Learning and Individual Differences 20 (2010) 225–230

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Intelligence assessment: Gardner multiple intelligence theory as an alternative

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ARTICLE INFO

Article history:
Received 3 March 2009
Received in revised form 19 November 2009
Accepted 17 December 2009

Keywords:
Psychometric tests
Multiple intelligences
Intelligence assessment
g Factor

ABSTRACT

In the multiple intelligence framework, newer and more contextualized cognitive tasks are suggested as alternative to more traditional psychometric tests. The purpose of this article is to examine whether or not these two types of instruments converge into a general factor of cognitive performance. Thus, the Battery of General and Differential Aptitudes (BADyG: reasoning, memory, verbal aptitude, numerical aptitude and spatial aptitude) and a set of Gardner's multiple intelligence assessment tasks (linguistic, logical, visual/spatial, bodily-kinesthetic, naturalistic and musical intelligences) were administered to 294 children aged 5 to 7. The confirmatory factor analysis points out the absence of a common general factor considering both batteries, indicating instead the existence of two general factors, which gather the tests that encompass them. Also, these two general factors correspond to traditional and multiple intelligence assessments and show a statistically moderate correlation between them. These results challenge Gardner's original position on refusing a general factor of intelligence, especially when considering the cognitive dimensions measured which do not coincide with the more traditional tests of intelligence.

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1. Introduction

Some dissatisfaction still remains among psychologists regarding the instruments available for the intelligence assessment. Such dissatisfaction seems to be greater in professional practice since in experimental studies, researchers are able to choose specific tasks that better explain the cognitive processes and functions they want to assess.

A lack of innovation in the methods and in the type of cognitive skills considered on intelligence assessment is pointed out by Sternberg and Kaufman (1996). Unlike other areas in which technological innovations are updated and replaced, psychology has not substantially succeeded in changing the intelligence tests. Thus, the tests available today are not radically different from those used a century ago. Furthermore, they can be understood simply as revisions of relatively classic tests (Horn, 1979).

Rather than cyclically questioning the relevance of the tests it is imperative to respond to that dissatisfaction (Almeida, Prieto, Ferrando, Oliveira, & Ferrándiz, 2008; Marañón & Andrés-Pueyo, 1999; Neisser et al., 1996; Oliveira et al., 2009). Specifically, the insufficient theoretical framework and the lack of inclusion of experimental cognitive studies in tests construction are found to be unsatisfactory (Woodcock, 2002). So, the psychometric approach still dominates in practice despite the advances in the conception of intelligence made by developmental and cognitive approaches (Almeida, 1994).

Another source of dissatisfaction is related to the insufficient ecological validity of the available tests. On the one hand, these tests aim to assess students' "maximal performance" in a daily context with "standard performances" and therefore, the psychometrical tests do not assess the most valuable cognitive aspects of these students (Ackerman, 1994). On the other hand, items are presented in an overly abstract manner and are not sensitive to the cultural context of the different social groups. Furthermore, some authors do not differentiate between academic learning and test scores (Ceci, 1991; Sternberg, Conway, Ketron, & Bernstein, 1981), and if intelligence tests are often considered as good predictors of academic performance (Te Nijenhuis, Tolboom, & Bleichrodt, 2004), these correlations in social and professional contexts are irrelevant (Sternberg, 1999).

In the last 25 years, Gardner's work has been considered as an exception to the dominant psychometric context. His theory of multiple intelligences (MI) brought some innovation both at a theoretical level and at intelligence assessment. Gardner breaks with the psychometrical tradition by task based on subjects' life. While seeking a better ecologic validity and a better link of information to learning situations and performance, the assessment of intellectual capabilities is done in a classroom context through practice activities, with attractive material, without time constraints and giving children

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doi:10.1016/j.lindif.2009.12.010

freedom to manipulate this material. The emphasis is on learning rather than on outcomes, as the evaluation process gathers information about individuals' capabilities to provide useful and relevant information for learning (Gardner, 1999a).

In this sense, Gardner considers the assessment of intelligence as a procedure which should be understood as a part of the teaching and learning process. Cognitive competency is assessed in a natural way at the appropriate moment. Thus abilities are assessed in the classroom as students learn the curriculum. Thus, the materials used in the assessment are intrinsically interesting, in contrast with traditional intelligence tests which usually include abstract items that few children are enthusiastic about. According to Gardner, cognitive assessment should happen in enthusiastic contexts where children solve problems and accomplish projects to obtain the best performance.

