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Accuracy and bias in Spanish secondary school students' self-concept of math ability: The influence of gender and parental educational level

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A B S T R A C T

The present two-wave longitudinal study investigated the accuracy or bias in students' math self-concept of ability during the transition to high school from the last year of secondary compulsory education (10th grade). The role of students' gender and parents' educational level in predicting the accuracy or bias in math ability self-concepts was also investigated. 424 Spanish students participated. The results analyzed with the person-oriented I-States as Objects Analysis (ISOA) showed four groups of students: high-accurate, low-accurate, optimistic, and pessimistic. Males more likely belonged to the high-accurate or optimistic self-concept math ability group. In addition, students whose parents had a high level of education more likely belonged to the low-accurate or pessimistic self-concept of math ability group.

1. Introduction

Positive self-concept of ability in different domains is a widely valued educational goal (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005) owing to its positive impact on academic learning and achievement (Eccles et al., 1997). Together with actual performance in different domains, during adolescence domain-specific self-concepts play a major role in educational decisions (Eccles, 2007; Pajares & Schunk, 2005; Simpkins, Davis-Kean, & Eccles, 2006; Wigfield & Eccles, 2000) and in determining students' future aspirations (Eccles, 2007; Simpkins, Davis-Kean, & Eccles, 2006; Wigfield & Eccles, 2002). However, some studies have showed that positive self-concept alone is not necessarily beneficial for one's future achievement and outcomes. Instead, a realistic and accurate self-concept helps students to better understand their own skill levels, making learning more meaningful (Dunning, Heath, & Suls, 2004). Likewise, accurate self-concept promotes self-regulated learning which further affects achievement outcomes, goal accomplishments, and domain-related choices (Fredricks & Eccles, 2002). Inaccurate beliefs about one's abilities, in turn, easily lead students to wrong-headed academic decisions and to subsequent low performance (Eccles, 2007; López-Sáez, Puertas, & Sáinz, 2011). This may further imply a decrease in students' academic motivation and career aspirations (Bong & Skaalvik, 2003; Pajares & Miller, 1994). However, regardless the importance of realistic self-concept on one's outcomes and academic/vocational choices, little is known about the accuracy of or bias in students' self-concepts of ability during the time when students are required to make future

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academic/vocational choices while facing the transition to secondary education. Moreover, research on the stability and changes in students' self-concept of ability during educational transitions is scarce. Consequently, the present two-wave longitudinal study investigated the accuracy of and bias in students' self-concept of math ability before and after the transition to high school. In addition, the role of student- (e.g., gender) and parent-related (e.g., level of education) antecedents in predicting the accuracy of, and bias in, students' math ability self-concepts was examined.

1.1. Self-concept of ability

Several terms (such as confidence, ability perceptions, and competence beliefs) have been used in the literature to make reference to ability self-concepts (Wigfield & Eccles, 2000). According to the expectancy value theory of achievement motivation (Wigfield & Eccles, 2002), self-concepts of ability refer to individuals' evaluations of their competencies in different domains and the feelings of self-worth that accompany competence beliefs (Pajares & Schunk, 2005). Students usually base their competence evaluations on their past performance or knowledge (Cole et al., 2001; Dweck & Molden, 2007; Jacobs, Osgood, Eccles, & Wigfield, 2002), on comparisons between their own and other students' capacities (Bong & Skaalvik, 2003; Bouffard, Markovits, Vezeau, Boisvert, & Dumas, 1998), and on evaluative feedback from parents (Rytkönen, Aunola, & Nurmi, 2007) and teachers (Upadyaya & Eccles, 2014). Variation exists in students' ability self-concepts in different domains, which together form broader academic self-concept of abilities (Elliot & Dweck, 2007).

Several studies have shown that changes occur in students' ability self-concepts over the school years. At the beginning of primary school children's self-concept of ability in different domains is typically overly positive, however, when students move into the higher grades their self-concept of ability in different domains begins to decrease and becomes sometimes even negative (Aunola et al., 2002; Bouffard, Vezeau, Roy, & Lengelé, 2011; Jacobs et al., 2002; Wigfield et al., 1997). These changes are partly normative and partly reflect the fact that students' ability self-concepts become more realistic as they grow up (Bouffard et al., 1998; Wigfield et al., 1997). Changes also occur in students' ability self-concepts during various educational transitions (Cole et al., 2001) which are typically reflected as declines in students' self-concepts of ability (Jacobs et al., 2002). According to the stage-environment fit (Eccles et al., 1993) negative changes in students' ability self-concepts reflect the poor fit between the individual (e.g., student) and context (e.g., school). Lesser personalized instruction, increased ability groupings, stronger teacher authority, and lower levels of student autonomy (Eccles et al., 1993), together with perceptions of increased academic pressures (Pajares & Schunk, 2005) often follow the transition to secondary education and contribute to these declines in students' ability self-concepts.

