

## Psychometric properties of the d2 selective attention test in a sample of premature and born-at-term babies

Marcelino Cuesta Izquierdo, María Jesús de Iscar Pérez\*, María Azucena Begega Losa, Magdalena Méndez López, Luis Álvarez Pérez, Gonzalo Solís\*\*, Belén Fernández Colomer\*\*\* y Jorge Luis Arias Pérez  
Universidad de Oviedo. \* Unidad de Atención Temprana, \*\* Servicio de Neonatología del Hospital de Cabueñes  
y \*\*\* Servicio de Neonatología del Hospital Universitario Central de Asturias

The psychometric properties of the d2 Selective Attention Test are analyzed in two samples of premature ( $n=63$ ) and born-at-term ( $n=78$ ) children. The reliability coefficients (internal consistency) reached values of around .90. Principal components analysis revealed a three-factor structure, which accounts for 58% of the variance, and thus coincides with the number of factors presented in the manual of the Spanish adaptation of the test but not with their composition. Results suggest that the d2 test has adequate psychometric properties both for the global sample and for each sub-sample.

*Características psicométricas del test de atención selectiva d2 en niños prematuros y nacidos a término.* Se analizan las propiedades ricas del test de atención selectiva «d2» en dos grupos de niños: prematuros ( $n=63$ ) y nacidos a término ( $n=78$ ). Los coeficientes de fiabilidad, calculados por métodos de consistencia interna, se han situado en valores en torno a 0,90. El análisis de componentes principales ha mostrado una estructura de tres factores explicando el 58% de la varianza, coincidiendo con el número de factores presentados en el manual de la adaptación española de la prueba pero no en cuanto a la composición de los mismos. Se concluye que la prueba d2 tiene un comportamiento psicométricamente adecuado tanto para el grupo global como para cada una de las submuestras empleadas.

Attention is a complex process which has obliged to the differentiation of the subtypes where the different neurobiological mechanisms underlie. Consciousness is selectively focussed when we pay attention, filtering and rejecting non-wished information. Therefore, this process constitutes a constant information flow which we perceive, select and can even maintain».(Leclercq, 2002). Attention is related to such different processes as short and long term memory and the so called executive functions (Ethepeborda & Abad-Mas, 2001).

This functional and anatomical complexity of attention is also shown in the clinical scope. It is altered in numerous illnesses such as dementias, craniocerebral traumatism, epilepsy and even evolutionary disorders such as autism and attention deficit with or without hyperactivity (Miranda, García & Soriano, 2005). This is the reason why attention assessment starts to be needed in order to have good intervention. Among the possible neuropsychological tests for attention in children, the d2 test offers the possibility to measure selective attention. Such attention is understood as the capacity to concentrate on one or more important stimuli while deliberately suppressing from the consciousness other irrelevant or

distracting ones. Furthermore, the application age range for this test is wide, covering from schoolchildren to adults and it also allows to determine how attention can be intimately related to development and brain maturity (Sastre-Riba, 2006).

Prematurity is one of the main risk factors of neurological alteration together with intra-uterine or perinatal infections, haemorrhage and convulsive crisis (Marlow, Wolke, Bracewell & Smara, 2005; Martínez-Bermejo, 2003). On the other hand, the percentage of premature children continues to grow above the figures recommended by the WHO. Therefore, it is interesting to know if this factor has influenced the children and their later cognitive development, affecting such basic capacities as their intellectual development, attention and mnesic processes among other higher functions (Narbona & Crespo-Equilaz, 2005; Ruiz-Contreras & Cansino, 2005). This is particularly relevant in order to set future intervention programmes and strategies within the clinical scope (Alvarez et al., en prensa; Bush, Valera & Seidman, 2005; Rios-Lago, Muñoz-Céspedes & Paúl-Lapediza, 2007).

This study analyses the d2 test in our groups to find out its properties. The d2 test is a validated test to evaluate and determine attention processes in a class of premature infant population on the rise, also showing vulnerability to possible alterations in basic processes such as attention. It is necessary to know the psychometric properties of a test in different contexts and with different subject groups before assessing its usefulness in the different scopes applied.

