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LEARNING TO READ IS MUCH MORE THAN LEARNING TO READ:

A NEUROPSYCHOLOGICALLY-BASED READING PROGRAM

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ABSTRACT

Departing from the observation that illiterate subjects significantly underscore in some neuropsychological tests, a learning-to-read method named as NEUROALFA was developed. NEUROALFA is directed to reinforce these underscored abilities during the learning-to-read process. It was administered to a sample of 21 adult illiterates in Colima (Mexico). Results were compared with two control groups using more traditional procedures in learning-to-read. The NEUROPSI (Ostrosky et al., 1997, 1999) neuropsychological test battery was administered to all the participants before and after completing the learning-to-read training program. All the three groups presented some improvement in the test scores. Gains, however, were significantly higher in the experimental group in Orientation in Time, Digits Backward, Visual Detection, Verbal Memory, Copy of a Semi-complex figure, Language Comprehension, Phonological Verbal Fluency, Similarities, Calculation Abilities, Sequences, and all the recall subtests, excluding Recognition. Performance in standard reading tests was also significantly higher in the experimental group. Correlations between pre-test NEUROPSI scores and reading ability were low. However, correlations between post-test NEUROPSI scores and reading scores were higher and significant for several subtests. Results are interpreting as supporting the assumption that reinforcement of those abilities in which illiterates significantly underscore, result in a significant improvement in neuropsychological test scores and notoriously facilitates the learning-to-read process. NEUROALFA method to teach to read adult illiterates is beginning to be used extensively in Mexico. To our knowledge, this is the first attempt to apply neuropsychological principles to approach social problems.

INTRODUCTION

A significantly decreased neuropsychological test performance has been documented in illiterate individuals (Ardila et al., 1989; Goldblum & Matute, 1986; Lecours et al. 1987a, 1987b, 1988; Manly et al., 1999; Ostrosky et al., 1998; Reis & Castro-Caldas, 1997; Rosselli, et al., 1990). Lowered scores are observed in most cognitive domains, including, naming, verbal fluency, verbal memory, visuoperceptual abilities, conceptual functions, and numerical abilities. Language repetition can be normal for meaningful words, but abnormal for pseudowords (Reis & Castro-Caldas, 1997; Rosselli et al., 1990). Similarly, copying meaningful figures can be easier than copying nonsense figures (Ostrosky et al., 1998). Furthermore, for illiterate people to use concrete situations can be notoriously easier than using non-real and abstract elements. When the information is related to real life, it can be significantly easier to understand. Thus, for the illiterate person, it is easier to solve the arithmetical operation "If you go to the market and initially buy 12 tomatoes and place them in a bag and latter on, you decide to buy 15 additional tomatoes, how many tomatoes will you have in your bag?" than the operation: "How much is 12 plus 15?". Semantic verbal fluency is easier than phonological verbal fluency (Reis & Castro-Caldas, 1997; Rosselli et al., 1990), seemingly, because phonological abstraction is extremely difficult for the illiterate person. Semantic verbal fluency requires the use of concrete elements (animals, fruits) whereas phonological fluency is tapping a metalinguistic ability.

It could be conjectured that learning to read stimulates the development of certain cognitive abilities: Verbal memory, visuoperceptual abilities, phonological abstraction, conceptualization, verbal knowledge, etc. As a matter of fact, very important cognitive consequences of learning to read and to write have been suggested: changes in visual perception, logical reasoning, and remembering strategies (Laboratory of Comparative Human

Cognition, 1983). Even the influence of schooling on formal operational thinking (Laurendeau-Bendavid, 1977) and functional brain organization (Castro-Caldas et al., 1998) have been pointed out. Conversely, training these abilities may make it easier to learn to read and to write.

It was hypothesized that a teaching-to-read program directed to reinforce some specific neuropsychological abilities could facilitate the learning-to-read process. Departing from the analysis of illiteracy, the abilities that should be most stimulated and reinforced include verbal memory, visuoperceptual abilities, and phonological awareness. Furthermore, a successful teaching-to-read program should at best use personal and concrete information dealing directly with the subject's personal situations and interests.

In Mexico, the National Institute of Adult Education *(Instituto Nacional para la Educación de los Adultos*, INEA) has a large program directed to teach to read and to write adult people. Approximately 1,135,250 adults attend this program every year, but only 28.63% successfully learn to read. (INEA, 1998). The rest do not complete the program or simply fail in learning to read.

Two different methods are used by the INEA when teaching to read and to write:

1. Global method: *Método Global de Alfabetización con el Nuevo Enfoque para la Educación Básica de los Adultos* known as NEEBA (INEA, 1994). It begins exploring different written materials (letters, newspapers, etc.). The purpose is to learn to read using the words that the subject can find in his or her environment. It includes 46 lessons grouped in eight units. Each lesson takes about one hour. It can be developed in six to 12 months depending upon the numbers of hours working weekly and the subject's own progress pace.

The general structure of the NEEBA is presented in Appendix 1.

2. Method Express (INEA, 1990) relies on a phonological strategy. The letters included in the subject's name are initially used. These letters are analyzed and the idea that words are formed by discrete sounds is reinforced. Further, it moves to other common words, emphasizing the relationships between phonemes and graphemes. Complex letter combinations are introduced later. It takes about 20 hours. It is considered a kind of brief and basic learning-to-read method. In a significant extent it is an individualized method, that depends upon each subject. There is not a sequence of lessons and Express method can be regarded as a rather elementary learning to read procedure.

The purposes of this study were (1) to develop a new method to teach adults to read and to write, departing from current knowledge about neuropsychological test performance in illiterates. This new method was named NEUROALFA. And (2) to compare the efficiency of the NEUROALFA method with the two traditional methods used in Mexico to teach to read and to write adult illiterates. Changes in neuropsychological test performance were analyzed.