Previous research has also shown that self-concept of ability in different domains is typically associated with performance in the same domain. Students often feel more competent in academic areas in which they achieve well (Wigfield & Eccles, 2002). Academic achievement is normally measured by grades and test scores which act as indicators of competence and provide both an internal (e.g., the same student thinks that he/she is better at reading than at math) and an external frame of reference (e.g., social comparison) for students (Marsh & Hau, 2004). Similarly, research on reciprocal effects has shown that prior self-concept predicts subsequent academic achievement (Marsh & Hau, 2005).

1.2. Accuracy or bias in students' self-concept of math ability: correlates and consequences

Although a large number of research exists on students' self-concept of ability in different domains, few studies have examined the accuracy or bias in students' ability self-concepts (Bouffard et al., 1998; Rytkönen et al., 2007). More concretely, there is a lack of research examining the accuracy and bias in students' ability self-concepts across the transition from compulsory secondary education to non-compulsory secondary school (high school).[1] The accuracy in student's self-concepts refers to the extent to which the students' ability self-concept is realistic. That is, the extent to which students' ability self-concept corresponds to their actual level of performance (Bouffard et al., 1998; Rytkönen et al., 2007; Sheldrake, Mujtaba, & Reiss; 2014). Bias in students' self-concept of ability can be positive (e.g., self-concept is higher than actual performance, overestimation) or negative (e.g., self-concept is lower than actual performance, underestimation). Accurate self-concept of ability can serve as a self-regulatory component, which directly affects achievement outcomes, goal accomplishments, and domain-related choices (Fredricks & Eccles, 2002), whereas inaccurate self-concept of ability may lead students to wrong-headed academic decisions and to subsequent low performance (Eccles, 2007; López-Sáez, Puertas, & Sáinz, 2011). Previous studies have revealed that self-concept of math ability does not always reflect the students' actual grades or performance in math (Fredricks & Eccles, 2002; Frome & Eccles, 1998). For example, students with learning difficulties or low performance tend to have an overly optimistic view of their abilities in math and other domains (Dunning, Heath, & Suls, 2004; Kruger & Dunning, 1999).

Other empirical research suggests that the more realistic ability self-concepts students hold in different domains, the

[1] In the current Spanish educational system, secondary school consists of two academic stages: compulsory and post compulsory. The compulsory one comprises grades from 7 to 10. The post compulsory stage is divided into high school and higher vocational training. High school (*Bachillerato*) targets university bound students and includes grades 11 and 12, where students have already chosen 1 out of the 3 academic tracks: science and technology; humanities and social sciences; and arts. The higher vocational training track also covers 2 years and, once completed, students can either enter the labor market or continue university studies.

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more realistic and adaptive study-related choices they will make in the future (Baumeister, Campbell, Krueger, & Vohs, 2003). Nevertheless, despite the importance of realistic ability self-concepts, aspirations, and career choices, literature examining the accuracy or bias in students' domain-specific self-concepts has not reached a consensus about what happens when academic self-evaluations are positively or negatively biased rather than based on true competence (Bouffard & Narciss, 2011). A positive evaluation bias (overestimation) is adaptive because it promotes motivation, persistence, self regulation, and achievement (Bouffard & Narciss, 2011; Bouffard et al., 1998). Moreover, positively biased unrealistic self-concepts may have both benefits and costs on learning, academic performance and job performance, whereas negatively biased ability self-concepts are typically described as maladaptive on learning and achievement (Butler, 2011). In the same fashion, the benefits of accuracy evaluations are called into question, when compared to positively biased self-concepts (Gonida & Leondari, 2011; Bouffard et al., 2011; Narciss, Koerndle, & Dresel, 2011). However, only few studies have examined the accuracy or bias in students' ability self-concepts (Bouffard et al., 1998; Rytkönen et al., 2007). Consequently, the present study aimed at examining the accuracy or bias in students' math ability self-concepts across the transition from compulsory secondary education to high school.

1.3. Developmental influences on accuracy or bias in students' self-concept of math ability

Developmental changes may also occur in the accuracy or bias in students' ability self-concepts. As the students grow older, due to cognitive development and maturity, increased achievement-related experiences, and better understanding of evaluative feedback students' self-concepts of ability become more realistic (Aunola et al., 2002; Bouffard et al., 1998; Jacobs et al., 2002; Wigfield & Eccles, 2002). In addition, at the inter-individual level self-concept of ability becomes increasingly accurate and stable within the course of development (Marsh, 1990). Students therefore become more accurate in their self-evaluations due to their growing experience in achievement-related situations (Jacobs et al., 2002; Wigfield & Eccles, 2002). However, at the individual level studies grounded in social psychology have suggested that self-evaluations such as self-concept of ability are flexible and driven by individual motives (i.e., Elliot & Mapes, 2005; Festinger, 1954), given that students want to have an accurate evaluation of the self (self-assessment) or protect the self from negative evaluations (self-enhancement). These individual motives lead students to a selective processing of available information (e.g., performance related to others, evaluative feedback), and allow them to construct accurate or enhanced ability self-concepts (Gniewosz, Eccles, & Novack, 2011).

