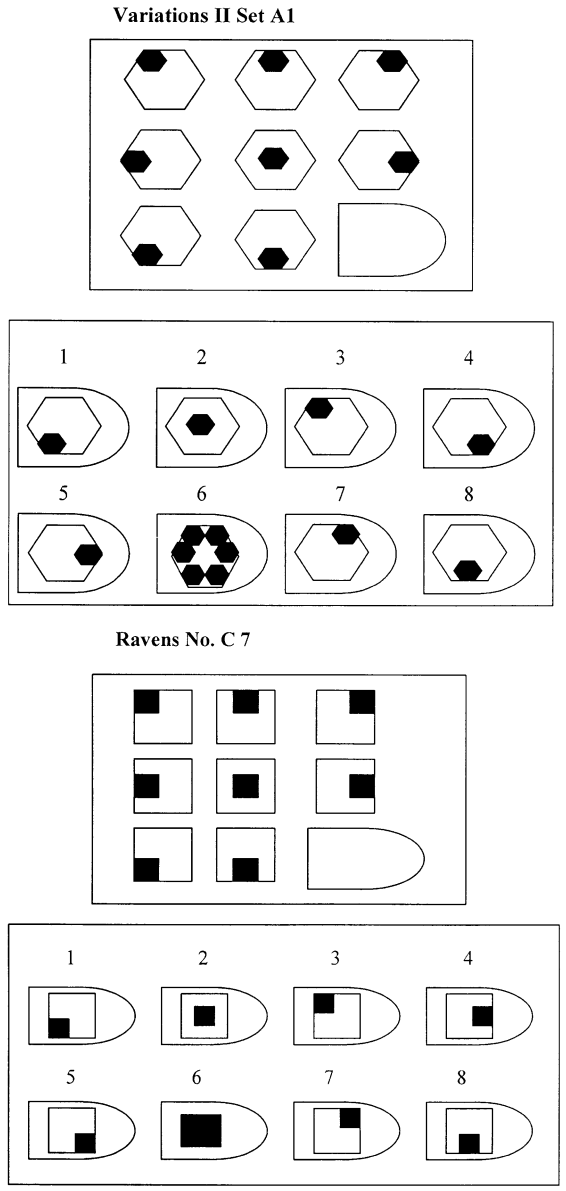

Fig. 1. Variations II Set A1 and Ravens Item No. C7.

subjects must complete representationally. The subject is presented with a stencil of a geometric design supported by a cardboard and asked to point to which stencils must be used and in what sequence so as to construct an identical design.

The Stencils Test consists of three phases namely: an Orientation Phase, a Learning/ Teaching Phase, and a Test Phase. The orientation phase served as an introduction to the test.

The aim of this phase was to familiarize the subjects with the stencils and make them aware of the similarities and differences between the different stencils. Subjects were asked to practice mentally moving a cutout stencil on to a solid one. This gave them some introduction and practice, or at least an orientation, to the concept of mental manipulation. The aim of this phase was to teach the subjects how to put the stencils together to make the correct designs. When subjects made errors, the nature of the mediation interventions depended on the type of error. Several categories of mediation were presented during the Stencils Test, including the modality of representational thinking, which is a prerequisite for the regulation of behavior (Feuerstein et al., 1983).

In the test phase, the subjects were asked to complete the test, which consisted of big colored photostat copies hung on the wall for all to see. Subjects are awarded points based on the number of correct stencils they choose. The maximum score obtainable in this test is 160. Like the Raven's, the Stencils Test begins easy and becomes progressively more difficult, with the number of stencils required to build a design increasing at each phase.

A criterion measure, the *examination marks*, represents the results that the students obtained in their end-of-the-year 2-h psychology examination, which took place about 2 months after the administration of the measures in this study. The examination result was included to determine the relationship between performance in psychology and on a measure of intelligence, before and after mediation. The examination mark counted 60% of the course and therefore did not include the marks from students' assignments and other projects done in the course. The examination was in a multiple-choice format and, thus, was also an objective measure of the student's performance. These marks were made available to the researchers by the Psychology 1 course coordinator at the university where the sample was obtained.

5. Results

Internal consistencies (Cronbach's alphas) on the Raven's ranged from 0.66 to 0.93 for the African and non-African pre- and posttests, respectively. While the alpha coefficients for the total scale were reasonably high for the African groups, the results for the non-African groups must be cautiously interpreted. Table 1 sets out the means and standard deviations for the total Raven scores (out of 60) for the two sets of experimental and control groups, along with their percentiles and IQ equivalents (using the 1993 US standardization sample, see Raven et al., 1990, 1996). Also shown in the table are mean scores (in percentiles) and standard deviations of the subjects in the final examinations. The non-African group had significantly higher scores than the African group ($t = 3.4$; $df = 96$; $P < .001$). The results are also illustrated in Fig. 2.