METHOD

Participants

Sixty illiterate subjects who first attended the INEA in Colima City (Mexico) were selected. Age ranged from 16 to 50 years. This group was divided into three subgroups matched by age and gender. (1) Group 1 (G1) (10 men, 11 women; mean age = 33.22; SD = 12.12). The NEUROALFA method was administered. (2) Group 2 (G2) (10 men, 11 women; mean age = 33.14; SD = 11.21) was administered the NEEBA method. And (3) Group 3 (G3) (8 men, 10 women; mean age = 32.90; SD = 12.15) was administered the Express method. Once all the participants were selected, they were randomly assigned to one of the three groups. However, it was further necessary to make some changes in the groups composition, in order to have a similar number of males and females and a similar age distribution in each group.

All the participants had a normal performance in daily life activities All were active and functionally independent (i.e., normal functional intelligence) according to the subject's own sociocultural environment. All the subjects were living in the east area of Colima City, which is considered as an extremely poor area. The University of Colima has a public health program known as UNI-Colima. This health program not only attends medical issues and distributes health information, but also recommend people to participate in alphabetization programs. All the subjects participating in this research were referred to the INEA by the UNI-Colima program. This is a customary procedure during the development of public health programs. Participants were unqualified workers, maids, and housewives. All the subjects were considered to be illiterate as a result of lack of schooling opportunities, and not as a result of poor academic performance. This lack of schooling opportunities included: extremely poor

economical conditions requiring the subject to work instead of attending school; absence of close schools in subjects coming from rural areas; and parents' preference to send boys but not girls to school; this last situation was observed in several illiterate women. Some subjects could recognize a few letters and even to write his/her own name without recognizing its phonology, but most of them "signed" using the fingerprint. They did, however, recognize diverse logographic signs, such as "stop", and the logographically written names of many commercial products (cigarettes, beverages, etc).

A neurological and psychiatric screening questionnaire was used to rule out previous neurological and psychiatric conditions such as: brain injury, cerebrovascular disease, epilepsy, Parkinson's disease, psychiatric hospitalizations, and the like. A handedness questionnaire was also presented. Four subjects were not included in the study due to history of alcohol abuse.

The NEUROPSI neuropsychological test battery (Ostrosky et al., 1997, 1999) was individually administered to all subjects before and after the learning-to-read training. Regular INEA teachers administered all the three learning-to-read methods. A volunteer INEA teacher was trained to administer NEUROALFA method. All the classes took place in the INEA facility in Colima City (Mexico). All the teachers were aware that a research study about methods in learning-to-read was in progress, but they did not have any knowledge about the specific purposes and hypotheses of the study. It is customary in the INEA programs to encourage the participants at best. In all the groups subjects were told that they were notoriously improving and, if carefully following the instructions, significant progress would be obtained. Thus, in all the groups the subjects assumed that the best effort was done and the best method was used. Class groups included only two or three students simultaneously working with one teacher.

Once the training was completed, all the 60 participants were evaluated in reading ability. The regular INEA reading tests and some additional reading and writing tests were administered (Ostrosky et al., 1990).

NEUROALFA Teaching-to-read method

It was conjectured that a successful method to teach to read and to write adult illiterates should have the following characteristics: (1) it should reinforce those abilities in which illiterates underscore in common neuropsychological tests. Such abilities include: (a) phonological abstraction, (b) semantic categorization, (c) finding similarities, (d) visoperceptual abilities, (e) verbal memory, and (f) abstracting abilities. And (2) concrete and personal situations should be preferred and used at best, such as family issues, home activities, everyday use of written language, personal documents, etc.

Departing from these considerations a teaching to read method was developed. It was named as NEUROALFA. It includes an Instructor's Manual and a Reading Book for the student. Instructor's Manual includes 34 exercises grouped in ten lessons. Each lesson takes about 3-4 hours, and each exercise takes about one hour. NEUROALFA can be developed in about three months, working three times weekly. Total administration time can be about 40 hours. The general structure of the different NEUROALFA lessons is presented in the Appendix 2.

NEUROALFA attempts to emphasize those abilities in which illiterates frequently get low scores in common neuropsychological tests. These abilities are reinforced during the learning to read process, not in separate training sessions. These are supposed to be the abilities

required to read (e.g., phonological awareness), and amplified during the learning to read process.

Comparing NEUROALFA and NEEBA methods, it is observed that NEUROALFA includes the following types of exercises, not found in the NEEBA method: (1) Exercises emphasizing phonological awareness: Phoneme discrimination, phonological similarity, decomposition of words in sounds and letters, to group words with common phonemes, and cross-words; (2) Exercises of semantic associations, (3) spatial exercises: spatial orientation of words, spatial discrimination of letters; (4) Proverb interpretation; and (5) Exercises emphasizing verbal memory, i.e., to recall sentences.

Neuropsychological Testing Instrument

The Spanish version of the NEUROPSI neuropsychological test battery (Ostrosky et al., 1997, 1999) was individually administered twice, at the beginning and at the end of the learning-to-read program. NEUROPSI includes the following sections:

1. Orientation. Time (day, month, and year), Place (city and specific place), and Person (how old are you? or, When were you born). Maximum score = 6 points.
2. Attention and concentration (Maximum score = 27).
    2.1. Digits backward, up to six digits. Maximum score = 6 points.
    2.2. Visual detection. In a sheet which includes 16 different figures each one repeated 16 times, the subjects are requested to cross-out those figures equal to the one presented as a model. The 16 matching figures are equally distributed at the right and at the left visual fields. The test is suspended after one minute. Two

scores are obtained: number of correct responses (maximum score = 16), and number of errors.

2.3. 20 minus 3, five consecutive times. Maximum score = 5)

3. Coding (Maximum score = 18)

3.1. Verbal memory. Six common nouns corresponding to three different semantic categories (animals, fruits, and body-parts), are presented three times. After each presentation, the subject repeats those words that he or she remembers. The score is the average number of words repeated in the three trials (maximum score = 6). In addition, intrusions, perseverations, recency and primacy effects are noted.

