Fully refereed paper presented at the AARE Annual Conference,

Melbourne, November 29 - December 2, 1999

An International Comparison of Students' Maths- and English-Related Perceptions through High School using Hierarchical Linear Modelling*®

Helen M. G. Watt & Jacquelynne S. Eccles

University of Sydney

University of Michigan

This large-scale international comparative study addresses changes in students' maths- and English-related self-concept of ability, subjective task-value and interest. Australian (N=1323) and American (N=651) students are from two separate studies with similar designs and samples, in three cohorts spanning grades 7 to 11 in Australia and 7 to 12 in the United States. Hierarchical linear models are derived modelling gender effects over time and also cohort effects where required. Gender effects appear in the expected direction for all Australian variables excepting subjective task-value of maths, where no gender effects are evident. In America gender effects appear only for self-concept of ability in maths, but are evident for all English perceptions. Overall, declines in student perceptions are infrequent, occurring more for maths than for English, with most perceptions becoming increasingly positive through high school. Growth trajectories are interpreted in light of contextual school and wider sociocultural factors.

Students' academic perceptions have been found to impact both on their general achievement, as well as influencing motivation for task selection (e.g. Bandura, 1996). In the specific area of maths, it has been theorised (Eccles & Jacobs, 1986) and demonstrated that students' ability perceptions affect plans for participation in higher-level senior maths independently of their performance, and hence students' plans for participation in maths-related careers (Watt & Bornholt, in press). Clearly students' academic perceptions are of great importance from a number of theoretical perspectives, including those of achievement motivation and self-efficacy, due to their impact on both achievement and planned participation in academic activities.

The changes and development in students' academic perceptions have not been a focus for much research. Most studies that have investigated changes in student perceptions have been confined to exploring the impact of school transitions on student perceptions (e.g. Anderman & Midgley, 1997; Seidman, Allen, Aber, Mitchell, & Feinman, 1994). In order to understand the nature and development of students' academic perceptions, however, research is needed that charts the growth patterns of these attitudes over an extended time period.

The inclusion of two academic domains in the present study, maths and English, allows identification of domain-specific versus general developmental effects. Similarly, use of

Australian as well as American data provides some opportunity of distinguishing culturally specific versus more general patterns of development.

Gendered Attitudes Related to Maths and English

Despite demonstrated similar mathematical performance of girls and boys (e.g. meta-analyses by Hyde, Fennema, & Lamon, 1990; and Friedman, 1989), differences exist in girls' and boys' attitudes related to maths, with boys having more positive perceptions (e.g. Eccles, Adler, & Meece, 1984; Marsh, 1989; Watt & Bornholt, 1994; Wigfield, Eccles, MacIver, Reuman, & Midgley, 1991). For English, performance differences have been found to favour girls, with boys reporting similar ability perceptions to girls (Skaalvik & Rankin, 1994; Halpern, 1986). This is supportive of the proposition that boys' perceptions are characterized by an 'illusory glow' (Bornholt, 1991), in which they perceive their performance as better than it actually is. Other studies, in contrast, report girls to have more favourable attitudes related to English (e.g. Bornholt, Goodnow, & Cooney, 1994; Wigfield *et al.*, 1991), which would support the notion that sex-typed messages foster higher maths perceptions for boys, and higher English perceptions for girls.

Over time, there is some research to suggest *gender intensification* occurs (Hill & Lynch, 1983), wherein gender-role activities become more important to young adolescents as they try to conform more to behavioural gender-role stereotypes (Eccles, 1987; Hill & Lynch, 1983). Thus we might expect girls to become increasingly negative about male-stereotyped domains, such as mathematics, while boys become more positive. The converse would be the case for English. Not all research has found this to be the case, however (e.g. Wigfield *et al.,* 1991; Watt, 1997). For mathematics, discrepant findings have been explained by suggesting mathematics is no longer perceived as a male domain (Wigfield *et al.*, 1991).

Changes in Students' Attitudes

As stated previously, much of the research investigating changes in student perceptions has confined itself to the transition from elementary to junior high school. These studies have addressed a range of student-level variables including self-esteem (e.g. Seidman, Allen, Aber, Mitchell, & Feinman, 1994; Simmons, Blyth, Van Cleave, & Bush, 1979), self-concept of ability (e.g. Wigfield *et al.*, 1991), perceptions of competence (e.g. Harter, Whitesell, & Kowalski, 1992), liking for school subjects (e.g. Wigfield *et al.*, 1991), and school grades (e.g. Anderman & Midgley, 1997; Kavrell & Petersen, 1984). The majority of these studies have found the overall impact of transition to secondary school to be negative in nature, leading to decreased self-esteem (Seidman *et al.*, 1994), lower self-concept of ability in specific school subject domains (Wigfield *et al.*, 1991), declines in perceptions of competence (Anderman & Midgley, 1997), decreased liking in specific school subject domains (Wigfield *et al.*, 1991), and lowered school grades (Anderman & Midgley, 1997).

