SUMMARY

Reading and mathematical abilities are two basic abilities which play an important role in school achievement. Research indicates that these two abilities are multicomponential in nature. At the cognitive level reading ability has been found to comprise of a basic structural and a higher order semantic components. Further subcomponents of these components have been identified among which phonological ability and word recognition have been found to play an important role in reading. Although research regarding mathematical ability is rather sparse, a simile can be drawn between its cognitive processes and those of reading ability.

It can be purported that here the basic processes might comprise of numerals, operands and computational processes, while at the higher semantic level mathematical vocabulary and problem solving strategy might play the same role as the structural and semantic components of reading ability.

The relationship between the two abilities receive further support from the fact that reading and mathematical deficits have been found to co-exist and procedural similarities in the deficits have also been observed. Neuropsychological studies have implicated the role of specific neural functions and brain areas which influence these abilities.

At the neuropsychological level verbal attention, short term deficits, remote verbal memory, language integration, nonverbal concept formation and upper body motor function have been found to
be associated to reading and spelling problems. Mathematical deficits have been found to be associated with a general attention deficit, visuospatial deficit, long term memory retrieval deficits, and procedural deficits (Gray, 1991; Levine, 1987). Overall neuropsychological scores have been found to predict reading and arithmetical performance and corresponding neuropsychological changes have been found to parallel improvements in reading and verbal strategies (Delazer et al., 1999). The role of specific brain areas has also been implicated as spelling and writing abilities have been found to be supported by left hemisphere mechanisms (Larsen, Baynes & Swick, 2004). Left hemispheric lesions have been reported to result in problems in reading and writing of numbers, with intact skills in other areas of arithmetical processing (Hecaen, 1962; McCloskey, Caramazza & Basili, 1985). Difficulties in the spatial representation of numerical information is often associated with damage to the posterior regions of the right hemisphere (Benson & Weir, 1972; Cohn, 1961).

Thus, identification of the cognitive and / or neuropsychological correlates of reading and mathematical ability could help in detection of the nature of deficits in these areas thereby making it possible to provide possible remedial measures.

Keeping in view the importance of early detection of these deficits, the present study was planned and the following problem was formulated.

PROBLEM

A study of structural, semantic and neuropsychological basis of reading and mathematical ability.
OBJECTIVES

The objectives of the study are given as follows:

1. To study the relationship of reading / mathematical ability to academic achievement.

2. To study the structure of reading and mathematical ability.

HYPOTHESES

To achieve the above objectives, the following hypotheses were formulated.

1. Ability (Reading / Mathematical) of high achievers would be significantly higher than that of low achievers

2. Ability (Reading/Mathematical) would be positively related to academic achievement (Hindi and Mathematics respectively).

3. Phonological ability and word recognition would be significant predictors of academic achievements.

4. Reading ability would be positively related to mathematical achievement and ability

5. Neuropsychological basis of reading and mathematical ability would be similar.

DESIGN

An Ex-post facto study was designed to achieve the above objectives. The study was conducted in three phases.

In the Phase I intelligence of the students was measured. Their academic achievement scores in Hindi and Mathematics were
obtained from the school record. Students were further divided into two group i.e. high and low achievers. In Phase II reading and mathematical abilities of high and low achievers ability was measured. In Phase III neuropsychological measures of subjects with low ability (Reading / mathematical) was obtained.

SAMPLE:

The initial sample pool for the present study was selected by multistage purposive sampling. The student pool consisted to 600, 6th, 7th and 8th class students (age 10-15.6 years) who were selected from various schools in two cities of Haryana (Rohtak and Rewari). From these 532 students of average intelligence were selected by administration of a nonverbal Intelligence Test. Further a sample of 318 students who were high / low in terms of academic achievement in Hindi and Mathematics were selected.

MATERIAL

The following tests were used for the present study.

1. Intelligence Test (Raven's Standard Progressive Matrices): This test provides a measure of nonverbal intelligence.

2. Neuropsychological Battery (AllMS Comprehensive Neuropsychological Battery): This battery give measures on neuropsychological functions as well as lobe scale separately.

3. Ability Tests: Reading and Mathematical (Constructed by Investigator): Reading ability test comprised of 10 subtests which provided separate measures of the structural and
semantic components. Mathematical ability test comprised of 2 subtests i.e. computational and conceptual components.

**METHODOLOGY**

The present study was conducted in three phases. In Phase I, 600 students were taken from 6th, 7th and 8th class. Their intelligence levels were measured with the help of Ravan's Standard Progressive Matrice. Academic achievement score in Hindi and Mathematics were obtained from school record. Then, these students were divided into two groups i.e. high and low achievers. In Phase II reading and mathematical ability of the students were measured with the help of self constructed reading and mathematical ability test. The high and low achievers (in both) were given both the tests in two separate group sessions. Students who were high / low in one ability and average on the other ability were given only one test. In Phase III neuropsychological measures was obtained by administration of AIIMS neuropsychological battery.

**STATISTICAL ANALYSIS**

For analysis of the data, initially, mean and standard deviation (S.D.) scores on academic achievement, total reading and mathematical abilities, and their components for the high achievement (HA) and low achievement (LA) groups were computed. The differences between the means of the groups were compared by applying t-test, in order to determine whether differences in ability or any of its specific components existed among high and low achievers. Further, in order to study the relationship among the various components and identify the predictors of academic achievement
correlational analysis (multiple correlation and regression) was employed. As the number of items for each component/subcomponent was different, the raw scores were converted into T scores in order to obtain a cognitive profile of low and high academic achievers. However, the initial analysis was done with raw scores as the subjects had been restricted to the upper and lower continuum of achievement and statistical analysis on the basis of T scores could be misleading. Thus T scores were used only for comparison of the relative contribution of the components/subcomponents.

For the neuropsychological components the mean T scores for total neuropsychological scores, along with function and lobe scores were computed. Neuropsychological profile of the subjects with low reading/or mathematical ability were prepared and correlations of neuropsychological scores with achievement/ability were computed.

RESULTS AND DISCUSSION

Considered together the results of the cognitive and neuropsychological sections indicate that high and low achievers differ significantly on the cognitive components as well as total ability (reading and mathematics). A positive relationship was obtained between ability and achievement and the relationship was observed even for the components/subcomponents of the ability. Comparisons across the high and low achievers presented a differential picture.

From the five subcomponents of reading ability, four i.e., word recognition, syntactic, phonological and orthographic were found to be significant predictors of academic achievement. These results implicate the role of structural components of reading ability.
Reading ability was found to be related to mathematical achievement, where two of the structural components i.e. syntactic and phonological emerged as its significant predictors. However, the relationship between the two abilities though significantly was rather low. The cognitive profile developed on the basis of these results shows that at least in case of reading ability, the structural components differentiate between high and low achievers.

The neuropsychological analysis indicated that below average reading and/or mathematical ability is associated with neuropsychological dysfunction. The neuropsychological functions and lobe profile for subjects with low reading / mathematical ability were found to be nearly similar. The results implicate a relationship of tactile, expressive speech, writing and arithmetic functions in reading, where the effect appears to be via the structural component. Asymmetry in hemispheric functioning was observed to be associated with poor ability.

Thus, from the five hypotheses proposed for the study three i.e. first to third were supported by the results of the present investigation. The fourth hypothesis was partially supported i.e. in case of achievement, while the fifth was not verified. However, here again, the neuropsychological profile provided support to this hypothesis.