Another factor influencing the stability and change in students' ability self-concepts, and the accuracy or bias in them, are various educational transitions. Previous research has shown that change is more typical than stability in students' self-concept of ability during secondary school transition (Cole et al., 2001). Moreover, following the transition periods, grades lose their predictive power for the construction of self-concept of ability in different domains and students may look for other sources of information rather than grades (i.e., parental or teachers' appraisals) to construct their ability self-concepts (Gniewosz et al., 2011). Students' accuracy may therefore suffer from a decline because the sources of information for the formation of self-competence beliefs after the transition (i.e., high school) are different from the ones that used to be valid before the transition (i.e., compulsory secondary education). The educational system is also more competitive, and peer comparison shapes students' academic perceptions and choices (Guimond & Roussel, 2001). However, there is a gap in research investigating the accuracy or bias in students' math ability self-concepts across the transition from compulsory secondary education to high school. Consequently, the present study aimed at investigating this.

1.4. Antecedents of students' self-concept of ability

Several antecedents can be found for students' self-concept of ability. One of the main antecedents is student's gender which plays a major role in the way students perceive their own competencies in different subject areas. Preceding research has shown that male students usually report high self-concept of math ability, whereas female students often experience low self-concepts of math ability (Watt, 2010). This pattern has been observed as early as first grade and it continues through middle-school (Fredricks & Eccles, 2002; Jacobs et al., 2002) and high school (Bleeker & Jacobs, 1993; Dupeyrat, Escribe, Huet, & Régner, 2011; Gonida & Leondari, 2011; Jacobs et al., 2002). However, associations between self-concept of math ability and math performance are stronger for females than for males, suggesting that female students are more accurate when assessing their abilities (see also Gonida & Leondari, 2011; Watt, 2010). Interestingly, research conducted in the U.S. suggests that unrealistic, inflated self-concept of math ability favors male students' academic achievement; whereas, the opposite is true for female students (Yoon, Eccles, & Wigfield, 1996).

Likewise, the appraisals of significant others (such as parents, teachers, or peers) play a key role in the construction of students' self-concept of ability (Eccles et al., 1993). Students' incorporate parents' beliefs concerning students' abilities into their ability self-concepts in different domains (Bleeker & Jacobs, 2004; Frome & Eccles, 1998; Jacobs et al., 2002), which further promotes or hinders the accuracy in students' ability self-concepts at earlier grades (Rytkönen et al., 2007). In addition, parents' educational level (especially fathers') positively predicts students' self-concept of math ability, as well as their scores in math achievement tests (Davis-Kean, 2005). Parents' educational level also conditions students' academic achievement and selection of studies, in part, through its direct and indirect impact on students' self-concepts of ability (Davis-Kean, 2005; Eccles & Davis-Kean, 2005; Simpkins et al., 2006). For example, parents with higher educational attainments provide their children with more intellectual stimulation opportunities (i.e., extracurricular activities or tutoring if children have difficulties at school), which may further increase children's awareness of their actual abilities in different domains, and thus promote the accuracy of their ability self-concepts. Moreover, parents with higher education tend to have more confidence in their children's academic abilities (Eccles & Davis-Kean, 2005; Rytkönen, Aunola, & Nurmi, 2005), which, in turn, may increase the accuracy of students' ability self-concepts (Rytkönen et al., 2007). However, there is a dearth of studies associating parental educational level with the possible accuracy or bias in students' ability self-concepts during the period when various changes occur in students' ability self-concepts and they are facing the transition from compulsory secondary education to high school. Consequently, the present study aimed at investigating this neglected area of research.

1.5. Rationale, research questions and hypotheses

The present study aimed at examining the following research questions:

1. What kinds of naturally occurring groups can be identified on the basis of the accuracy of, or bias in, students' self-concept of math ability before and after the transition from compulsory secondary education to high school?

Hypothesis 1. We expected to find at least three groups of students with varying levels of accuracy in their math ability self-concepts: over-optimistic, accurate, and pessimistic (Gonida & Leondari, 2011; Bouffard et al., 2011; Dupeyrat et al., 2011; Narciss et al., 2011).

2. What kinds of changes occur in the accuracy or bias in the student's math ability self-concepts over the transition to high-school?

Hypothesis 2. Since changes in students' ability self-concepts are more common than stability during the transition to high school (Cole et al., 2001), it was expected that changes would occur instudents' self-concept of math ability groupings across the two time points.

3. Are there any gender differences between the groups?

Hypothesis 3. It was expected that boys more often than girls would overestimate their math abilities, whereas girls more often than boys would underestimate their math abilities or to evaluate them accurately (Gonida & Leondari, 2011; Yoon et al., 1996; Watt, 2010).

4. To what extent does parental educational level predict the accuracy or bias in students' self-concept of math ability?

Hypothesis 4. Given the absence of empirical research testing the relationship between parental educational level and the degree of accuracy or bias in students' self-concept of math ability and based on existing research looking at the influence of parental educational level on their children's ability self-concepts (Eccles & Davis-Kean, 2005; Rytkönen et al., 2005, 2007), we formulated this hypothesis in a exploratory way. It was therefore expected that high parental educational level would increase the accuracy in students' math ability self-concepts.