Some theorists have suggested that such negative changes are inevitable due to physiological and psychological pubertal changes occurring at this time (e.g. Blyth, Simmons, & Carlton-Ford, 1983; Hill & Lynch, 1983; Rosenberg, 1986; Simmons *et al.*, 1979). This view has been challenged by research showing that declines in students' expectancies and values in mathematics relate to differences in the classroom environment pre- and post-transition (Eccles & Midgley, 1989; 1990). These analyses have been interpreted in the form of a model of *person-environment fit* (Eccles & Midgley, 1989; 1990), in which it is suggested that lack of fit between the junior high school environment and the needs of young adolescents impacts negatively on student attitudes. The present study is able to investigate whether such negative changes form part of a more general decline in student perceptions, of which only a subset has been investigated, or whether such negative changes are localised at times of change in school context.

It is important to note there have been suggestions of 'recovery' following the initial drop in perceptions post-transition (Wigfield *et al.*, 1991). The study by Wigfield and colleagues utilised three time points being the year before and the two years subsequent to the junior high transition, and found that by the third time point, students' perceptions had increased from the second, but had still not regained their initial levels. This lends support to the interpretation of the decline at transition as being due to an initial mismatch between the needs of the individual and the junior high school environment. This finding is, however, at odds with the gender intensification hypothesis, which would suggest that for girls, maths-related perceptions would continue to decline over time, while for boys, English-related perceptions would continue to decline.

Domain Specificity

The importance of assessing transitional impact on separate school subject domains has been recognised since not all domain-related perceptions are affected in the same way (e.g. Wigfield *et al.*, 1991), and domain-specific findings differ from general student perceptions. For example, Harter (1982) found general perceptions of competence to be stable from grades 3 to 9. Clearly these general measures mask domain-specific changes over this time period.

The present study examines developmental changes in students' perceptions related to both maths and English, since these are domains in which negative changes have been found to occur at the transition to junior high (e.g. Wigfield *et al.*, 1991). Mathematics is also a domain that is regarded as being of substantive importance, since students' mathematics-related attitudes impact strongly on school mathematics course selections (e.g. Eccles & Jacobs, 1986; Watt & Bornholt, 1994) and mathematical career relatedness (Watt, 1995; Watt & Bornholt, in press), participation in both of which is considered socially important. It is an intention of the present study to identify patterns which are domain specific, in that they hold for English but not mathematics and vice versa.

Academic Perceptions

Self-concept of ability, task-valuation and interest are key variables in the present study. Most studies of domain-specific student beliefs have examined perceptions of ability for different activities (e.g. Cauce, 1987; Harter, 1982), with one study including subject liking as a value-indicator in addition to perceived ability (Wigfield *et al.*, 1991). A major theoretical model in the area of students' academic plans is the Expectancy-Value Theory of Achievement Motivation proposed by Eccles(Parsons) and colleagues, wherein mathematics participation is consequent upon expectation of success mediated by perception of ability, and subjective task value mediated by goals (Parsons, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983). The present study utilises three of these key elements and charts their ontogeny from junior through to senior high school.

Cultural Specificity

The value of an Australian-American comparison lies in the opportunity to distinguish culturally specific developmental patterns for students' attitudes. Sociocultural factors contributing to differences in the samples can be identified for points at which differences occur. For example, an important time point for the international comparison is at grade 9, when American students make the transition to senior high school, while Australian students remain at secondary school from grades 7 through 12. Differences in patterns of changes between the samples at this time point would strengthen the interpretation of declines in student perceptions as resulting from school transitions.

Hypotheses

It is hypothesised that gender effects favour boys in maths and girls in English where they occur. Also that *gender intensification* may result in boys' maths self-perceptions becoming increasingly positive (and girls' increasingly negative) over time, and conversely for English. A decline in academic self-perceptions is expected on commencement of junior high school, with a possible 'recovery' post-transition, which, if occurring uniformly, is at odds with the gender intensification hypothesis. Task-related perceptions of utility and interest may not be negatively affected, since these may be largely independent of *self*-perceptions and hence more stable and robust. Domain and culture specific patterns of change are of particular interest.

METHOD

Design

The present study charts the gendered developmental trajectories of Australian and American adolescents in their maths- and English-related perceptions at school using hierarchical linear modelling. Findings from each country are then compared.

Participants

Participants span grades 7 to 12 in a cohort-sequential design, from each of an Australian and American longitudinal project. The Australian sample comprises 1323 students in 3 cohorts spanning grades 7 to 11, while the American sample comprises 651 students also in 3 cohorts spanning grades 7 to 12. There is substantial overlap between the two designs as shown in Table 1, which depicts the sample size for each cohort, the grade of participants at each year of data collection and the gender composition for each cohort. Both projects sample the same grades for the youngest and middle cohorts (beginning 1996 in Australia and 1994 in America), but data for the Australian students in cohort 3 commence with grade 9, while their American counterparts commence with grade 10. The combined sample provides information on students from grades 7 to 12, with replication of grade effects across countries and cohorts.