In synthesis, intelligence assessment on MI should (i) turn to diverse and attractive material to evaluate the different intelligences; (ii) identify the strengths and weaknesses of several intelligences through the use of observation scales, portfolios, working styles and inventories; (iii) help identify abilities and forms of taking advantage of these abilities in order to overcome the discrepancy between strengths and weaknesses; (iv) inform teachers about students' competencies in order to foster the transfer of those competencies to curriculum domains; (v) create the conditions that allow the child commitment and expertise; and (vi) focus on gathering information which is relevant for the teaching and learning process.

Hence, considering Spearman's (1927) *g* factor has now reassumed enough importance within the hierarchical models of intelligence, our goal is to verify whether a general factor of intelligence emerges by using both Gardner's tasks and classical intelligence tests. We talk about a general intelligence factor guided by the intuition and deductive reasoning processes, namely in problem solving tasks, and in line with the concept of fluid intelligence proposed by Cattell, as opposed to the crystallized intelligence associated to cultural learning (Carroll, 1993; Cattell, 1971; Horn, 1991).

Concretely, we aim to observe how traditional intelligence tests and those based on MI Gardner's theory are interrelated. Specifically, we focus on overlapping and specificity of these two groups of intelligence assessment instruments to investigate the existence of any independence of MI (as proclaimed by Gardner) or their convergence around a single factor in terms of the *g* factor.

2. Method

2.1. Participants

The sample was composed of 294 children belonging to three different schools from Murcia and Alicante (Spain). Sample distribution was: kindergarten (aged 5, $n = 100$), first year of elementary school (aged 6, $n = 96$) and second year of elementary school (aged 7, $n = 98$). We balance the sample for each year according to gender and school types. Thus, the sample was composed of 141 boys (48%) and 153 girls (52%); 48% from the state school system, and 52% from semi-private schools (public funded but keeping a private management policy).

2.2. Instruments

2.2.1. Battery of differential and general aptitudes (BADyG — Yuste, Martínez Arias, & Galve, 1998)

We used two versions of this battery depending on the students' age. The BADyG-I (ages 4 to 6) is composed of 38 items that are grouped into six subtests: numerical quantitative concepts, information, figural vocabulary, non-verbal mental ability, reasoning with figures and puzzles. The global score provides an IQ defined as intellectual maturity. The BADyG-E1 (ages 6 to 8) is composed of 162 items, which measure logical reasoning, analogical relationships, numerical problems, logical matrices, numerical calculus, complex verbal orders, rotated figures and discrimination of differences. Both tests allow us to obtain an IQ as well as partial scores for the following factors used in this study: verbal (reliability index .86 for BADyG-I and .70 for BADyG-E1), numerical (reliability index .77 for BADyG-I and .86 for BADyG-E1), spatial (reliability index .75 for BADyG-I and .84 for BADyG-E1), logical reasoning (reliability index .87 for BADyG-I and .87 for BADyG-E1) and memory (reliability index .92 for BADyG-I and .87 for BADyG-E1).

2.2.2. Activities for MI evaluation

We used seven activities proposed by Gardner, Feldman, and Krechevsky (1998a,b,c) published in the "spectrum project" and previously adapted to the Spanish population (Ferrándiz, 2004; Ferrándiz, Prieto, Bermejo, & Ferrando, 2006).

To assess naturalist intelligence, we used two tasks: "Discovery" and "Why do some objects float and others sink?" In "Discovery", students are asked to play with different natural objects such as a feather, a stone, etc. They are requested to seek the differences and similarities between these objects and describe them in detail as they focus on their qualities. In "why do some objects float and others sink?" teachers ask whether each object would float or sink in a tank of water and why. Both tasks assess: accurate observation (capacity to pay attention to details); identification of relationships (ability to establish cause and effect between facts, similarities and differences between objects and establish classifications); formulation and verification of hypotheses (ability to think about problems, identify shortcomings and fix them by using logical reasoning); experimentation (ability to manipulate objects and see different uses and possibilities of working with them); and the interest that students show in activities related to their knowledge of the natural world.