3.2. Copy of a semi-complex figure. A figure similar to the Rey-Osterrieth Complex Figure, but notoriously simpler is presented to the subject. The subject is instructed to copy the figure on his or her best. A special scoring system is used, with a maximum score of 12 points.

4. Language (Maximum score = 26).

4.1. Naming. Eight different line drawing figures are presented to be named. They correspond to animals, musical instruments, body-parts, and objects. If the subject presents visual difficulties, an alternative procedure is used: the patient is required to name small objects placed in the hand, and body-parts. Maximum score = 8.

4.2. Repetition. The subject is asked to repeat one monosyllabic word, one three-syllabic word, one phrase with three words, and one seven word sentence. Successful repetition in each one is scored 1. Maximum score = 4.

4.3. Comprehension. On a sheet of paper two circles (small and large) and two

squares (small and large) are drawn. Six consecutive commands, similar to those used in the Token Test are given to the subject. The easiest one is "point the small square", and the hardest one is "in addition to the circles, point to the small square". Maximum score = 6.

4.4. Semantic verbal fluency (animals). Two scoring systems were used: (a) the total number of correct words; and (b) A 4-point scale was used. One point was given to 0-5 words; two points to 6-8 words; three points to 9-14 words; and four points to 15 or more words in a minute. Intrusions and perseverations are noted.

4.5. Phonological verbal fluency (words beginning with the letter F). Two scoring systems were used: (a) the total number of correct words; and (b) A 4-point scale was developed. One point was given to 0-3 words; two points to 4-6 words; three points to 7-9 words; and four points to 10 or more words in a minute. Intrusions and perseverations are noted.

5. Reading. The subject is asked to read aloud a short paragraph (109 words). Three questions about the paragraph are presented. Maximum score = 3.

6. Writing. To write under dictation a six word sentence; and to write by copy a different six word sentence. Maximum score = 2.

7. Conceptual functions (maximum score = 10)

7.1. Similarities. Three pairs of words (e.g., orange-pear) are presented to find the similarity. An example is provided. Each one is scored as 0 (physical similarity: both are round), 1 (functional similarity: both can be eaten), or 2 (the answer corresponds to the supraordinate word: fruits). Maximum score = 6.

7.2. Calculation abilities. Three simple arithmetical problems are presented. Maximum score = 3.

7.3. Sequences. The subject is asked to continue a sequence of figures drawn on a paper (what figure continues?). Maximum score = 1.

8. Motor functions (maximum score = 8)

8.1. Changing the position of the hand. To repeat three positions with the hand (right and left). The model is presented by the examiner up to three times. A maximum score of 2 is used for the left and for the right hand. Maximum score = 4.

8.2 Alternating the movements of the hands. To alternate the position of the hands (right hand close, left hand open, and to switch). Maximum score = 2.

8.3 Opposite reactions. If the examiner shows the finger, the subject must show the fist; if the examiner shows the fist, the subject must show the finger. Maximum score = 2.

9. Recall (maximum score = 30).

9.1 Recall of verbal information.

9.1.1. Spontaneous recall. Maximum recall = 6

9.1.2. Cueing recall: Recall by categories (animals, fruits, and body-parts). Maximum score = 6.

9.1.3. Recognition. The examiner reads 14 different words, and the subject must tell which ones were previously presented. Maximum score = 6

9.2. Recall of the semi-complex figure. Maximum score = 12

In total, 26 different scores are obtained. Maximum total score is 130. Testing was performed in a single session. Administration time is 25 to 30 minutes. Reading and writing sections were not included. Normative results and reliability of this test battery is presented somewhere else (Ostrosky, Ardila & Rosselli, 1999).

Reading Testing

Two types of tests were used:

(1) Texts to assess oral and silent reading (Ostrosky et al., 1990). It included six different texts, used in primary school, and ranked in different levels of difficulty. Time is taken, and the numbers of words read in one minute for each condition is calculate. Reading comprehension is assessed presenting direct questions about the texts.

(2) Reading words. Three different lists, each one containing 25 words are used. The lists have different level of difficulty. Time is measured.

Statistical Analyses

Mean and standard deviations were calculated for the initial NEUROPSI scores. Pre-test and post test NEUROPSI scores were compared using ANOVAs with the Bonferroni correction. A $p < 0.05$ was considered statistically significant. Differences between the post test and pre test scores were calculated, subtracting the initial test score from the final test score. Means and standard deviations in each group were calculated and ANOVAs comparisons were established using the Bonferroni correction. Mean and standard deviations were calculated in the reading tests. ANOVAs comparisons were established using the Bonferroni correction. Finally, Spearman's correlations between NEUROPSI (pre-test and post-test) subtest scores and reading scores were calculated.

RESULTS

Two different types of analyses were performed: (1) NEUROPSI neuropsychological test battery scores before and after the learning-to-read training program were compared; and (2) performance in standard reading tests in the three groups at the end of the training period was analyzed.

Table 1 presents the initial scores in the NEUROPSI test battery and normative scores for illiterates. No significant differences among the three groups were found. Scores are similar to those reported for illiterate subjects in the NEUROPSI neuropsychological test battery (Ostrosky et al., 1998, 1999). Table 2 presents the scores in the NEUROPSI after the training program. In general, an increase in the scores is observed. However, improvement is stronger in the first group (NEROALFA method) than in the other two groups. Neuropsychological test performance in the experimental group is similar to that observed in individuals with one to four years of schooling (Ostrosky et al., 1998). Significant differences between the first (experimental) group and the two control groups are observed in 11 test scores, whereas in 13 test scores no significant differences across groups are found. Differences are noted in all battery domains, excepting Motor Functions. Strongest differences are found in Coding and Conceptual (executive) functions domains. Significant differences are observed in the following subtests: Orientation in Time, Digits Backward, Visual Detection, Verbal Memory, Copy of a Semi-complex Figure, Language Comprehension, Phonological Verbal Fluency, Similarities, Calculation Abilities, Sequences, and all the recall subtests, excluding Recognition..