Method

Participants

The sample used comprised 141 children living in the Principality of Asturias born between November 1994 and November 1997, 78 of whom were born at term, accounting for 55.3% of the sample and 63 of whom were prematurely born (44.7%). The average age of the born-at-term children was 8 years and 3 months and the premature ones were 8 years and 6 months on average. The samples from the born-at-term children were obtained in several educational institutions in Asturias (Colegio Público La Ería, Colegio San Ignacio and Colegio Auseva School). The samples of premature children were obtained from the neonatology service of two hospitals in the region, Hospital de Cabueñes and Hospital Universitario Central de Asturias.

Procedure

The children were individually evaluated by two psychologists between May 2004 and February 2006, with the previous explicit consent from parents. During the sessions the children were also applied psychometric tests other than the d2 test.

Instrument

The d2 test measures selective attention and mind concentration, understood as «the capacity to selectively focus on certain relevant aspects in a task while ignoring other irrelevant ones as well as doing so quickly and accurately. The Spanish version has been made by Seisdedos (2002).

The test can be applied either individually or collectively, lasting between 8 and 10 minutes. It is made up by 14 lines with 47 characters each for a total 658 items. These contain letters «d» and «p» which might appear with one or two little dashes above or below each letter.

The subject has to check carefully, from left to right, the contents of each line marking every letter «d» showing two little dashes (both above, below or one above and one below). These are the relevant elements, whereas the remaining combinations (the «p»s with or without dashes and the «d»s with one or no dash) are considered as irrelevant elements. The subject is given 20 seconds for each line.

The resulting scores are: TR, overall answer, number of elements tried on the 14 lines; TA, number of correct guesses, this is, number of correct relevant elements; O , omitted elements, number of relevant elements tried but not marked; C, commissions, number of irrelevant elements marked; TOT, total test effectiveness, that is : TR – (O+C); CON concentration index: TA-C; TR+, line with a greater number of tried elements; TR-, line with a lower number of elements tried and VAR, variation index or difference (TR+ - TR-).

Data analysis

The statistical analysis were performed with SPSS (V 14.0) program. The following calculations were used both for each group as for the whole sample of individuals: the descriptors of the different scores on the test, the test reliability and the relation

among the different scales. A main component analysis was also performed using TR, TA, O and C scores for each item. In this case only the whole group was analysed in order to have enough individuals to perform the analysis.

Results

Descriptive results

Table 1 shows the statistic indicators describing the d2 scores for the whole sample and for the two sub-samples.

Reliability

This internal consistence analysis was performed by means of Cronbach’s  $\alpha$  procedure. The four basic scores obtained in the d2 test (TR, TA, O y C) have been used and the analysis has been made for the whole sample and for each of the sub-samples (born-at-term and premature children) (see table 2).

Independently of the sample used all coefficients take high values, even more if it is taken into account that only 14 items are considered. The values reached are similar to those obtained in the test adaptation process in Spain. They are also similar to the values obtained in Germany and the USA as can be seen in the manual for the test in Spanish (Seisdedos, 2002).

*Table 1*  
Means, standard deviations and comparisons between groups

	Group	Mean	Stand. dev.	Sig (p)	N
TR	control	347.95	69.975	0.316	78
	premature	336.49	63.743		63
	Total	342.83	67.269		141
O	control	12.10	19.864	0.752	78
	premature	11.21	11.754		63
	Total	11.70	16.685		141
C	control	4.12	6.277	0.147	78
	premature	6.22	9.944		63
	Total	5.06	8.159		141
TA	control	133.62	30.557	0.489	78
	premature	130.24	26.358		63
	Total	132.11	28.706		141
TOT= TR - (O + C)	control	331.73	68.990	0.267	78
	premature	319.06	64.636		63
	Total	326.07	67.141		141
CON= TA - C	control	129.50	32.875	0.315	78
	premature	124.02	31.117		63
	Total	127.05	32.104		141
VAR= TR+ - TR-	control	14.96	4.979	0.443	78
	premature	15.68	6.159		63
	Total	15.28	5.528		141
E%= (100(O+C))/TR	control	4.6208	5.91649	0.496	78
	premature	5.2699	5.20136		63
	Total	4.9108	5.59810		141

*Relations among scales*

As a first approach to the validity of the test, a correlation test has been performed with the different scores obtained from the test. Again the analysis has been repeated for the whole sample and for each of the sub-samples. (Tables 3 & 4).