The evaluation of visual–spatial intelligence took place in two sessions with the following structured activities: "Create a sculpture", "Draw an animal, a person and an imaginary animal". In "Create a sculpture", students are asked to create any figure with clay. Later, they are asked to draw an animal they know, a person and an imaginary animal. These activities assess: representation (ability to create recognizable symbols of current objects, such as people, plants, animals or houses, as well as the aptitude to spatially coordinate these elements into a unified whole); exploration (ability to reflect on the designs, and on the use of materials of artistic expression, flexibility, creativity and invention); and artistic talent (ability to use various pieces of art to express emotions, produce certain effects and beautify drawings).

We assessed bodily-kinesthetic intelligence using "Creative movement" in which students are asked to do some simple physical exercises, such as to follow the rhythm of clapping while rowing, and also to represent ideas by using their body, such as "imagine that you are a robot, move like a robot". This activity assess: sensitivity to rhythm (ability to control movements following the pace); expressiveness (ability to express different emotions using the body); body control (capacity to maintain a balance by using different elements such as ropes on the ground, benches, etc.); and production of ideas through movement (ability to invent new ideas on how to move the body).

The linguistic intelligence, was assessed with two activities: In "Story-telling" the students play with a model that has a scenery and several characters. The scenery and characters are ambiguous to allow different interpretations. They are asked to make up a story and tell it. In "Reporter", we showed them a short voiceless video and after watching it, we asked them to tell what happened in the video story. These activities assess: the primary functions of language (narration, interaction with adults, research, description and categorization); narration skills (narrative structure, thematic consistency, use of narrative voice, use of dialogue, temporal sequences, expressiveness, range of vocabulary and structure of sentences); and skills referring to information and

communication (level of organization, content accuracy, plot structure, vocabulary complexity, details level and sentence structure).

In order to assess logical–mathematical intelligence, we used the "Game of the dinosaur". It is a table game in which participants advance positions depending on a score acquired with two dices. One dice marks the number of positions, the other marks the direction to follow with a minus (backward movement) and plus (advance) sign. Hence, when the students were familiar with the mechanics of the game, the teacher asked them which was the best and worst throw of the dice and why. They also asked which throw would be needed to win the game when the counters were in a specific position, and so on. This activity assesses: numerical reasoning (ability to view, organize and solve problems, which involves using operations and making the appropriate calculations required); logical reasoning (ability to articulate the data in the best way possible to win the game); and spatial reasoning (ability to view the data of the game and understand the necessary movements).

We evaluated musical intelligence through the activity "Singing". We asked the students to sing different songs — easier and more complicated songs. A musical teacher evaluated this activity that contemplates skills such as sensitivity to pitch (ability to distinguish between short and long notes of a song or melody); rhythm (ability to express the correct number of musical notes, to distinguish between short and long notes, or maintain the regular timing of the song); and musical ability (ability to sing a song with correct melody and rhythm, including expressiveness).

For each activity, the observers used a Likert point scale (the scores range from 1, or never expresses, to 4, or always expresses). Regarding the reliability, previous research presents coefficients ranging from .63 for kinesthetic intelligence to .87 for visual–spatial intelligence (Ferrándiz, 2004; Ferrándiz, Prieto, Ballester, & Bermejo, 2004).

2.3. Procedure

The head teacher, teachers and parents authorized the study. Accordingly, we informed children of the study aims and its confidentiality. The tests were administrated during school time. Due to the nature of the MI activities, the assessment was carried out in small groups and with five researchers per classroom. We administered the tests according to the guidelines provided by the Spectrum Project (Gardner et al., 1998c), and adapted for the Spanish context by Ferrándiz (2004). A pleasant and relaxed environment was created to promote students' performance.

3. Results

In order to understand the existing relation between the different measures of intelligence obtained, we present the correlations (Pearson product-moment coefficient) between the scores obtained in Gardner's multiple intelligence tasks (1 to 6) and in BADyG battery (7 to 11). The mean and standard deviation values are also presented (Table 1).

While the correlations obtained were statistically significant in most of the cases, they showed that these two different kinds of measures are not assessing the same cognitive aspects. To our understanding, these aspects of cognitive processes, strategies or abilities that may be presented in both types of measures should show higher correlations. Such discrepancy is also present when considering the task's content of those relationships. For example, the linguistic intelligence is not highly correlated with verbal reasoning, and the numerical does not correlate with logical–mathematical intelligence. Contrary to what we expected, the naturalistic (classification elements) and visual–spatial intelligences present better indices of correlation with the classic intelligence tests.