See Table 1 and Table 2

Differences between the pre-test and post-test scores were calculated. Gains in scores

between the two evaluations (before and after the training program) were analyzed. Differences in the three groups are presented in Table 3. It is apparent that score gains were more robust in the first group. Gains were significantly higher in the first group in Orientation Time, Visual Detection, Verbal memory, Copy of a Figure, Language Comprehension, Phonological Verbal Fluency, Similarities, Sequences, and all the recall subtests, excluding Recognition. No statistically significant differences between groups were observed in the other subtests.

See Table 3

Table 4 presents the scores of a standard reading test, designed to evaluate reading ability in first graders. Reading speed was almost twice faster in the first group compared with the two control groups. By the same token, reading comprehension was significantly superior in the NEUROALFA group. These differences were observed not only in the reading aloud condition but also in silent reading.

See Table 4

Correlations between reading ability and neuropsychological test performance were calculated so for the pre-test (Table 5) as for the post-test (Table 6) results. Correlations were established between NEUROPSI scores and reading ability scores in the total sample (n=60), considering that the three groups were small. Correlations between initial scores and reading ability scores in general were low and statistically no significant. However, several correlations between post-test NEUROPSI scores and reading ability scores were found statistically significant. Highest correlations ($p<0.001$) were found in the following subtests: Digits Backwards, Visual Detection, Verbal Memory, Copy of a Figure, Verbal Fluency (both conditions), Motor Functions: Right-Hand Position, Similarities and Recall (cueing and

Recognition).

See Table 5

DISCUSSION

Current results have significant implications to understand the effects of literacy. Learning to read reinforces certain fundamental abilities, such as verbal memory, phonological awareness, and visuospatial discrimination. It is not surprising that illiterate people underscore in cognitive tests tapping these abilities. Furthermore, attending school also reinforces certain attitudes and values that may speed the learning process, such as the attitude that memorizing information is important, knowledge is highly valuable, learning is a stepwise process moving from the simpler to complex, etc. It has been emphasized that schooling improves an individual's ability to explain the basis of performance on cognitive tasks (Laboratory of Comparative Human Cognition, 1983). The fundamental aims of schools are equivalent for all schools and school reinforces certain specific values regardless of where they are located. Hence, school could be seen as a culture unto itself, a transnational culture, the culture of school. School not only teaches, but also helps in developing certain attitudes that will be useful for future new learnings. Ciborowski (1979) observed that schooled and non schooled children can learn a new rule equally well, but once acquired, schooled children tend to apply it more frequently in subsequent similar cases.

NEUROALFA was developed as a learning-to-read method in which these fundamental abilities and these attitudes were not just tangentially considered, but directly targeted. Special exercises were developed to reinforce these fundamental abilities. For example, combining sounds to form new words, finding phonological and semantic similarities between words, memorizing the information that is read, analyzing proverbs to emphasize that the language has different levels of meaning, and emphasizing the visual discrimination of letters, upper and lower-case letters. A positive attitude for learning was reinforced at best using strategies such as:

departing from purely personal and family issue; emphasizing that learning to read is important for understanding a medical prescription and having access to booklets dealing with health issues. Reading the newspaper is crucial to knowing and understanding better the surrounding world, etc.

Current results support the assumption that direct training and reinforcement of those abilities in which illiterates significantly underperform will result in a significant improvement in neuropsychological test scores. Improvement was observed in various cognitive domains, but especially in visuoconstructive ability (Copying a Semi-Complex Figure); Phonemic Verbal Fluency; finding similarities (Similarities subtest); and language understanding (Language Comprehension subtest). In some domains, however, no significant improvement was observed (Motor Function subtests).

All the three learning-to-read- methods resulted in some improvement in neuropsychological test performance. Improvements in scores were potentially the result of two different factors: (a) re-testing and (b) training program. Of course, other non-controlled variables might be involved, even though it is unlikely they could have a significant impact on the results. What was really surprising was the mild or no improvement observed in several subtests in the two control groups. We suspect that this poor cognitive test performance improvement is highly correlated with the above-mentioned observation that only 28.63% of the adult students attending the traditional INEA programs successfully learn to read.

It is important to emphasize that observed differences among groups are also in some extent related with teaching time. Express method is notoriously shorter, and evidently final reading performance in this group was very low. However, NEEBA and NEUROALFA require a

similar amount of time (about 40 hours, plus the exercises). In consequence, the really valid comparison that can be established is between NEUROLAFA and NEEBA methods.

The most crucial step in teaching an adult to read is making sure that the subject really understands how the writing system works and gets personally involved in the process. A significant introductory process and deep personal involvement are required. In the NEUROALFA method the two first teaching topics are: (1) to emphasize at best that reading is most important in everyday life, and any significant information can be represented in writing. Furthermore, written language is alike and parallels spoken language. And (2) to read his or her own name. To recognize how our own name is written is a very exciting experience for everyone. For all of us it is very exciting to find out how our name is written in a different writing system, for instance Chinese characters, and to understand how different lines and symbols correspond to different parts of the name. A similar excitement is observed in the illiterate when first understanding how his or her name is written on IDs, on the class roster, on the blackboard, etc., and to discover the strategies used in representing the name. The following step in the NEUROALFA is the analysis of the proper name into the sounds that form it, and further creating new words using the proper name letters. This is really the first step to understand how the writing system works. If this initial process fails, the whole learning-to-read process will fail.

Noteworthy, significant improvement was observed in some subtests that were not directly targeted during the learning-to-read program. This was true with regard to Orientation in Time, Calculation, and Sequences subtests. As a matter of fact, all these three abilities can be partially interpreted as executive function abilities. It may be conjectured that the strategies reinforced when analyzing and understanding the reading system require the application of some

metacognitive principles (e.g., using analytic strategies, planning, organizing output sequences, etc.). These metacognitive principles become available to be applied to some other tasks. For instance, for successfully deducing what figure continues a sequence (Sequences subtest).