Regarding the scores in the simple scales (TR, TA, C, O) the same independent patterns appear despite considering the whole sample or the sub-samples. The working speed measure (TR) correlates in a positively and quite intensive way with the amount of work measure (TA), in a positive and weak way with the omission errors (it seems reasonable considering that certain relevant stimuli might be ignored when working more quickly) and it does not show any relation with the commission errors.

Focussing on the (TOT, CON, VAR, E%) derived scores, a high positive relation is observed between the two balance measures related to working speed and accuracy (TOT y CON). The variability (VAR) does not show any relevant relation to any other variable and the relative error (E%) is intensively and negatively related to concentration (CON). In the same way as the simple

*Table 2*  
Reliability coefficients

Sample	Method	TR	TA	O	C
Total	Cronbach's $\alpha$	0.941 p= .000	0.951 p= .000	0.940 p= .000	0.930 p= .000
Born atterm	Cronbach's $\alpha$	0.947 p= .000	0.960 p= .000	0.954 p= .000	0.888 p= .000
Premature	Cronbach's $\alpha$	0.932 p= .000	0.937 p= .000	0.893 p= .000	0.950 p= .000
Manual	Two halves	0.910	0.930	0.860	0.960

*Table 3*  
Correlations among scales for the whole sample

	TR	O	C	TA	TOT	CON	VAR	E%
TR		.238 p= .005	-.091 p= .283	.796 p= .000	.954 p= .000	.735 p= .000	.200 p= .017	-.021 p= .809
O			.262 p= .002	-.388 p= .000	-.042 p= .619	-.414 p= .000	.351 p= .000	.859 p= .000
C				-.299 p= .000	-.278 p= .001	-.522 p= .000	.105 p= .214	.667 p= .000
TA					.930 p= .000	.970 p= .000	-.033 p= .696	-.568 p= .000
TOT						.902 p= .000	.100 p= .236	-.315 p= .000
CON							-.056 p= .506	-.678 p= .000
VAR								.300 p= .000
E%								

*Table 4*  
Correlations among scales in the sub-samples. Born at term: upper triangle.  
Premature: lower triangle

	TR	O	C	TA	TOT	CON	VAR	E%
TR		.253 p= .025	-.085 p= .459	.754 p= .000	.949 p= .000	.717 p= .000	.192 p= .092	.034 p= .766
O			.234 p= .039	-.434 p= .000	-.052 p= .649	-.448 p= .000	.326 p= .004	.906 p= .000
C				-.281 p= .013	-.245 p= .031	-.452 p= .000	.130 p= .256	.564 p= .000
TA					.915 p= .000	.983 p= .000	-.050 p= .661	-.588 p= .000
TOT						.897 p= .000	.089 p= .437	-.277 p= .014
CON							-.072 p= .532	-.654 p= .000
VAR								.297 p= .008
E%								

scales, these patterns are repeated with slight numerical variations in the whole sample and in the sub-samples.

When compared with the data provided in the manual for subjects of the same age as those in the sample, a different correlation pattern between TR and the two error types (C & O) is observed.

*Factor structure*

Following the guidelines shown in the manual of the Spanish adaptation of the test, the scores for each item in TR, TA, C and O were subjected to a principal components analysis with oblique rotation, finally obtaining 56 scores. In this case only the whole sample was used given the high number of variables included in the analysis.

Based on the sediment graphic (Graphic 1) three components were obtained, which led to a quite clear structure which explains 58% of the variance. Those weights lower than 0.40 have been omitted in the results and the items have been arranged from higher to lower component weight.

The factor solution found in our data agrees in terms of number of factors with the one presented in the Spanish adaptation but not in terms of their components. In the manual, the first component comprises scores in TR and O, the second those in C and the third those in TA. In our sample the first factor comprises TR and TA scores referring to the amount of work developed, the second factor includes omission errors (O) and the third commission errors (C). The relation between the first and second factor is nearly nonexistent and it is slightly negative with the third one. The relation between the two factors referred to as errors is slightly positive.

The differences found when compared with the results shown in the manual are consistent with those already mentioned in the interrelations among scales.

