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**DYSLEXIC STUDENTS IN CHEMISTRY CLASSES:
THEIR DIFFICULTIES WITH CHEMICAL FORMULAE**

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ABSTRACT: The aim of this preliminary study was to investigate whether dyslexic students encounter difficulties with the use of chemical formulae, in particular structural formulae. Two groups of final-year, upper secondary students (grade 12) were studied: a control group, consisting of 32 normal learners (17 boys and 15 girls), and an experimental group of 5 dyslexic students (3 boys and 2 girls). All students had to solve numerical exercises on colligative properties. In each exercise, a student had to replace in the corresponding colligative-property equation the value of the molecular weight of the solute. Molecular weight had to be determined either from the molecular formula or from the structural formula of the compound. The findings of the study showed that dyslexic pupils had lower scores in the reading of both molecular and structural formulae. The wrong estimation of molecular weights resulted from: (a) omission of atoms; (b) omission of subscripts; (c) misreading them. The findings indicate that, if there are dyslexic students in a class, we must be very cautious with the use of chemical formulae. [*Chem. Educ. Res. Pract. Eur.*: 2000, 1, 277-280]

KEY WORDS: dyslexic students; chemical formulae; structural formulae; molecular weight

INTRODUCTION

The issue of defining dyslexia is still open. Therefore, two of the most representative (according to our opinion) definitions have been chosen here. The first is given by the *British Association of Dyslexia* (Jacobson, 1997):

«Dyslexia is a complicated neurological situation that has constitutional origin. The symptoms may affect many sectors of learning and activities and may be described as a special difficulty in reading, spelling and written language. One or more of these sectors may be affected. The handling of numbers and musical signs may be messed up. However, it is particularly related to the control of written speech, even though oral speech is to some extent affected.»

The second definition comes from the *American Association of Dyslexia Orton Society* (Pumfrey, 1997; Thomson, 1997):

«Dyslexia is a neurological, often family disorder that is expressed through difficulty in engagement of language and lingual expression, including phonological elaboration, difficulty in reading, writing, spelling and sometimes arithmetic. Dyslexia is not attributed to lack of motivation, sensory malfunction, improper teaching, or inappropriate

environmental conditions, it does however co-exist with such situations, even though dyslexia is a problem that people face for their entire life. Some dyslexic people often respond successfully to timely and proper intervention.»

Margaret Rawson, at the age of 95, after dealing for more than 55 years with the problem of dyslexia, wrote about the issue of defining it (Anastasiou, 1998):

«... there are concepts, such as language itself, for which it could be said that anyone knows what they are, but no one is able to give a global definition of them. Experience has convinced me that dyslexia is such a problem.»

It is estimated that about 10% of the school population faces problems in reading, writing and spelling, while a part of these children are dyslexic (Critchley, 1981).

From a series of epidemiological studies performed by Rutter *et al.* in Britain, it has been found that between 4-10% of students in primary education face serious difficulties which are not due to low intelligence (Yale, 1988). However there is no agreement about the exact percentage of dyslexic students and this is mainly due to:

- the problem of defining dyslexia, and therefore its diagnosis;
- technical problems such as the kind of reading tests or IQ tests performed;
- the problem of defining the threshold of low reading capability; and
- the researchers' personal perceptions and prejudice about the dyslexia phenomenon (Anastasiou, 1998).

The Greek Ministry of Education estimates the incidence of dyslexia at 5% (Ministry of National Education and Religion of Greece (1992).

The dyslexic pupils have difficulties in:

1. Reading and writing: They read ignoring punctuation; their writing is messy, difficult to read and contains spelling mistakes; they confuse words with others similar in meaning; they omit or add letters to words; they present reflected reading and writing.
2. Memory and arrangement of sequences: They have memory problems; they have difficulty in following arranged sequences (e.g. enumeration of even numbers, months of the year in chronological order, etc.).
3. Time-space orientation: They have time-and-space orientation difficulties; they confuse left and right, north and south, and so they face difficulties in reading maps and telling the time.
4. Organizing their daily lives: The lack of organization which characterizes everyday life of childhood accompanies the dyslexic child into puberty as well; he/she is messy, mixes up his/her homework, his/her books and note pads, losing his/her patience and calm.

However, the dyslexic student should not be confused with a special-needs child that might have dyslexic elements. The dyslexic student:

- i) has normal to high intelligence;
- ii) displays the general behavior of a pupil more able than his/her school performances suggest;
- iii) is the «misunderstood» pupil, that is often characterized as lazy and disobedient, but when given the right opportunities amazes us. He/she is hypersensitive as far as criticism is concerned, has low self-confidence, and is easily discouraged.

The question is raised here whether dyslexic students, besides the expected difficulties that normal students have, encounter additional difficulties in reading and writing in a scientific language and, in particular, with symbolic mathematical physico-chemical terms and expressions (Miles & Miles, 1994). Can any such problems be attributable to dyslexia? Porpodas (1991) reports that:

«...the problem of the dyslexic child is reduced mostly to reading and writing the language, while learning other symbolic systems, mathematical symbols or mathematical and physical concepts or musical elements may or may not be affected.»