To separate the effects of literacy from the effects of school is not easy. School not only teaches but also reinforces some attitudes and values. During the development of the NEUROALFA program these school-based values were emphasized at best: to memorize, to make practical use of reading in the everyday life, etc. Scribner and Cole (1981) attempted to separate the effects of literacy from the school effect. Among the Vai people in Liberia they found some individuals who were literate in the Vai script but who had not attended formal schools. Using a battery of cognitive tests they found that there were no general cognitive effects of literacy, but there were some specific tests performances that were related to the particular features of the Vai script. They concluded that literacy makes some differences to some skills in some contexts. Berry and Bennet (1989) carried out a partial replication of this study among the Cree of Northern Ontario. Our results partially corroborate Scribner and Cole's results. Noteworthy, improvement in neuropsychological test performance was quite limited in our G2 and G3. G3, however, significantly improved in the Phonological Verbal Fluency test, which was mot likely related to the phonological approach used in the Express Method.

It should be emphasized that in both the Global Method (NEEBA) (G2) and Express Method (G3), the emphasis is placed in learning to read, not in learning to write. As a matter of fact, Express method does not include writing at all. In the NEEBA method even though writing is included, emphasis is placed in reading, not in writing. This was a major difference with the NEUROALFA method that potentially may account for some of differences observed in test

performance among the three groups. In Scribner and Cole, and Berry and Bennet studies mentioned above, this also was a potentially confounding factor. Learning to write requires the use of significant graphomotor and visuospatial abilities that are not crucial for reading and are not reinforced in just learning to read.

It is important to emphasize that correlations between pre-test scores and reading ability scores were in general low and no significant. However, correlations between post-test NEUROPSI scores and reading ability scores were significant in several subtests. This observation support the assumption that neuropsychological tests scores indeed do not exactly predict learning to read scores, but learning to read reinforces those abilities required to obtaining a high performance in neuropsychological tests. This observation may be most important in the cognitive testing domain and in the analysis of the relationship between education and cognitive test performance.

Though it is well established that there a significant correlation between cognitive test scores (e.g., IQ) and school attendance (e.g., Matarazzo, 1972) interpreting this correlation has been polemic (Brody, 1992; Neisser et al., 1996). The really crucial question is: Do cognitive (intelligence) tests indeed predict school performance? Or rather, does school train those abilities appraised in intelligence tests? To answer these questions is not easy, even though frequently the interpretation has been that IQ predicts school performance (e.g., Hunter, 1986). Other researchers, however, consider that IQ scores are to a significant extent a measure of direct and indirect school learning (e.g., Ardila, 1999; Ceci, 1990).

Ceci (1991) presented an extensive and detailed review of available data in this area. The general conclusion is that school attendance accounts not only for a substantial portion of variance

in children's IQ but also apparently some, though not all, of the cognitive processes that underpin successful performance in IQ tests. The magnitude of this influence ranges between 0.25 to 6 IQ points per year of school. In consequence, the association between IQ and education cannot interpreted assuming that IQ predicts school success. Intelligence and schooling have complex bidirectional relationships, each one influencing variations in the other (Ceci & Williams, 1997). According to our results, even though bidirectional relationships may exit, the really significant relationship is between schooling (in our case, learning to read) and cognitive test performance. That is, learning to read significantly impacts cognitive test performance.

For English speakers it can be surprising the short time required learning to read Spanish language. It is important to note that Spanish possesses a phonologically transparent reading system, and a less transparent writing system. Ambiguity in its reading writing system goes only in one direction: many words potentially can be written in different ways. In other words, in Spanish, homophonic heterography can be found (e.g., *ha* and *a* are both read as /a/), whereas homographic heterophony is absent. That is, any word or pseudoword can be read in only one way; i.e., there are not alternative readings for any string of letters. As a result of the simplicity of the Spanish reading system, usually children can learn to read during the first school grade. First grade reading books usually begin reviewing the sounds of the different letters. The letters M, P and S (in that order) are initially presented and simple words (e.g., *mamá, mapa*) and short phrases (e.g., *Mi mamá puso mi sopa*) are introduced. Further, they introduce complex syllable combinations (e.g., PR, BL) and longer sentences (e.g., *Tu profesor te prepara para la vida*). Finally, reading short paragraphs and one-two pages long stories are presented (e.g., Grupo de Asesoría Didáctica, 1984). During the first school grade it is expected that children will also learn

to write any word without "non-homophone" errors (additions, omissions of substitutions of letters that in that particular position result in and erroneous phonographemic conversion), but not without "homophone" or "orthographic" errors (additions, omissions or substitutions of letters that in that particular position do not result in erroneous phonographemic conversion). To teach adults to read is usually accomplished in one year or less. As a matter of fact, INEA traditional programs take about 20-50 hours of direct training plus, of course, significant additional homework.

We suppose that directly targeting and emphasizing some weak abilities (e.g., phonological awareness) required to read will speed the learning to read process. We further suppose that writing may required some additional abilities (e.g., spatial,) no so crucial for reading. In our study G3 (Express) had a shorter training, and comparisons between G1 (NEUROALFA) and G2 (NEEBA) are seriously biased by this time factor. Learning time, however, was equivalent between G1 (NEUROALFA) and G2 (NEEBA). NEEBA method also includes some writing. It can be conjectured that NEUROALFA method was better targeting these abilities required for reading.

Finally, it is interesting to mention that the NEUROALFA method has been accepted as the best teaching-to-read adult program in Colima State (Mexico). Currently, they are beginning to use it in extensively. It is likely that in a near future NEUROALFA method will be adopted by the INEA as the official method to teach adults to read in the Mexican Republic. To our best knowledge, this would be the fist extensive application of neuropsychological principles to approach social problems.

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Table 1. Initial scores in the NEUROPSI neuropsychological test battery and normative scores for illiterates (Ostrosky et al., 1998). Mean and standard deviations (in parenthesis) and group differences are presented.