When considering the correlation between subtests belonging to the same group (either traditional tests or MI task), we also found some correlations between independent constructs (traditional assessment and MI tasks) that, although statistically significant, suggest weak associations between those. In particular, we highlight the finding of higher correlations between bodily-kinesthetic and naturalistic intelligences ($r = .35$, $p < .01$) in the Gardner tasks. We found slightly higher correlation values within the traditional measures, namely between logical reasoning and verbal aptitude ($r = .64$, $p < .01$). To test changes to the patterns presented in Table 1, partial correlations were conducted, adjusting gender, age and type of schools. Partial correlations revealed that MI tasks and classic intelligence tests maintain the strength and direction of the previous associations. Thus, bodily-kinesthetic and naturalistic intelligences still have high associations ($pr = .40$, $p < .01$), whereas the highest correlation between Gardner tasks were between linguistic and naturalistic intelligences ($pr = .43$, $p < .01$). For all tasks, the highest correlations remain between logical reasoning and verbal aptitude ($pr = .63$, $p < .01$).

After considering the correlation obtained, we conducted a Confirmatory Factorial Analysis (CFA) using the AMOS 6.0 (Arbuckle, 2005). The data were previously standardized into *Z* scores. We used the procedure of Maximum Likelihood (ML) as an estimation method. This procedure presents advantages in terms of the statistical processing of relatively small samples (200 to 500 subjects) and consequently, the fitness index seems to work better with ML than with other statistical estimation procedures (Hoyle, 1998). Regarding our choice of fit indices, our decision is essentially based on the chi-square analysis, GFI (Goodness-of-Fit Index), RMR (Root Mean Residual), RMSEA (Root Mean Squared Error of Approximation) and AIC (Akaike Information Criterion), taking the indices suggested in the literature (Akaike, 1987; Hancock & Freeman, 2001; Macmann & Barnett, 1994).

Table 1
Descriptive analyses and intercorrelations between Gardner's tasks and psychometric intelligence tests.

	M	SD	1	2	3	4	5	6	7	8	9	10
1. Naturalistic	2.43	0.49										
2. Linguistic	2.06	0.56	.34**									
3. Bodily-kinesthetic	2.73	0.48	.35**	.26**								
4. Visual–spatial	2.56	0.59	.22**	.29**	.25**							
5. Musical	2.53	0.49	.13*	.18**	.20**	.12*						
6. Logical–mathematical	3.53	0.55	.34**	.25**	.19**	.28**	.12*					
7. Verbal	42.77	26.84	.21**	.07	.15**	.28**	.07	.09				
8. Numerical	37.85	31.41	.20**	.16**	.09	.16**	.13*	.13*	.34**			
9. Spatial	32.00	29.12	.13*	.13*	.16**	.27**	.06	.12	.34**	.23**		
10. Logical reasoning	35.74	30.16	.26**	.11	.19**	.24**	.09	.09	.64**	.50**	.45**	
11. Memory	36.62	31.28	.09	.11	.19**	.16**	.13*	.18**	.03	.14*	.07	.09

Note: M = mean; SD = standard deviation.
* $p < .05$.
** $p < .01$.

The first model (Fig. 1) aimed to verify the existence of a single factor of intelligence (*general intelligence*) that associates both the traditional and Gardner tests of intelligence in a single latent variable. We tested the CFA by establishing parameter one between the verbal and the latent variable. The results suggest an unadjusted model [$\chi^2(44, N=294)=195.28$, $p<.01$, GFI = .864, RMR = .088, RMSEA = .108, AIC = 239,286].