The following question comprises the field of the present research: Do dyslexic pupils encounter particular problems when faced with language and chemical symbols?

PROCEDURE

Two groups of pupils were studied. Their ages ranged from 16 to 18. The control group consisted of 32 ordinary pupils (17 boys and 15 girls), whilst the experimental group comprised 5 dyslexic students (3 boys and 2 girls). The pupils of the experimental group had been characterized as dyslexic by the medicopedagogical centers of the Greek Ministry of Education.

All pupils were asked to solve chemistry problems, from the unit on «colligative properties». The knowledge and application of only one colligative-property formula was requested in each exercise (there are similar exercises also in the textbook of the Ministry of Education), and the pupils had already been taught these formulae and similar exercises. The total number of exercises was 12, organised in four tests. Tests 1 and 4 used molecular formulae, whereas Tests 2 and 3 used structural formulae. In all exercises, the pupils were given the corresponding colligative-property formula, and had to calculate the molecular weight value of a substance from its molecular formula (6 exercises) or from its structural formula (6 identical exercises); the exercises were given alternately and at appropriate time intervals of about 15 days, as it is appropriate for the test-retest method (Papanastasiou, 1993).

The tests were marked on the basis of the following:

- a) Errors in operation: they refer to arithmetical and algebraic errors in general; one point was subtracted for each error.
- b) Errors in meaning: they refer to errors made in respect to the problem's meaning and concepts pertaining to the relevant physics and chemistry; one point was subtracted for each error.
- c) Errors in the reading and writing of the chemical formulae; again one point was subtracted for each error.
- d) Errors demonstrating complete confusion and inability of the student to solve the problem; no points were allocated.

RESULTS

It was found that dyslexic pupils had lower scores in reading both the molecular and the structural formulae. The difficulties in reading the chemical formulae led to wrong estimation of molecular weights. The summary of the findings is as follows:

1. In arithmetical and algebraic operations, the dyslexic pupils committed 21.7% of errors, compared with 15% by non-dyslexic pupils.
2. On meanings, the dyslexic pupils committed 5% of errors, compared with 11.3% by non-dyslexic pupils.
3. In the reading and writing of chemical formulae, the dyslexic pupils committed 16% of errors, compared with 3.3% by the non-dyslexic pupils.
4. In complete-confusion errors, there were 7.1% and 3.3% of errors for dyslexic and non-dyslexic pupils respectively.

CONCLUSION AND IMPLICATIONS FOR INSTRUCTION

Undoubtedly, this subject needs greater, more extensive and more in-depth investigation. However, it is important, as a start, to recognize the existence of the problem. In any case, even for preventive reasons, the findings of this research indicate that we must be very cautious in the use of chemical formulae (which we consider indispensable and operational in chemistry) when there are dyslexic pupils in our audience.

During teaching, we must be aware of the difficulties encountered by dyslexic students in the reading and writing of chemical formulae. This may mean that we should avoid their use when they are not a *sine qua non*. In tests and examinations that are intended for dyslexic pupils, chemical formulae must be clearly written and should be used only when they are absolutely necessary (Pollock & Waller, 1996).

The teacher's adherence to the above, along with his/her patience and persistence will make the attendance of chemistry lessons easier for dyslexic students, lessening the already existing difficulties.

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REFERENCES

- Anastasiou, D. (1998). *Dyslexia* (in Greek). Athens: Atrapos.
- Critchley, M. (1981) *Dyslexia: An overview*. In G. Pavlidis & T.R. Miles (eds.), *Dyslexia research and its application to education*. Chichester: Willey and Sons.
- Jacobson, J. (1997). *The Dyslexia handbook 1997*. Reading: BDA.
- Miles, T. & Miles, E. (1994). *Dyslexia and mathematics*. London: Routledge.
- Ministry of National Education and Religion of Greece (1992). Circular G6/106/3-4-1992. *Pupils with dyslexia* (in Greek). Athens.
- Papanastasiou, K. (1993). *Measurement and evaluation in education* (in Greek). Nicosia: Pedagogical Institute of Cyprus.
- Pollock, J. & Waller, E. (1996). *Day to day dyslexia in the classroom*. London: Routledge.
- Porpodas, K. (1993) *Dyslexia* (in Greek). Athens: Morphotiki.
- Pumfrey, P. D. (1997). Special developmental dyslexia: Origin, identification, treatment (in Greek). In E. Tafa (ed.), *Co-education of children with and without problems of learning and behavior*. Athens: Hellenika Grammata.
- Thomson, P. (1997). *Dyslexia - Whose problem?* In P. Thomson & P. Gilchrist (eds.), *Dyslexia: A multidisciplinary approach*. London: Chapman and Hall.
- Yale, W. (1988) *Dyslexia: Not one condition but many*. *British Medical Journal*, 297, 501-502.