Subtests	G1 (n=21)	G2 (n=21)	G3 (n=18)	F	p	Normative Scores
Orientation: Time	1.95(1.09)	2.40(0.94)	1.25(1.25)	0.13	0.658	2.3(0.8)
Place	1.86(0.35)	1.95(0.22)	2.00(0.00)	2.37	0.104	1.9(0.2)
Person	1.00(0.0)	0.22(0.10)	1.00(0.00)	0.67	0.514	0.9(0.1)
Attention: Digits backward	2.04(1.09)	2.42(1.14)	2.00(1.15)	2.91	0.091	2.4(1.1)
Visual detection	8.95(4.15)	10.10(3.75)	9.50(4.35)	0.42	0.653	9.9(4.5)
20 minus 3	1.86(2.00)	2.25(2.00)	1.00(1.141)	0.71	0.496	3.1(1.9)
Coding: Verbal memory	4.36(0.90)	4.25(0.63)	3.75(0.50)	1.07	0.350	4.2(0.6)
Copy of a figure	8.20(2.35)	8.05(1.70)	7.00(2.85)	0.53	0.588	7.5(2.0)
Language: Naming	7.31(1.05)	7.50(0.76)	8.00(0.00)	1.04	0.360	7.3(0.8)
Repetition	3.63(0.49)	3.75(0.44)	3.75(0.50)	0.33	0.719	3.8(0.4)
Comprehension	3.18(1.13)	3.80(1.23)	3.50(0.57)	1.49	0.234	3.7(1.2)
Verbal fluency: Semantic	11.90(3.66)	12.60(3.08)	13.75(3.50)	0.57	0.567	13.5(4.6)
Phonol	0.77(1.84)	1.10(1.58)	0.00(0.00)	0.67	0.470	3.1(3.7)
Conceptual functions: Similarities	1.27(1.83)	1.80(2.21)	1.00(0.81)	0.50	0.605	2.1(2.2)
Calculation abilities	0.59(0.85)	0.85(1.13)	0.00(0.00)	1.38	0.261	0.9(1.0)
Sequences	0.00(0.00)	0.05(0.22)	0.00(0.00)	0.63	0.532	0.1(0.3)
Motor functions: Right-hand pos	0.95(0.65)	1.05(0.68)	1.25(0.50)	0.37	0.690	1.1(0.7)
Left-hand position	1.18(0.66)	1.15(0.74)	1.25(0.50)	0.03	0.963	1.0(0.7)
Alternating movements	0.86(0.77)	1.10(0.71)	0.75(0.50)	0.71	0.493	0.8(0.7)
Opposite reactions	1.95(0.21)	1.75(0.44)	2.00(0.00)	2.34	0.108	1.7(0.5)
Recall: Words	3.59(2.19)	2.85(2.34)	4.00(0.41)	0.81	0.449	3.1(2.2)
Cueing	4.50(1.33)	4.15(1.30)	3.25(0.95)	1.64	0.205	4.1(1.4)
Recognition	5.54(1.10)	5.75(0.71)	6.00(0.00)	0.55	0.579	5.4(1.1)
Semi-complex figure	6.45(2.32)	7.20(1.68)	5.75(1.84)	1.19	0.311	6.3(2.2)

Table 2. Final scores in the NEUROPSI neuropsychological test battery after the administration of the teaching to read program. Mean and standard deviations (in parenthesis) and group differences are presented.

Subtests	G1 (N=21)	G2 (n=21)	G3 (n=18)	F	p	Differences
Orientation: Time	2.68(0.47)	2.45(0.82)	1.25(1.20)	6.63	0,003	1,2vs3
Place	2.00(0.00)	1.95(0.22)	2.00(0.00)	0.63	0.532	none
Person	1.00(0.00)	0.95(0.22)	1.00(0.00)	0.63	0.532	none
Attention: Digits backwards	2.86(0.83)	2.65(0.87)	1.50(0.57)	4.48	0.017	1,2vs3
Visual detection	12.5(2.82)	9.75(4.37)	8.50(3.69)	4.08	0.020	1vs3
20 minus 3	3.18(1.94)	2.40(1.95)	1.00(1.14)	2.49	0.090	none
Coding: Verbal memory	4.95(1.48)	4.30(0.65)	3.75(0.50)	11.44	0.001	1vs2,3
Copy of a figure	10.6(1.09)	8.15(1.82)	7.50(2.27)	10.06	0.003	1vs.2,3
Language: Naming	7.90(0.29)	7.65(0.74)	8.00(0.00)	1.51	0.231	none
Repetition	3.90(0.29)	3.75(0.44)	4.00(0.00)	1.41	0.253	none
Comprehension	4.59(0.90)	3.75(1.16)	2.75(0.95)	7.03	0.002	1vs3
Verbal fluency: Semantic	13.0(3.86)	12.90(2.90)	14.50(2.64)	0.38	0.680	none
Phonol	8.04(3.37)	2.05(2.18)	2.75(1.70)	25.28	0.001	1vs2,3
Conceptual functions: Similarities	4.69(1.64)	2.00(2.10)	1.25(0.50)	13.55	0.001	1vs2,3
Calculation	2.00(0.87)	1.20(1.15)	0.75(0.95)	4.62	0.015	1vs3
Sequences	0.63(0.49)	0.05(0.22)	0.00(0.00)	14.47	0.001	1vs2,3
Motor functions: Left-hand pos	1.36(0.65)	1.15(0.67)	1.50(0.57)	0.79	0.460	none
Right-hand pos	1.50(0.59)	1.30(0.73)	1.25(0.50)	0.59	0.598	none
Alternating mov	1.36(0.78)	1.20(0.61)	1.00(0.00)	0.61	0.613	none
Opposite reactions	1.86(0.35)	1.75(0.44)	2.00(0.00)	0.90	0.410	none
Recall: Words	5.00(1.34)	3,00(2.19)	3.50(0.57)	6.42	0.003	1vs2,3
Cueing	5.45(0.67)	4.25(1.16)	3.50(0.57)	13.16	0.001	1vs2,3
Recognition	6.00(0.00)	6.00(0.00)	6.00(0.00)			none
Semi-complex figure	9.02(1.40)	7.27(1.67)	6.00(1.68)	10.28	0.002	1vs2,3

Table 3. Differences between the pre and post administration. Mean and standard deviations (in parenthesis) and group differences are presented.