2. Method

2.1. Sample

The sample consisted of 424 secondary school students who were enrolled in their last year of compulsory secondary education (10th grade, academic year 2009–2010) in Catalonia, Spain. The data was gathered once during the students' last year of secondary school (Time 1; mean age = 15 years; s.d. = .70) and once during their first year of high school (Time 2; mean age = 16 years; s.d. = .62). Time lag between measurements varied from 9 to 10 months. Approximately half of the students were females (56.3%) and 68% of them belonged to intermediate socioeconomic status (i.e., students with parents holding administrative and white collar positions, who had completed postcompulsory secondary education). The majority of students had a Spanish background (89%), with fathers (60.5%) and mothers (59%) having completed at least postcompulsory secondary education. The schools were randomly selected for the study, targeting over 30 Catalonian schools of which 10 agreed to participate. These schools were located in the metropolitan (57%) and in other non-metropolitan areas of Barcelona (e.g., Lleida, and Tarragona). More than 90% of the targeted students were included in the final data collection (900 students in Time 1 and 775 in Time 2). However, only 424 students who participated in the study both measurement times (Times 1 and 2) were included in the final sample.

As the attrition rate reached 53% (drop-out students either chose vocational training instead of high school and left the school premises or repeated course), attrition analyses were carried out by comparing those students who participated in the study at each measurement time ($N = 424$) with those who had missing data at some measurement time ($N = 476$). The results indicated that those who participated in the study at each measurement time showed higher math achievement ($M = 53.89$, $S.D. = 9.68$) and self-concept of ability ($M = 52.09$, $S.D. = 9.87$) than those who did not participate (math achievement = 48.12, $S.D. = 9.76$; math self-concept = 46.83, $S.D. = 9.26$), t (895) = –11.08, $p < .001$; t (883) = –6.05, $p < .001$.

Interestingly, more males (28.87%) than females (23.86%) dropped out. No gender differences were observed in self-concept of math ability (t (274) = –.72, $p > .05$) and math performance (t (466) = –1.89, $p > .05$) among students who only

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participated at Time 1. However, in the longitudinal sample females ($M1 = 51.01$, $S.D. = 9.46$; $M2 = 48.68$, $S.D. = 9.44$) reported lower self-concept of math ability than males at both measurement times ($M1 = 53.48$, $S.D. = 10.07$; $M2 = 51.86$, $S.D. = 9.36$), $t1$ (421) = 2.57, $p = .01$, $t2$ (423) = 3.45, $p = .001$. No gender differences emerged in math performance. Q8

2.2. Measures

Self-concept of math ability was measured at Times 1 and 2 with a translated version of the Eccles and Harold (1991) scale concerning students' perceptions of their abilities in math. The scale consists of five questions measuring students' math self-concept (e.g., "*In comparison to other subjects, how good are you at math?*" and "*How good do you think others think you are at math?*"). Students rated their responses on a 7-point scale ranging from 1 (low competence) to 7 (high competence). Two sum scores were calculated for students' self-concept of math ability at each measurement time. Cronbach's alpha reliabilities were .80 and .81 respectively. Bartlett's test of sphericity is statistically significant χ^2 (10) = 2,244,670, $p < .001$. Kaiser's measure of sampling adequacy was 83. The Principal Component Analysis for the five items shows that this factor accounts for 61.48% of the total variance (see Sáinz & Eccles, 2012).

2.3. Math performance

Students reported (at Times 1 and 2) their average final grade obtained in the last math course they took (see Sáinz & Eccles, 2012). The answers ranged from 1 (failed) to 5 (excellent). The grades corresponded to the grading system that students receive in Spain at the end of each trimester or at the end of the academic year. For confidentiality reasons, the majority of the participant schools did not provide students' actual grades.

2.4. Level of parental education

With a 4-point rank order scale students rated the highest educational level completed by the two parents (at Time 1). The options were: (1) no studies, (2) primary school, (3) post-compulsory secondary education (e.g., high school or vocational education),[2] and (4) university studies. Most parents had completed post-compulsory secondary education (60.5% of the fathers and 59% of the mothers), while some of them had completed university studies (33% of the fathers and 36.5% of the mothers). Few parents had only completed primary school (2.6% of the fathers and 3.5% of the mothers).

2.5. Procedure

The research team administered the survey on average to four classrooms per school at Time 1 and three classrooms per school at Time 2, with approximately 27 students per classroom. Complete class course levels were surveyed. The survey was distributed during classroom time in order not to interfere with daily academic life. Both the anonymity of the participants and confidentiality of the data collected were guaranteed. For the follow-up throughout the two measures, students were asked to fill in an identification code that protected their anonymity.