To investigate the effects of mediation on the posttest scores, a two-way ANCOVA was performed on the Raven's totals with four groups as variables (African Experimental, African Control, Non-African Experimental, and Non-African Control). On the pretest, there was a significant effect due to race [$F(1,93) = 298.03$, $P < .001$] and on the posttest (with the pretest as the covariate), there was a significant effect due to the intervention [$F(1,93) = 14.7$, $P < .001$] and a nonsignificant result for race. This means that mediation was effective in

Table 1
Pre- and posttest mean Raven's scores, IQ equivalent scores, standard deviations, and examination mean scores for African and non-African experimental and control groups

		African experimental ($n=41$)		African control ($n=29$)		Non-African experimental ($n=14$)		Non-African control ($n=14$)	
		Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Raw scores	*M*	43.05	49.63	43.41	45.97	50.07	55.86	53.07	55.92
	S.D.	7.84	5.85	10.24	11.43	6.06	3.84	3.05	2.2
Percentiles		12	41	12	19	41	75	55	75
IQ Equivalents		83	96	83	87	96	110	102	110
Examination mark	*M*	56.76	–	58.90	–	66.38	–	68.36	–
	S.D.	13.08	–	17.52	–	9.59	–	10.38	–

Percentiles are based on US adult norms.

improving the performance of both the African and non-African students. There was also a two-way interaction showing that the intervention was more effective in the African group [$F(1,67)=16.99$, $P<.001$].

To examine the relation between the Raven's scores and performance on the psychology examination, both pre- and postmediation Pearson's correlations were calculated across all subjects for both the African and the non-African groups. The results were effectively zero (mean $r=.05$).

Pearson correlations were computed on the sample's Raven's and Stencils pretest and posttest scores, respectively. Significant correlations were obtained at both the pretest and posttest stages($r=.63$ and .66, respectively; $P<.01$) and for all the subgroups of the sample. This suggested considerable commonality in the constructs measured by the two tests.

To assess the transferability of skills acquired from mediation to performance on the Stencils Test (Stencils), we compared the pre- and posttest scores obtained on the Stencils by

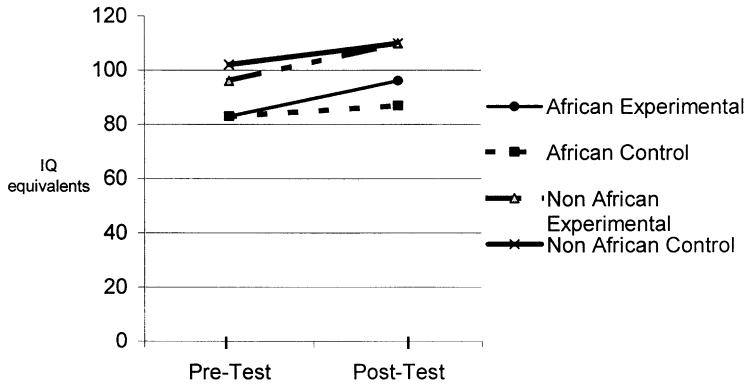

Fig. 2. IQ equivalents on the Raven's for African and non-African experimental and control groups.

Table 2
Pre- and posttest mean scores and standard deviations for African and non-African experimental and control groups on the Representational Stencil Design Test

	African experimental ($n=40$)		African control ($n=24$)		Non-African experimental ($n=14$)		Non-African control ($n=8$)	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
M	65.77	96.70	70.21	94.75	111.36	127.14	128.87	142.62
S.D.	28.92	23.00	30.84	32.73	36.10	29.74	22.16	11.56

the experimental and control, African and non-African groups. Table 2 and Fig. 3 respectively present and illustrate the mean scores and standard deviations for these groups.

A two-way ANCOVA was computed on the Stencils totals, with the four groups as variables and the Raven's posttest score as covariates. The Raven's posttest score as a covariate was significant at $P<.001$ for both Stencils pre- and posttest scores. The non-African group also scored higher than the African group on the Stencils pre- and posttests [$F(1,81)=22.09$, $P<.001$ and $F(1,81)=12.87$, $P<.001$, respectively). The difference between experimental and control groups on the Stencils pretest scores was also significant ($P<.05$) in favor of the control group. No significant differences were found between the original experimental and control groups on the Stencils posttest scores.

Separate ANCOVAs were then computed for each racial group to see if there were any differences in transferability of skills between experimental and control groups. The Raven's posttest score (the covariate) was still significantly related to the Stencils pre- and posttest scores for both African and non-African groups ($P<.001$). However, for both groups, there were no significant differences between experimental and control groups on the Stencils pre- and posttest scores. The expected superior performance of the experimental group due to mediation from the Raven's was not supported.