Subtests	G1 (n=21)	G2 (n=21)	G3 (n=18)	F	p	Differences
Orientation: Time	0.72(0.98)	0.05(0.22)	0.00(0.00)	6.63	0.003	1vs2,3
Place	0.13(0.35)	0.00(0.00)	0.00(0.00)	0.63	0.532	none
Person	0.00(0.00)	0.00(0.00)	0.00(0.00)			none
Attention: Digits backwards	0.82(1.40)	0.20(0.69)	0.50(0.57)	1.67	0.199	none
Visual detection	3.59(4.48)	0.35(0.98)	0.45(0.20)	4.08	0.021	1vs2,3
20 minus 3	1.31(2.07)	0.15(0.67)	0.00(0.00)	2.49	0.900	none
Coding: Verbal memory	0.59(0.85)	0.05(0.22)	0.00(0.00)	4.58	0.001	1vs2,3
Copy of a figure	1.86(2.11)	0.10(0.44)	0.50(1.00)	7.15	0.002	1vs2,3
Language: Naming	0.59(0.95)	0.15(0.36)	0.00(0.00)	1.51	0.231	none
Repetition	0.27(0.63)	0.00(0.00)	0.00(0.00)	1.41	0.253	none
Comprehension	1.40(1.25)	0.05(0.22)	0.00(0.00)	7.03	0.002	1vs2,3
Verbal fluency: Semantic	1.09(2.84)	0.30(1.34)	0.75(1.50)	0.66	0.510	none
Phonol	7.27(3.89)	0.95(2.11)	2.75(1.70)	25.28	0.001	1vs2,3
Conceptual functions: Similarities	3.36(2.42)	0.20(0.52)	0.25(0.50)	19.04	0.001	1vs2,3
Calculation	1.40(1.05)	0.35(0.81)	0.75(0.95)	4.62	0.015	none
Sequences	0.63(0.49)	0.00(0.00)	0.00(0.00)	14.47	0.001	1vs2,3
Motor functions: Left-hand pos	0.40(0.73)	0.10(0.30)	0.25(0.50)	1.55	0.223	none
Right-hand pos	0.31(0.77)	0.00(0.00)	0.00(0.00)	1.45	0.235	none
Alternating mov	0.50(1.05)	0.10(0.30)	0.25(0.50)	0.61	0.546	none
Opposite reactions	0.00(0.00)	0.00(0.00)	0.00(0.00)			none
Recall: Words	1.40(2.44)	0.25(0.78)	0,05(0.57)	3.13	0.040	1vs2,3
Cueing	0.95(1.36)	0.10(0.30)	0.25(0.50)	4.13	0.020	1vs2
Recognition	0.45(1.10)	0.25(0.71)	0.00(0.00)	0.55	0.579	none
Semi-complex figure	2.56(1.94)	0.07(0.24)	0.25(0.28)	18.63	0.001	1vs2,3

Table 4. Mean scores and standard deviation obtained by the three group in a reading test (Ostrosky et al., 1990).

	G1 (n=21)	G2 (n=21)	G3 (n=18)	F	p
Reading aloud					
Words/minute	65.89 (11.55)	38.78 (6.58)	34.80 (5.30)	51.79	0.001
Reading understanding (%)	86.36 (18.9)	67.14 (26.96)	60.01 (23.09)	4.68	0.014
Silent reading					
Words/minute	62.87 (11.42)	40.62 (5.78)	39.47 (3.81)	63.30	0.001
Reading understanding (%)	89.09 (10.19)	66.01 (26.83)	60.01 (23.09)	8.35	0.009

Table 5. Spearman's correlations between initial scores in the NEUROPSI and reading ability scores. Total sample (N=60)

Subtests	Reading understanding				Words/minute			
	Oral		Silent		Oral		Silent	
	r	p	r	p	r	p	r	p
Orientation: Time	-0.135	0.304	-0.144	0.270	-0.194	0.136	-0.240	0.064
Place	-.0177	0.176	-0.208	0.111	-0.209	0.108	-0.245	0.058
Person	-0.136	0.299	-0.156	0.234	0.057	0.661	0.060	0.645
Attention: Digits backward	0.006	0.961	0.009	0.943	-0.006	0.960	0.029	0.824
Visual detection	0.118	0.369	0.102	0.436	0.104	0.426	0.167	0.201
20 minus 3	0.243	0.064	0.197	0.131	0.023	0.862	-0.049	0.705
Coding: Verbal memory	0.097	0.461	0.073	0.629	0.044	0.734	-0.055	0.753
Copy of a figure	0.192	0.142	0.185	0.156	0.272	0.0350	0.212	0.103
Language: Naming	0.286	0.026	0.313	0.150	0.326	0.011	0.317	0.013
Repetition	0.284	0.280	0.281	0.030	0.247	0.056	0.206	0.043
Comprehension	0.205	0.116	0.271	0.036	0.181	0.093	0262	0.043
Verbal fluency: Semantic	0.035	0.780	0.103	0.430	0.175	0.182	0.211	0.105
Phonol	0.136	0.299	0.283	0.023	0.136	0.299	0.171	0.191
Conceptual functions: Similarities	-0.096	0.464	-0.055	0.674	0.048	0.715	-0.052	0.689
Calculation abilities	0.237	0.062	0.222	0.082	0.102	0.437	0.075	0.566
Sequences	-0.274	0.022	-0.301	0.020	0.117	0.374	0.126	0.337
Motor functions: Right-hand pos	0.182	0.163	-0.154	0.239	-0.185	0.156	-0.221	0.091
Left-hand pos	-0.043	0.741	0.023	0.861	0.003	0.981	-0.026	0.844
Alternating mov	-0.067	0.611	-0.225	0.083	-0.036	0.784	0.111	-0.844
Opposite react	0.048	0.712	0.071	0.588	0.083	0.528	0.104	0.427
Recall: Words	-0.089	0.494	0.017	0.183	-0.128	0.328	-0.120	0.359
Cueing	-0.111	0.401	-0.262	0.043	0.064	0.626	0.035	0.790
Recognition	-0.314	0.011	-0.343	0.007	-0.266	0.390	-0.288	0.251
Semi-complex figure	0.106	0.142	0.185	0.156	0.272	0.035	0.212	0.103

