Developmental Eye Movement (DEM) test: validity reassessment in Italian population

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Introduction

The Developmental Eye Movement (DEM) test is an inexpensive, practical and easy method that is used to asses and quantify ocular motor skills in children In the updated manual (Richman, 2009) and in a original article (Garzia et al, 1990) the qualities of the test (validity, reliability and normative results) are reported. The validity of the test is concerned with what the test measures and how well it does so (Urbina, 2004). As reported in the DEM manual, data used to test the validity and results are listed, but there is no clear explanation of the results. The purpose of this study is to reevaluate these and other parameters of validity in subjects from the Italian population, by using a language-specific test of reading to confirm and expand the validity of DEM after acquiring specific normative values.

Experiment

The validity of a test can be subdivided into three main categories: content, criterion and construct. Despite this division, the more recent studies place all the aspects of validity into a construct validity, thus bypassing the older separation of validity into criterion and content (Urbina, 2004). Construct validity is defined as a totality of evidence that represent a check of the construct (Anastasi, Urbina, 1997).

In consideration of this new concept, the DEM test was reanalyzed by means of construct validity and new statistical methodology. These new and original methods of analyses are being employed 20 years after the original American values were obtained. Since different language, educational programs and the concept of educational agreement can modify the DEM values, all these factors will be considered to reassess validity in Italian population.

Subjects

Three different samples of children have been used that were obtained in several interdisciplinary school screening programs conducted by optometrists and psychologists.

Sample	Description	Test Collected
1	46 children from 6 to 10 year: 6y (4); 7y (10); 8y (12); 9y (11); 10y (9)	DEM SDO (Jimenez et al., 2003) Kitap (Zimmermann, 2003)
2	40 children from 7 to 11 year: 7y (1); 8y (9); 9y (10); 10y (10); 11y (10)	DEM NSUCO (Maples, 1995) Subtest 4 and 5 of DDE-2 Battery (Sartori, Job, Tressoldi, 1995)
3	42 children from 7 to 13 year: 7y (5); 8y (10); 9y (3); 10y (6); 11y(4); 12y (7); 13y(7) 24 Learning Disabled children from 7 to 13 year: 7y (1); 8y (5); 9y (7); 10y (4); 11y (2); 12y (3); 13y (2)	DEM Subtest 4 and 5 of DDE-2 Battery

For each group, the analysis pertinent to test and collected data was performed taking into account, if not specified, the adjusted value of the horizontal (AHT) and the vertical (VT) time. Data from the Learning Disabled (LD) group was taken into account only for the evaluation of the pathological group, comparing LD and the remainder of sample 3 as control. Diagnosis of dyslexia was made by a multidisciplinary team at a specific centre.

Methods

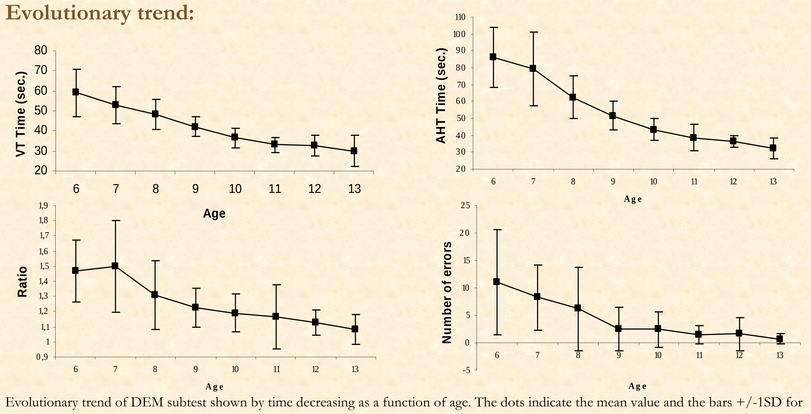
A full psychometrical evaluation of validity was applied to the DEM and other psycho-educational tests using a construct validity scheme (Urbina et al., 2004).

Results:

Age	n.	VT	AHT	Ratio	Err.
6	4	59,02 (11,80)	86,17 (17,90)	1,47 (0,21)	11 (9,52)
7	16	52,80 (9,31)	79,39 (22,07)	1,50 (0,31)	8,25 (5,89)
8	31	48,09 (7,48)	62,59 (12,70)	1,31 (0,23)	6,16 (7,66)
9	24	42,11 (4,91)	51,70 (8,59)	1,23 0,13)	2,54 (3,90)
10	25	36,58 (4,90)	43,43 (6,52)	1,19 (0,12)	2,40 (3,24)
11	14	33,17 (3,69)	38,67 (7,88)	1,17 (0,21)	1,5 (1,60)
12	7	32,70 (5,37)	36,55 (3,37)	1,13 (0,09)	1,57 (2,93)
13	7	30,10 (7,69)	32,09 (6,12)	1,08 (0,10)	0,71 (0,95)

Mean results (seconds) of all samples (SD in parenthesis)

Evolutionary trend:



Evolutionary trend of DEM subtest shown by time decreasing as a function of age. The dots indicate the mean value and the bars +/-1SD for all samples taken together

The various components of the DEM test generally reflect an improvement of skills as a function of age (All $p<0.0001$). Although Ratio shows a slight increase at age 7 years, subsequent years demonstrate a similar evolutionary trend as the other components.