3. Results

3.1. Research question 1. Grouping according to the accuracy or bias in students' self-concept of math ability

The first aim of the present study was to examine what kinds of naturally occurring groups can be identified on the basis of the accuracy, or bias, in self-concept of math ability among the participating students. In order to identify the groups on the basis of accuracy of students' self-concept of math ability (R.Q.1), a person-oriented research strategy applying a cluster analysis in group identification was used. Since data of students' math self-concept from two measurements was gathered, the I-States as Objects Analysis (ISOA) procedure (Bergman & El-Khouri, 1999) was used. In comparison to other analytical tools, this procedure provides the possibility to identify homogenous groups according to math performance and self-concept of ability, taking into account the measurement points at once, and not separately. Therefore, these groups can be identified using similar categories and criteria across different time points. The standard ISOA procedure (Bergman & El-Khouri, 1999) was followed when performing the analyses. The analysis was run with SPSS.17 and was carried out as follows:

1) Each of the criteria variables (students self-concept of math ability and math performance at the two measurement points) was standardized (z scores and then adding 50 to each z value).
2) Since the purpose of this study was to achieve similar categories (cluster solutions) for the two time-points, longitudinal data was reorganized as follows: a new file was created in which the first (Time 1) and second (Time 2) measurement of each student was coded as that of a separate individual. That is, student A at Time 1 and student A at Time 2, etc., each of which refers to a different I-state in the ISOA procedure (Bergman & El-Khouri, 1999).

[2] Secondary education refers to the completion of either high school or vocational training.

3) A clustering-by-case analysis was carried out according to the standard procedure. The "agglomeration tree" was run. The number of clusters was determined on the basis of two criteria: theoretical interpretation and the number of cases in each cluster.
Given that the cluster solution in this particular clustering method depends on the order of cases in the file, the analyses were run several times until the solution was stabilized. In this process, the final centers of each earlier solution were saved and used as initial centers in the next run.
4) Finally, the data (cluster membership) were reorganized in such a way that the data from each student at Times 1 and 2 were again handled as two successive measurements of the same student. This ISOA procedure yielded a similar classification (clustering solution) for each time point, and the cluster membership variables from Times 1 and 2 were used for the further longitudinal analyses.

On the basis of this clustering-by-case analysis, four math ability self-concept groups were identified. Two of the groups described accurate self-concept of math ability with differing levels of math performance: (1) *High-accurate self-concept of math ability group* (N = 168 at Time 1; with 83 females and 85 males) was characterized by a high level of self-concept of math ability and a high level of math performance and (2) *Low-accurate self-concept of math ability group* (N = 90 at Time 1; with 53 females and 37 males) was characterized by a low level of math ability self-concept and a low level of math performance. The other two groups described inaccurate self-concept of math ability (e.g., the standardized values of self-concept of ability and performance did not correspond to each other): (3) *Optimistic self-concept of math ability group* (N = 76 at Time 1; with 38 females and 38 males) was characterized by a moderate level of self-concept of math ability and a low level of math performance and (4) *Pessimistic self-concept of math ability group* (N = 83 at Time 1; with 60 females and 23 males) was characterized by a low level of math ability self-concept and a moderate level of math performance. The means and standard deviations for the criteria variables in each group are presented in Table 1.

It was further found that at Time 2 there was a decrease in the number of students belonging to the high accurate group. In addition, young males were more likely than young females to belong to the optimistic rather than to the pessimistic group (21.9%). Young females, in turn, were more likely than young males to belong to the pessimistic rather than the optimistic group (22.6%).

3.2. Research question 2. Stability in students' self-concept of math ability grouping

In order to examine the stability of and changes in adolescents' self-concept of ability group memberships (R.Q2), frequency tables across the two time points were analyzed, by implementing log-linear models. Log-linear models are statistical tools used to analyze multi-way frequency tables that provide a basis for many kinds of testing strategies. These models can be useful in testing hypotheses relating to stage-like relationships between variables. We thereby selected an approach that examined the extent to which a change pattern in the values of categorical variables at time t and time $t+1$ was typical or atypical. These models included the main effects of the grouping variables in the two successive measurements but not their interactions. On the basis of these models, expected frequencies were calculated and compared to observed frequencies. These comparisons produced standardized residuals that provided information about whether more cases were found in each cell compared to the overall distribution of the two variables included in the analysis. The standardized residuals of this independency model (interpreted as t-values) inform about stabilities and changes in group membership from Time t to Time $t+1$, which differ from those that can be expected on the basis of variable distribution at the two time points.

Fig. 1 shows the number of students in each group at the two time points, as well as stabilities and changes in group membership between the measurements that go either above (straight line) or below (dotted line) the number of changes expected by chance. The statistical significance of these changes was estimated on the basis of the standardized residuals. The results showed that self-concept of math ability group memberships were relatively stable during the students'

Table 1
Means and standard deviations of standardized variables for all the groups.

	Self-concept of math ability group					
	High-accurate (a) (n = 304)	Low-accurate (b) (n = 187)	Optimistic (c) (n = 170)	Pessimistic (d) (n = 179)	F	p
Self-concept of math ability						
M	0.93[a]	−1.38[b]	0.26[c]	−0.39[d]	994.53	0.001
Math performance						
M	0.98[a]	−1.21[b]	−0.74[c]	0.30[d]	1167.08	0.001
$S.D.$	0.41	0.46	0.47	0.44		

Note: group means with different superscripts showed a statistically significant difference ($p < .001$) when tested with Bonferroni's procedure. n describes I states (e.g., a state referring to a specific individual at a specific time) rather than number of students (Bergman & El-Khouri, 1999).