Discussion and conclusions

*Table 5*  
Rotated component solution

	1	Component 2	3
TR6	.812		
TR4	.793		
TR10	.789		
TR8	.788		
TA8	.782		
TR13	.762		
TR3	.761		
TA6	.755		
TR5	.755		
TR12	.755		
TA5	.748		
TA2	.744		
TA11	.744		
TR11	.739		
TA10	.736		
TA13	.716		
TA4	.712		
TA3	.705	-.413	
TR14	.697		
TR2	.691		
TA12	.684		
TR9	.669		
TR7	.665		
TA14	.664		
TA7	.663		
TA9	.642		
TA1	.623		
TR1	.619		
O5		.905	
O4		.853	
O3		.843	
O13		.806	
O12		.749	
O6		.744	
O14		.739	
O7		.716	
O9		.705	
O8		.693	
O1		.671	
O2		.665	
O10		.649	
O11		.641	
C4			.858
C7			.825
C5			.824
C3			.768
C14			.742
C6			.736
C10			.729
C13			.716
C2			.714
C1			.695
C8			.677
C9			.647
C11			.621
C12			.539

The aim of this study was to explore the behaviour of a measuring instrument for selective attention, such as the d2 test. This should be done in terms of its psychometric properties in the inferior limit of its application age range and comparing two-subject types: premature and born-at-term children.

The analysis of the descriptive indicator values in the sample object of this research shows no relevant differences between the control and the premature groups in the different derived scales in the test. If there are differences they have no statistical significance. The general pattern points to a slightly lower performance in the premature group.

When the values obtained in this work are compared with the corresponding scales shown in the manual for the Spanish adaptation for this age group, it is observed that the performance has been fairly good on the whole sample as well as on the sub-samples.

Regarding reliability, the values found are considerably higher. They follow the same pattern in terms of scales as the values shown in the Spanish manual and in the different international researches on this issue.

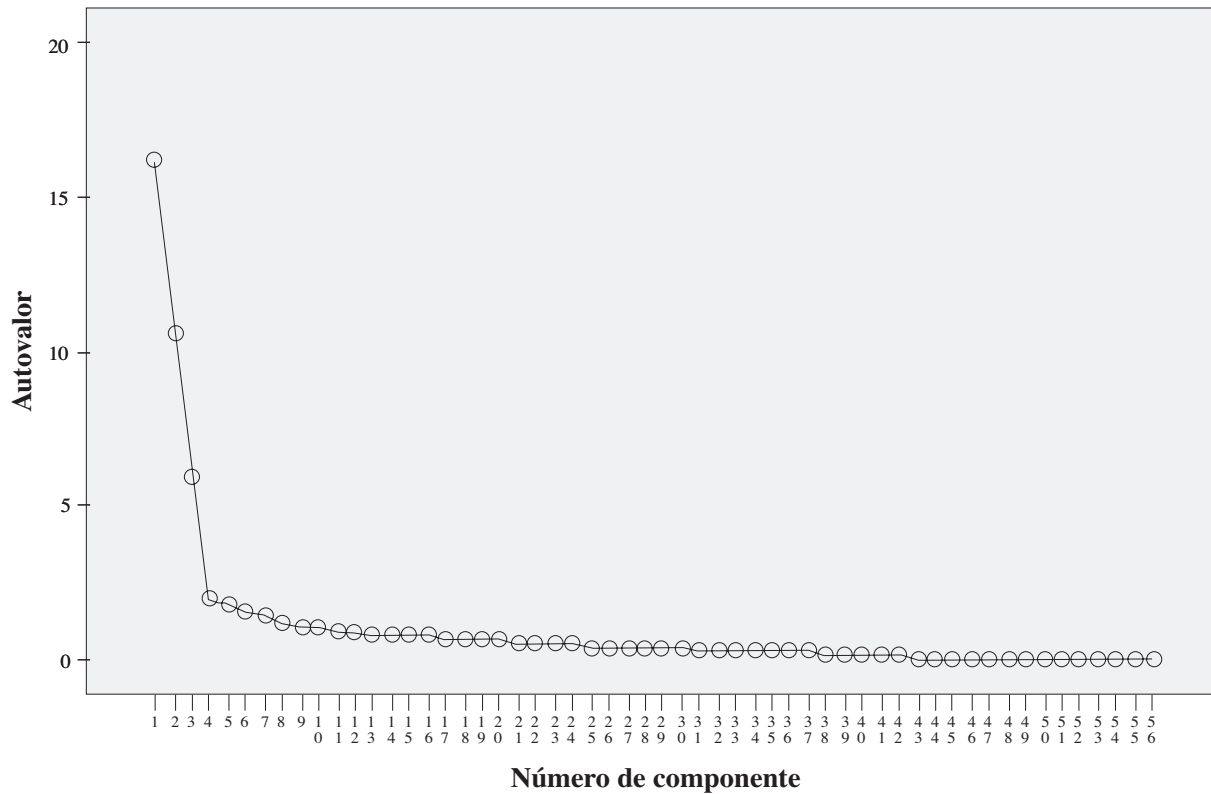
The main discrepancies found with the results in the Spanish adaptation lie in the relations among scales and consequently, in the resulting factor scale. Both studies coincide in finding a factor structure composed of three factors but the variable grouping obtained differs. In the manual, a first factor referred to as productivity comprises TR and O scores, the second factor referred to as error comprises the commission errors (C) and the third one comprising the TA scores is named effectiveness. In our study, the first factor comprises both TR and TA scores, the second comprises the omissions (O) and the third the commissions (C). This way it would seem that the work load scorings are separated from the other two-error types which originate the other two factors.