Internal correlation:

It is better to refer to the internal correlation of the test, instead of the internal coherence by correctly using the Pearson r correlation. For all groups, the correlation for each of the component variables of the DEM is highest beween VT and AHT ($r=0.85$, $p<0.01$) and between Ratio and AHT ($r=0.76$, $p<0.01$), but lowest between Ratio and VT ($r=0.33$, $p<0.01$).

	VT	AHT	RATIO
AHT	0,85**		
RATIO	0,33**	0,76**	
ERR	0,50**	0,58**	0,45**

But removing covariation due to age, using partial correlation, the relationship between variables appears clearer and more correctly subdivided than that reported in the test manual

	VT	AHT	RATIO
AHT	0,66**		
RATIO	-0,06	0,69**	
ERR	0,30*	0,43**	0,31**

Relationship with reading test:

The comparison between subtests 4 and 5 of the DDE-2 Battery and DEM show:

The correlation between AHT and time 4 (0,65 $p<0,01$) is bigger than AHT and time 5 (0,43 $p<0,01$) and can be explained by automatism for high speed reading of word.

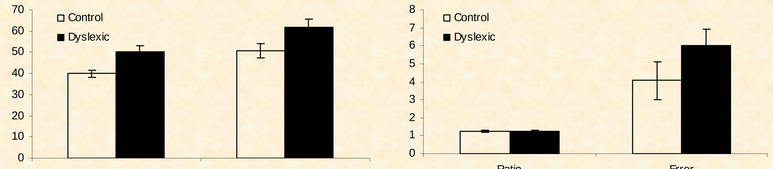
The higher correlation between AHT - time 4 (0,65 $p<0,01$) is bigger than VT – time 4 (0,40 $p<0,01$) and it's related to similar ocular movement required in performing these two tasks.

The relationship to ratio, the value for ocular movement present the highest relationship with a list of words (0,39 $p<0,01$) compared to non words (0,10 $p<0,05$).

	VT	AHT	Ratio	Err
Subtest 4 (words) time	0,40**	0,65**	0,39**	0,16
Subtest 4 error	0,18	0,37**	0,26*	0,21
Subtest 5 (non words)	0,47**	0,43**	0,10	0,10
Subtest 5 error	0,30*	0,27*	0,03	0,28*

Partial correlation (age removed) between reading skill and DEM variables for sample two and three taken together (* $p<0.05$; ** $p<0,01$).

Relationship with pathological group (Dislexic children):



Comparing the dyslexic group to sample number three (control), the age was statistically the same ($t_{(64)}=0,59$ p=n.s.); but there are differences observed in speed and accuracy of reading as measured by DDE-2 battery test between the two groups (dyslexic vs. control).

However, in evaluating the DEM test there are significant differences for VT ($t_{(64)}=3,40$ $p<0,005$) and AHT ($t_{(64)}=2,10$ $p<0,05$), but there are no significant differences for Ratio and Error.

Convergence and divergence validity:

✓In sample 1, there was a significant correlation between AHT and the visual exploration subtest of KITAP battery of attention (Zimmermann, 2003) **r=0.279 p<0.01**

✓In sample 1, there was no significant correlation between DEM subtest and Saccade Direct Observation (Jimenez et al., 2003) AHT – SDO **r=-0.16 p=n.s.**

✓In sample 2, there was no significant correlation between DEM subtest and NSUCO test (Maples 1995) AHT - accuracy of saccades **r=0,10 p=n.s.**

Factorial analysis:

For analysis was used the Varimax rotation of the factorial axis to maximize the factor loads.

	Factor 1	Factor 2	Factor 3
VT	**0,963586**	0,118295	0,235855
AHT	**0,749040**	0,603825	0,265131
Ratio	0,171499	**0,963488**	0,202685
Errors	0,262199	0,222216	**0,939080**
Expl.Var	1,587719	1,356288	1,048875
Prp.Totl	0,396930	0,339072	0,262219

This model has a good validity (Explained variance 99,8%) The results show correctly saturation to three independent main factors. As viewed in internal correlation, the high correlation between first factor, VT and AHT, was explained by a common part of naming process in VT and AHT.

Conclusion

The more extensive scheme of construct validity and new methods of psychometric and statistical analyses has permitted reconfirmation and expansion of the original results of the DEM test. This study reconfirms the validity of the DEM test to assess ocular motility in the developmental age also in the Italian population and permits differentiation of ocular motility and naming problems.

The final confirmation of validity and the only kind of validity which has not been tested in this research is the relationship between DEM test and an objective measurement of ocular movements. To the extent that validity has been reconfirmed by this study, this has created a foundation for a future standardization of the DEM test in the Italian population.

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