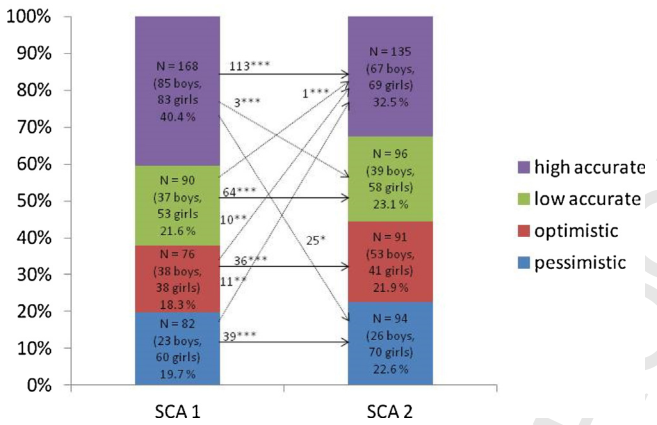

Fig. 1. Stability and changes in the self-concept of math ability (SCA) groupings at both times.
Note: the numbers indicate frequencies; straight lines refer to changes that are more likely than expected by change; dotted lines refer to changes that appear less likely than expected by change (chi square tests) $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$.

transition from compulsory secondary school to high school. The percentage of students in the high-accurate self-concept of math ability group decreased, whereas the percentage of students in the other three groups increased slightly.

3.3. Research questions 3 and 4. Gender and parents' educational level as predictors of accuracy in students' ability self-concepts

In order to investigate the extent to which students' gender (R.Q.3) and parents' educational level predicted the accuracy of students' math ability (R.Q.4) self-concept during the transition to high school, several multinomial logistic regression analyses were carried out. Logistic regressions measure the relationship between the categorical dependent variable and one or more independent variables by estimating probabilities using a logistic function. These analyses enabled the prediction of the categorical variable self-concept of math ability groupings. Group membership was therefore separately predicted by students' gender and parents' educational level. At Time 2, the impact of previous group membership at Time 1 was controlled for in the analyses. In addition, all self-concept of math ability groupings were compared to the remaining groups.

The results illustrated that young males were more likely than young females to belong to the high accurate group at Time 1 ($b = .84$, Wald = 8.17, $p < .01$, $OR = 2.33$) or to the optimistic group at the two time points ($b = .90$, Wald = 7.02, $p < .01$, $OR = 2.45$ at Time 1; $b = 1.13$, Wald = 11.98, $p < .01$, $OR = 3.10$ at Time 2) than to the pessimistic group. Moreover, when the fathers' educational level was high, students were more likely to belong to the pessimistic than to the high accurate self-concept of math ability group at Time 1 ($b = .50$, Wald = 3.65, $p < .06$, $OR = .61$). In the same vein, when the parental educational level was high the students were more likely to belong to the low accurate than to the high accurate self-concept of math ability group at Time 1 ($b = .57$, Wald = 5.29, $p < .05$, $OR = .56$ for fathers; $b = .52$, Wald = 4.32, $p < .01$, $OR = .60$ for mothers).

Q9 A gender × parental education interaction analysis showed that males whose fathers had a high level of education more often belonged to the pessimistic than to the high self-concept of math ability group at Time 1 ($b = 1.62$, Wald = 8.74, $p < .01$, $OR = .20$).

4. Discussion

The present two-wave longitudinal study aimed at filling a gap in the existing literature by examining the accuracy and bias in students' math ability self-concepts using a person-oriented approach and by focusing on the time period when students are facing the transition to high school. The results showed that two accurate (high and low) and two biased (optimistic and pessimistic) groups of students could be identified according to their math ability self-concept and performance. These groups were relatively stable across the two measurement times, however, the number of students in the high-accurate self-concept of math ability group slightly decreased over the transition to high school. In addition and congruently with expectations, gender and parental educational level predicted student's math ability group membership.

Furthermore, these findings highlight the importance of studying accuracy and bias in math ability self-concept among students in secondary education, whereas previous research has, to a great extent, focused on elementary school students (i.e., Bouffard et al., 1998; Rytkönen et al., 2007) and secondary school students (i.e., Dupeyrat et al., 2011; Gonida & Leondari, 2011). Similarly, the use of person-oriented approach enables to identify four groups of respondents whose math ability self-concept was different from the overall trend (typically captured by variable-oriented methods). Moreover, the present research demonstrates that the transition into high school seems to be an ideal time framework to investigate the extent to which students' self-perceptions of their abilities are accurate. This is also the time when students are in the process of selecting their future studies and career paths (Eccles, 2007) and may need other sources of information rather than grades

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to construct their ability self-concepts (Gniewosz et al., 2011). However, one should keep in mind that these findings can be generalized only to the students who participated in the present study at both measurement times. Students who dropped out or chose the vocational track showed slightly lower levels of math achievement and self-concept of ability, which might have influenced their educational decisions and/or reflect their interest in other than academic studies. More future research would be needed to examine the accuracy and bias in vocational students' ability self-concepts.