This difference might be caused by the different sample sizes used in both studies, as the sample in the present study is much more reduced. A second cause, which has certainly influenced these discrepancies more, could be the different nature of the samples, teenagers and adults in the Spanish adaptation and 8-year old children in our case.

Therefore, we can eventually conclude that the instrument shows adequate performance in the sample used for this study, independently from the fact that the subjects may belong to one or the other sub-samples part of the original group.

*Table 6*  
Correlations among components

Component	1	2	3
1		-.043	-.159
2			.227
3			



Graphic 1. Scree test

References

Alvarez, L., González-Castro, P., Núñez, J.C., González-Pienda, J.A., Alvarez, D., & Bernardo, A. Programa de intervención multimodal para la mejora de los déficits de atención. *Psicothema*, 19, 591-596.

Bush, G., Valera, E.M., & Seidman, L. (2005). Functional neuroimaging of attention-deficit/hyperactivity disorder: A review and suggested future directions. *Biological Psychiatry*, 57, 1273-1284.

Etchepareborda, M.C., & Abad-Mas, L. (2001). Sustrato biológico y evaluación de la atención. *Revista de Neurología Clínica*, 2(1), 113-124.

Leclercq, M. (2002). Theoretical aspects of main components and functions of attention. En Leclercq, M. and Zimmermann, P. (eds.): *Applied Neuropsychology of attention: Theory, diagnosis and rehabilitation* (pp. 3-55). London Psychology Press.

Marlow, N., Wolke, D., Bracewell, M.A., & Smara, M. (2005). Neurologic and developmental disability at six years of age after extremely preterm birth. *National English Journal of Medicine*, 352, 9-19.

Martínez-Bermejo, A. (2003). Diagnóstico e intervención de los factores neonatológicos de riesgo causantes de discapacidad. *Revista de Neurología*, 36 (Suppl. 1), 117-122.

Miranda, A., García, R., & Soriano, M. Habilidad narrativa de los niños con trastorno por déficit de atención con hiperactividad. *Psicothema*, 17(2), 227-232.

Narbona, J., & Crespo-Equilaz, N. (2005). Trastornos de memoria y de atención en disfunciones cerebrales del niño. *Revista de Neurología*, 40 (Suppl. 1), 33-36.

Ríos-Lago, M., Muñoz-Céspedes, J.M., & Paúl-Lapediza, N. (2007). Alteraciones de la atención tras el daño cerebral traumático: evaluación y rehabilitación. *Revista de Neurología*, 44(5), 291-297.

Ruiz-Contreras, A., & Cansino, S. (2005). Neurofisiología de la interacción entre la atención y la memoria episódica: revisión de estudios en modalidad visual. *Revista de Neurología*, 41(12), 733-743.

Sastre-Riba, S. (2006). Condiciones tempranas del desarrollo y aprendizaje: el papel de las funciones ejecutivas. *Revista de Neurología*, 42 (Suppl. 2), 143-151.

Seisdedos, N. (2002). *D2, test de atención. Adaptación española*. Tea Ediciones: Madrid.