The effect of Stencils mediation on the performance of Africans vs. non-Africans and experimental versus control groups was also assessed. The results of the ANCOVA revealed a significant result for the mediation [$F(1,81)=146.28$, $P<.001$]. As Table 2 indicates, and as graphically illustrated in Fig. 3, while the non-African experimental and control groups

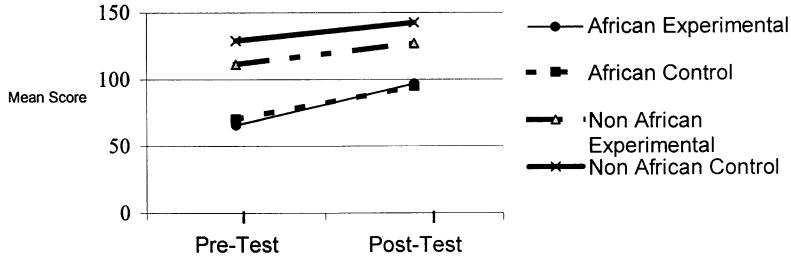

Fig. 3. Mean score on the Stencils for African and non-African experimental and control groups.

showed almost equal postmediation changes, the African experimental group displayed a slightly greater change relative to the original control group.

However, no significant differences were found between the African and non-African and original experimental and control groups. When the two racial groups were analyzed separately, the effect of mediation was still significant at $P < .001$ for both groups, but still with no significant differences between the experimental and control groups. This means that all groups benefited equally from mediation on the Stencils Test, irrespective of whether or not they had previously received mediation on the Raven's.

6. Discussion

The results obtained on the initial presentation of the Raven's were similar to those found in Rushton and Skuy's (2000) study of a comparable group of first year African and non-African psychology students at the University of the Witwatersrand. African university students averaged a Raven's score of 43, with an IQ equivalent of 85. The non-African students averaged a Raven's score of 53, with an IQ equivalent of 105.

In this study, mediation according to the principles of Feuerstein was applied to all students after the initial testing. Thereafter, the scores of the African group improved significantly, and to an extent greater than the non-African group, which, nevertheless, also showed a significant improvement. Although the initial scores of the African group were lower than those of their White counterparts, their scores were substantially above the chance level of correct scores for the test (i.e., they achieved 43 out of 60 or 72% as opposed to 13%). This indicates that the interaction obtained between race and intervention was robust.

The greater improvement of the African South Africans over other groups is also consonant with the theory of Feuerstein (1979) and Skuy (1997) in terms of which African students, by virtue of their sociopolitical history, are especially likely to have been deprived of mediated learning experience. However, even after mediation, the non-African group still scored significantly higher than the African groups on the Raven's, as also on their examination results in the psychology examination, although, of course. there was considerable overlap in all scores between the African and non-African subjects.

The Raven's scores were not significantly correlated with performance in the psychology examination, either before or after mediation. Thus, for individual African and non-African students, the Raven's Test did not appear to be a valid predictor of performance in psychology. This raises questions either about Raven's as a measure of intelligence or the adequacy of the psychology examination in this regard.

Overall, various issues are raised by the results presented here, including what it is that the Raven's actually measures and what it is that was improved by our interventions. For example, although Jensen (1998) reported the Raven's Test has a high *g* loading, and Rushton and Skuy (2000) found that the higher the *g* loading, the more pronounced were the African–White differences, others (e.g., Carroll, 1997) contend that the scores on the Raven's are also influenced by particular skills and by spatial abilities. As such, these may be more related to schooling, literacy, and the cognitive demands imposed by the environment, and, thus, they

may vary more from culture to culture. Performance on Raven's may have been affected by the fact that the test requires specific strategies and cognitive styles that may not be as characteristic of Black culture. In support, Sowell (1994) has observed a preference for spontaneity and improvisation over abstract thinking in Black cultures all over the world.

The skills acquired through mediation on the Raven's were not transferred to the Stencils for either the African or non-African subjects. The Stencils Test was chosen as a transfer measure since, like the Raven's, it requires representational/abstract thinking. Thus, it was considered as a good measure of transfer of cognitive skills developed through mediation on the Raven's. The high correlations obtained between the two measures supports this assumption. However, since the Raven's and the Stencils require different set-specific mental operations/cognitive processes, an improvement on the Stencils might possibly be considered a case of far transfer, and too much to expect following the limited amount of mediation provided in this study.

Finally, while non-Africans continued to score higher than Africans in this study, this effect was somewhat moderated as a function of Feuerstein's Mediated Learning Experience. This approach does not claim to produce extensive cognitive changes so much as to assess individuals' potential for change. The modification that occurred after such a short investment holds out the promise for even greater change after longer-term intervention. Given the years of educational and sociopolitical deprivation to which African students have been exposed, considerable mediation may be needed to overcome the various cognitive deficits.

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