4.1. The development of self-concept of math ability across the transition to high school

The first aim of the present study was to investigate what kind of groups of students could be identified according to the accuracy of and bias in their math ability self-concepts. The results of the person-oriented ISOA analyses showed that four (two accurate and two biased) math ability self-concept groups could be identified. Most of the students (40%) belonged to a high-accurate self-concept of math ability group which was characterized by a high level of self-concept of math ability and a high level of math performance. The second largest (21%) low-accurate self-concept of math ability group was characterized by a low level of math ability self-concept and a low level of math performance. The third largest (20%) pessimistic self-concept of math ability group was characterized by a low level of math ability self-concept and a moderate level of math performance. The smallest (18%) optimistic self-concept of math ability group was characterized by a moderate level of self-concept of math ability and a low level of math performance. These results suggested that, in general, young males and females showed relatively "realistic" self-perceptions concerning their math abilities. At both time points, more than 50% of the students belonged to an accurate self-concept of math ability group (regardless of whether their math abilities were high or low). Most students with an accurate perception of their math abilities reported a positive rather than a negative evaluation at the two time points.

Nevertheless, some participants did not become more realistic and accurate as they transitioned into high school (see also Bouffard et al., 2011; Rytkönen et al., 2007; Wigfield & Eccles, 2000). These results may be due to the fact that, during the transition from compulsory secondary school into high school, some students (particularly those in non science and technology high schools) choose paths with low math requirements. Thus, some students who at Time 1 belonged to the high accurate group transitioned to the low accurate and pessimistic self-concept of math ability groups and reported lower math performance at Time 2 than at Time 1. In both groups, students' self-concept of math ability became also lower than in the previous high-accurate group. These results may also reflect the competitiveness of the high school, increased skill comparison among peers, and high school ability groupings and tracking system in Spain, all of which have an impact on students' appraisal of their math abilities (Eccles et al., 1993; Jacobs et al., 2002). This could also explain why, over time, most changes in the self-concept of math ability groups occurred in the high-accurate group whereas smaller amount of changes were observed in the three remaining groups (e.g., the number of students transitioning out from the high-accurate group was higher than the number of students transitioning out from the low-accurate, positive, and pessimistic groups). As a result, the high-accurate group became also smaller across the transition to high school. These findings are in line with other studies indicating decreases in students' math ability self-concepts and performance as they move into higher education (Fredricks & Eccles, 2002; Jacobs et al., 2002; Sáinz & Eccles, 2012).

Equally, and in support of the person-environment fit theory, changes connected to structural and non-structural factors before (i.e., the quality of teacher-student interaction, teachers' feedback about students' abilities, evaluation procedures) and after the transition to high school (i.e., new ways of interacting in the class with peers and teachers, changes of peers and teachers, choosing one of the available tracks) may also have contributed to the changes in the accuracy of students' math ability self-concepts (Eccles & Roeser, 2009; Yoon et al., 1996). It is also probable that, for some students (especially those in the high accurate group), the fact that high school is a less supportive environment (students have to compete in order to get the highest grades in order to have access to the desired university studies) than compulsory secondary education could have affected the way they reported their self-concept of ability (see also Eccles & Roeser, 2009). In this sense, the grouping of students according to their general performance (not only in math) might also have impacted their perceptions of their math abilities across the two time points.

4.2. Factors shaping students' perception of ability and suggestions for intervention

In line with some previous studies (Bouffard et al., 2011; Gonida & Leondari, 2011), more students belonged to the accurate than biased self-concept of ability groups. Moreover, students with high-accurate and optimistic views of their math abilities at the two time points reported higher math ability self-concepts than students in the low-accurate and pessimistic groups. These findings suggest that both high accurate and inflated views of ability can be beneficial for some students (Bouffard et al., 2011; Gonida & Leondari, 2011). This is probably true especially for students in the science and technology track and who will need high mathematical skills across high school years. However, a low or negatively biased view of one's math abilities may be adaptive for students with a poor math performance, providing excuses for their low performance and risk avoidance by not attempting challenging tasks (Owens, 1993). This is probably more true for students in the humanities and artistic tracks who are not necessarily enrolled in any math courses because mathematical skills are not always valued among them as much as other skills, such as linguistic or artistic skills, typically more prominent in their fields.

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The results further illustrated a gender gap in students' attitudes relating to mathematics, similar to some previous findings (Davis-Kean, 2005; Dupeyrat et al., 2011; Gonida & Leondari, 2011; Sheldrake et al., 2014). Male students were more likely than their female counterparts to belong to the high-accurate self-concept of math ability group than to the pessimistic self-concept of ability group. Thus, male students who are good at math seem to be more aware of their math ability than their female counterparts. Additionally, female students were more likely to belong to the pessimistic self-concept of math ability group, since they rated their math abilities below their real performance (Dupeyrat et al., 2011; Gonida & Leondari, 2011; Yoon et al., 1996; Watt, 2010).