We also tried to develop a model with two latent variables that would describe two general factors of intelligence — one associated with classic tests (classical general intelligence) and another related to IM (Gardner's general intelligence). We have set the parameters by unit in the relation between the latent *classical general intelligence* variable and the verbal subtest, such as between *Gardner's general intelligence* and naturalistic intelligence. With these settings, we obtained the model shown (Fig. 1) which reflects 46.5% of the BADyG subtest variance that is associated to the latent *classical general intelligence* variable (SE = .076, $p<.01$). The second latent variable represents 35.2% of Gardner's general intelligence factor which are explained by the six dimensions of the MI studied (SE = .094, $p<.01$). We also highlight the existing correlation between the two latent variables ($r=.41$, $p<.01$). Although these correlations are significant, they are still far from the unit and suggest the existence of different dimensions of a general intelligence. This model shows acceptable rates of adjustment [$\chi^2(43, N=294)=72{,}153$, $p<.01$, GFI = .959, RMR = .055, RMSEA = .048, AIC = 118,153] and, except for the regression between the memory variable and the classical general intelligence variable, all other variables show significant regression coefficients ($p<.05$).

4. Discussion

By analyzing the data obtained, we can affirm the relative independence between Gardner's tasks and the classic intelligence test scores. In fact, a confirmatory model advocating a possible convergence of all measures around a single *g* factor did not present an adequate level of structural adjustment. Rather, the existence of two independent general dimensions of intelligence is confirmed. One of these is the most representative, accounting for 46.5% of the global variance associated with traditional intelligence tests (BADyG), while the other general dimension is associated to Gardner's MI tasks and accounts for 35.2% of their variance. We also found a correlation of .41 ($p<.01$) between these two general factors, suggesting an association between the two general dimensions obtained.

This is a significant result considering the correlation between the traditional tests was predicted from previous research, independently of whether or not we agree that the reasons are due to the verbal and linguistic loading of the traditional task (Gardner, 1983). Additionally, according to our results, the MI assessment task also converts into a *g* factor. Gardner could argue that we use our intelligences as a whole. For example, we use our musical intelligence when playing a piano, but we also use our corporal intelligence to strike the keys, as well as our personal and interpersonal intelligence to communicate a feeling. It could be said then that as White (2006) states, intelligence action has to do with flexible adaptation of means in pursuit of one's goals, meaning