Table 6. Spearman's correlations between final scores in the NEUROPSI and reading ability scores. Total sample (N=60)

Subtests	Reading understanding				Words/minute			
	Oral		Silent		Oral		Silent	
	r	p	r	p	r	p	r	p
Orientation: Time	0.302	0.019	0.207	0.112	0.286	0.021	0.314	0.001
Place	-0.097	0.461	-0.103	0.433	-0.102	0.436	-0.222	0.085
Person	-0.125	0.260	-0.132	0.277	-0.157	0.632	-0.217	0.096
Attention: Digits backward	0.522	0.000	0.437	0.000	0.728	0.000	0.712	0.000
Visual detection	0.603	0.000	0.533	0.000	0.862	0.000	0.806	0.000
20 minus 3	0.356	0.005	0.374	0.003	0.197	0.131	0.184	0.159
Coding: Verbal memory	0.639	0.000	0.534	0.000	0.728	0.000	0.629	0.000
Copy of a figure	0.601	0.000	0.507	0.000	0.853	0.000	0.803	0.000
Language: Naming	0.231	0.075	0.238	0.066	0.301	0.020	0.176	0.178
Repetition	0.252	0.062	0.284	0.093	0.210	0.103	0.114	0.280
Comprehension	0.269	0.370	0.197	0.131	0.464	0.000	0.521	0.000
Verbal fluency: Semantic	0.571	0.000	0.501	0.000	0.801	0.000	0.762	0.000
Phonol	0.574	0.000	0.542	0.000	0.811	0.000	0.783	0.000
Conceptual functions: Similarities	0.491	0.000	0.463	0.000	0.688	0.000	0.649	0.000
Calculation abilities	0.058	0.655	0.225	0.083	0.181	0.165	0.132	0.314
Sequences	0.003	0.982	0.037	0.744	0.121	0.358	0.031	0.813
Motor functions: Right-hand pos	0.492	0.000	0.428	0.000	0.711	0.000	0.682	0.000
Left-hand position	0.007	0.957	0.052	0.690	0.028	0.829	0.021	0.876
Alternating movements	0.343	0.000	0.257	0.041	0.405	0.001	0.421	0.001
Opposite reactions	0.396	0.002	0.266	0.041	0.598	0.000	0.522	0.000
Recall: Words	0.156	0.233	0.108	0.407	0.264	0.034	0.316	0.001
Cueing	0.622	0.000	0.551	0.000	0.861	0.000	0.802	0.000
Recognition	0.605	0.000	0.533	0.000	0.865	0.000	0.813	0.000
Semi-complex figure	0.616	0.000	0.513	0.000	0.853	0.000	0.797	0.000

APPENDIX 1

General structure of the NEEBA method

Lesson Objective	**Strategies**	**Target**
1-10 To recognize some characteristics of written language and basic reading To identify own name To identify with different words To identify important news.	To explore different materials To recognize own name in different materials. Guided reading: popular tales. Recognition of upper and lower case words. Identifying and writing words and short sentences. Reading the words in a calendar. Reading instructions..	To get a basic reading
11-25 To increase the words that can be recognized. Improve reading. To find information of social interest To interpret information in written materials.	Reading and writing public services. To compare oral and written words and writing. Recognizing and writing short texts. To find new words. Description of common logotypes. Identifying masculine and feminine words. To find information in a national map. Identification of songs. Redaction of letters and messages.	To improve reading and writing
26-35 To improve reading To practice reading comprehension.	Reading and writing brief texts. Recognition of interrogative sentences. Preparing different types of letters. To create a history from a picture. Autobiography. Synonymous. Writing brief texts.	To improve reading and writing
36-46 To improve reading ability and understanding	Reading about everyday situations. Reading Newspapers.	Understanding.

APPENDIX 2

General structure of the NEUROALFA method

Lesson Objective	**Strategies**	**Target**
PART I		
1. To demonstrate how important it is to read in everyday life	To present, analyze, discuss subjects' ID, names of the streets, medical prescriptions, songs, labels in institutions	To demonstrate the importance of reading in personal life
2. To recognize the letters of someone's own name	Phonological discrimination of the letter sounds included in name. To combine these letters	To be able to read words
3. To read and write letters corresponding to other family members	To form new words. To group words according to the phonological similarity	To write and to read some words
4. To read and to write the whole name of family members	Visual discrimination of letters. Visual recognition of words. Decomposition of words into letters to form new words using the letters of the family members	To be able to read sentences and to recall them.
5. To recognize and use the letters of the Family members orientation	Visual discrimination of words. Reading and copying words: Semantic associations of words. To group words having three common phonemes. Upper-case and lower-case letters and their use.	To read and to create a text about the family. To use spatial of letters. Using the distribution of words..
6. To read about home activities	Names of home elements and activities. Cross-words: analysis of phonemes. To write about home activities.	To read and create a text about the home activities.
7. Identification of the whole alphabet	Identification of new letters. Reading traffic signals. Proverbs. Analyzing the meaning of proverbs.	To read and to write the whole alphabet

PART II

1, 2, and 3 Applications of reading and writing	Messages, letters, IDS, receipts, immunization booklet. Reading and writing text regarding health, reading and commenting on the Newspaper, etc.	To actively pursue reading and writing. To recall written tests