Interestingly, these results were especially true after the transition into high school, suggesting that the gender gap in adolescents' perceptions was more pronounced after the transition. It is possible that the transition to a new school environment challenges students' general self-esteem. However, whereas females show a pessimistic self-concept, young males boost their math self-concepts (Jacobs et al., 2002). Likewise, in comparison to female students, male students were more likely to belong to the optimistic group at both measurement times, as they rated their math abilities higher than their actual performance in math (Watt, 2010; Gonida & Leondari, 2011). These findings may mirror male students' tendency to exaggerate their own abilities in masculine domains (Guimond & Roussel, 2001), which may help young males to better adapt to the new school environment and demands after the transition. In some cases, this tendency reflects their study choices (e.g., males who take math courses in high school may have a more optimistic perception of their actual math skills).

Some researchers have discouraged the design of interventions aimed at promoting overconfident self-concept or at lowering students' efficacy beliefs (for instance, Schunk & Pajares, 2002). Following this idea, it would be important for students to learn about their limitations and to deploy the right strategies to perform different tasks (Schunk & Pajares, 2002). However, individual students might need individually targeted support. For example, students with optimistic self-Q10 perceptions but low performance would also benefit from the enhancement of their competences. Consequently, recent research (Baumeister et al., 2003; Gonida & Leondari, 2011; Narciss et al., 2011) has suggested that interventions should aim to prevent students from having negative unrealistic assessments of their abilities in different domains. For instance, teachers' feedback about students' academic progress and achievement can be crucial at modifying students' negative self-evaluation in a positive direction (Narciss et al., 2011; Upadyaya & Eccles, 2014). More specifically, interventions should address the tendency of young females to undervalue their math abilities.

The results showed further that parents' educational level played an important role in predicting the accuracy or bias in students' self-concept of math ability (Davis-Kean, 2005). In this regard, parents' role is more pronounced in determining students' self-concept during 10th grade than in high school. This decrease in parental influence may be related to the fact that high school students have already chosen an academic track and peer influence becomes more crucial in the formation of their self-concept of ability (Gniewosz et al., 2011). Contrary to expectations, students whose parents had a high educational level were more likely to belong to the low accurate or pessimistic self-concept of math ability group than to the high accurate group. It is possible that parents with a high educational level have also high expectations concerning their children's academic achievement (Davis-Kean, 2005), which may place extra pressure on some students, making them underestimate their math abilities. Moreover, a process of social comparison between students' own abilities and their parents' abilities may lead students to underestimate their own abilities (Felson, 1990). However, future research should empirically test this hypothesis in the Spanish context. Furthermore, the present research suggests that especially fathers' educational level influences students' appraisal of their own math abilities. Fathers with university degrees may often hold high math demanding occupations, leading their children to compare their math skills to their fathers'. More future studies would be needed to examine these associations further. In addition, it would be important to involve parents in the future research and interventions aiming at preventing students from having negatively biased ability self-concepts and at promoting positive and accurate ability self-concepts and enhancing performance (Bouffard et al., 2011).

4.3. Limitations and future directions

There are several limitations that should be taken into consideration when generalizing the findings of the present study. First, the time framework of the present study was relatively short. Future studies should examine the stability and changes in the accuracy of students' ability self-concepts over a longer time period (Bouffard et al., 2011). This would provide researchers and educators with more detailed knowledge concerning the development of accuracy in students' ability self-concepts before and after school transitions. Similarly, future longitudinal research should involve different educational transition points (such as the transition from primary into compulsory secondary education) because during that time students are challenged by new contextual and educational changes (Eccles et al., 1993), leading them to inaccurately evaluate their abilities in different domains. Second, the present study was conducted in Spain; thus, the results can be generalized only to the Spanish cultural context. More cross-cultural research should be carried out to analyze whether the results observed in this study differ across cultures and different educational systems, and to contrast whether or not our societies and educational institutions promote secondary students to achieve realistic ability self-concepts in various academic domains.

Third, the attrition rate is a limitation of the present study and could explain (among other aspects) the relative stability of self-concept of math ability group memberships during the students' transition from compulsory secondary school to high school.

Fourth, the fact that more males than females dropped out the study could have an effect on some of the reported findings. Thus, the higher attrition rates among males could explain why more males were more likely to belong to the high accuracy self-concept of ability group than to the pessimistic self-concept of ability group.

Fifth, the order of presentation of the measurements (questions concerning students' grades were presented before ability self-concepts) may have influenced the way adolescents perceived their self-concept of ability and reduced inaccuracy in their ability self-concepts.

Finally, students' math performance was measured with self-reports, which might have influenced the internal validity of the study and the way participants viewed their own self-concept of math ability. This is an important limitation that future research should overcome, as most of the participant schools were reluctant for confidential reasons to provide this information.

Uncited reference

Bergman (1998).

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