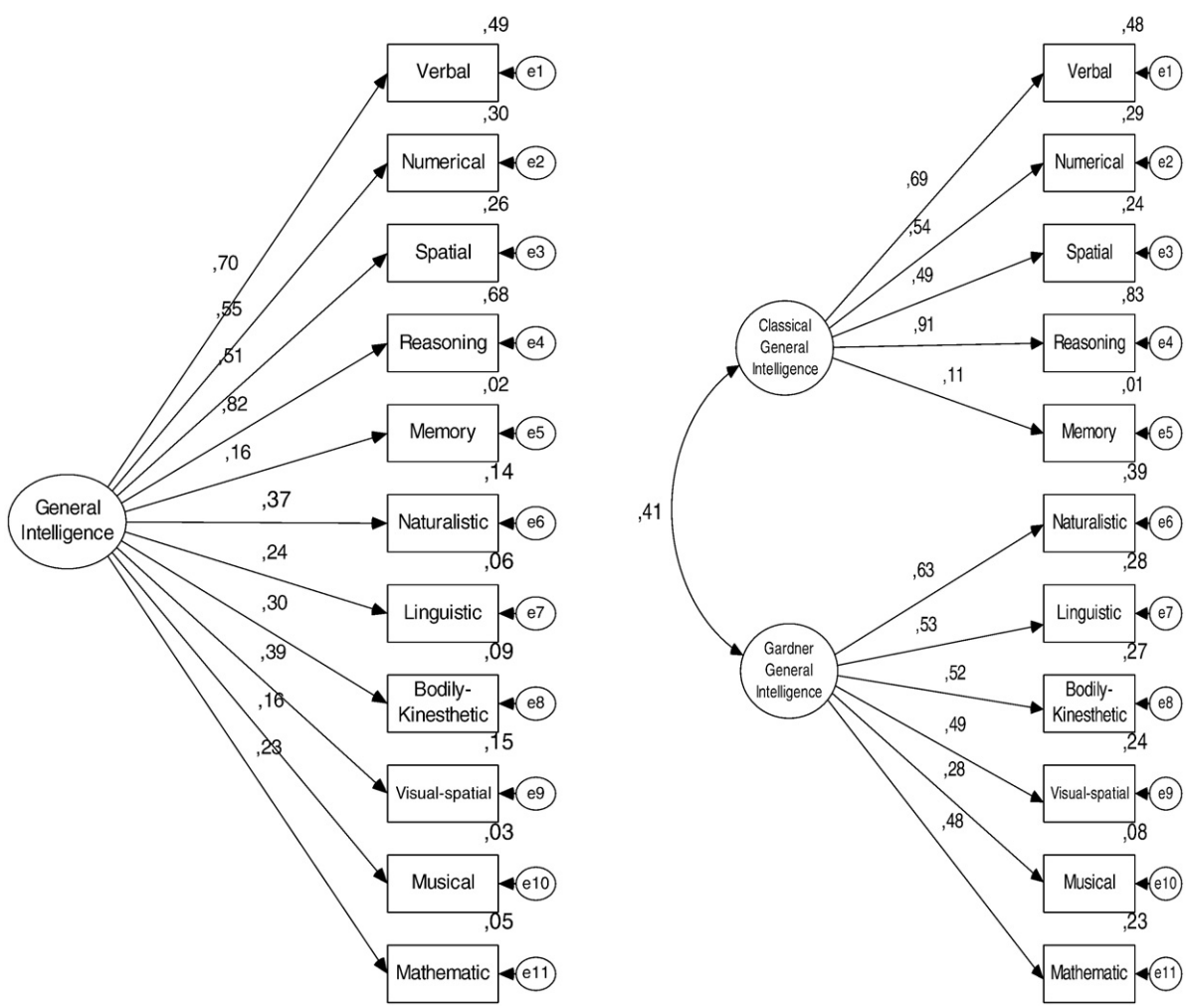

Fig. 1. On the right side the Confirmatory Factorial Model between both tests scores and a general intelligence dimension is displayed. On the left, Confirmatory Factorial Model between both tests scores and two general intelligence dimensions.

that there are as many types of human intelligence as there are types of human goals.

These results seem to confirm the relevance of a *g* factor of intelligence, no longer as a factor of first order as proposed by Spearman (1927), but rather as a second and third order factor analysis that considers the intercorrelations among more specific factors previously isolated. The results obtained now seem to negate some of the theoretical principles of Gardner, in particular his refusal of a *g* factor in the definition of intelligence or its definition as a mere statistical abstraction (Gardner, 1999b). Moreover, there is evidence that Gardner's tests also converge into a single factor, suggesting that a general dimension of intelligence is an inescapable reality and corroborating, to some extent, the arguments of Sternberg (1994) in which the theory of multiple intelligences resembles *g*.

Many psychometric and neuropsychological studies, even today, highlight the possibility of a *g* factor in the definition of intelligence. Some literature has emphasized that the neural networks share important areas in terms of emotions and cognitive skills, such as musical skills, logical–mathematical and spatial skills, from which the Gardner's theory is based on (Koelsch et al., 2004; Lieberman, 2002; Morgane, Galler, & Mokler, 2005; Norton et al., 2005).

Therefore, intelligence may be understood as a complex aptitude that involves important aspects of problem solving, as well as the ability to infer relationships and to think in an abstract manner (Rindermann, 2007). This definition reveals the multiple dimensions of intelligence and highlights that cognitive skill measures are positively correlated with each other depending on the cognitive processes involved and on the tasks' content (Almeida, 1994; Gustafsson & Undheim, 1996; Visser, Ashton, & Vernon, 2006).

Finally, the MI theory as well as the assessment activities used to validate it, need further studies which support their validity. Gardner's theory of multiple intelligences has an important cultural component associated to the different dimensions of intelligence (Gardner, 1999a). From this perspective, various studies should be considered to account possible cross-cultural differences. Additionally, a more representative sample may be beneficial to evaluate if this one-factor structure is replicable. Accordingly, further studies are required in order to decide whether to reject either the existence of a *g* factor or the idea of equally important intelligences. Because the tasks proposed by Gardner have significant gaps in terms of their validity (Sternberg & Grigorenko, 2004), it is important to increase the investment in the empirical validation of his theory (Gardner, 2004; Gardner & Connell, 2000; Gardner & Moran, 2006). These studies are essential in order to promote that educational psychologists combine the psychometric tests with contextual tasks on intelligence assessment, such as proposed by Gardner model, which is also important to help teachers in attending the students' cognitive diversity abilities instead of the traditional focus on verbal and logical aspects.

Acknowledgments

The research reported in this article was supported by The Spanish Ministry of Science and Technology (BSO2002-02282 and BSO2002-02022).

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