Australian participants were drawn from three upper-middle class coeducational secondary schools in metropolitan Sydney, matched for socioeconomic status (ABS Index for Education and Occupation, 1995). American participants were initially from 10 elementary schools in Michigan and are also from middle-class backgrounds.

Procedure and Materials

Administration took place in the regular classroom each year in order to maximise ecological validity. Researchers were present at each administration to clarify and answer questions where necessary. Questionnaires assessed student perceptions of perceived ability, value and interest in relation to maths and English. These data were gathered at each time point in the Australian sample, but data for English were not collected at the middle time point in the American sample. The Australian items were based on those used by Eccles and colleagues in the ongoing American project, but with some modifications. It was therefore necessary to demonstrate construct comparability at the item level before proceeding with further analyses. Confirmatory factor analyses using LISREL established satisfactory fit of the data to the imposed models constraining factor loadings to be invariant across countries at each time point, and allowing for freely estimated variance in some items (maths ability items at all time points, the first maths value item at T1 and T2, the second at T2; the first English value item at T1, and the first English ability item at T3), as shown in Table 2. Consequently it was appropriate to compare the perceived ability, value and interest constructs across the two countries. Construct items are presented in Table 3, and Cronbach a coefficients, establishing each construct as internally consistent, are shown in Table 4.

Analyses

Hierarchical Linear Modelling (HLM, Bryk & Raudenbush, 1992) is used to derive growth models for self-concept of ability, subjective task-value and interest in the domains of maths and English, with separate analyses conducted for the two countries. Because of the multiple cohort nature of the design, it is necessary to first establish whether any grade X cohort interaction effects exist. This is necessary in any accelerated longitudinal design to avoid the inferential danger of interpreting differential change within cohorts as developmental effects (Raudenbush & Chan, 1993). In the event of there being no cohort effects, a common model for all cohorts can be formulated within each country. Full maximum-likelihood estimation is used so that determination of the existence of cohort effects can be based on the likelihood ratio test of the cohort-based and common models.

Formulation of a Cohort-Based Hierarchical Linear Model. At level-1 each student's observed development is conceived as a polynomial function of grade and random error. The coefficients of this polynomial are allowed to differ from person to person, so that each student is assumed to have his/her own growth trajectory. The three occasions at which data were collected dictate a function of maximum order 2, a quadratic, in this case. At level-2, these individual parameters are assumed to vary as a function of cohort, such that separate trajectories are estimated for each cohort.

Australian Cohort-Based Model. Student grade was centred about the mean grade within each of the three cohorts, such that the level-1 intercept refers to the value at the mean grade for each cohort over the three occasions at which data were collected (grades 8, 9 and 10, respectively for cohorts 1 to 3). Dummy variables were introduced at level-2 with the youngest cohort being the reference group.

level-1 equation: $Y_{ij} = p_0j + p_{1j}(grade_c)_{ij}\ p_{2j}(grade_c)_{ij}^2 + e_{ij}$ (1)

- Y_{ij} is the ability self-concept, task-value or interest score for subject *i* at occasion *j*, *j*=1,2,3 and *i*=1, ..., n.

- $(grade_c)_{ij}$ represents the grade of subject *i* centred about the mean grade across occasions *j* for each cohort. Mean grades are 8 for cohort 1, 9 for cohort 2 and 10 for cohort 3, corresponding to -1,0,1 centred grades. This parameter represents the linear component of the growth curve.

- $(grade_c)_{ij}^2$ represents the quadratic component of the individual growth curve, being simply the square of the $(grade_c)_{ij}$ parameter. It was necessary to include this term so that in comparison of this model and the quadratic common model the former would be nested in the latter.

- p_0j is the intercept, representing the score for subject *i* at the mean grade for each cohort.
- p_{1j} is the expected rate of increase per year in perception ratings for subject *i* at the mean grade. This corresponds to the slope of the tangent at the mean grade, which can be interpreted as the mean velocity for each subject *i*.
- p_{2j} is the quadratic parameter, representing the rate of acceleration per year for subject *i.*

- e_{ij} represents the random within-subject error of prediction for subject *i* at occasion *j*. These errors are assumed mutually independent and normally distributed with mean of zero and variance of s^2 (i.e. $e_{ij} \sim N(0, s^2)$).

level-2 equations: $p_0j = b_{00} + b_{01}D_1 + b_{02}D_2 + u_{0j}$

$p_{1j} = b_{10} + b_{11}D_1 + b_{12}D_2 + u_{1j}$ (2)

$p_{2j} = b_{20} + b_{21}D_1 + b_{22}D_2$

At level-2, individual change parameters depend on cohort membership, where

- D_1=1 if person *i* belongs to cohort 2, =0 if not.

D_2=1 if person *i* belongs to cohort 3, =0 if not.

- b_{00} , $b_{00} + b_{01}$, $b_{00} + b_{02}$ are the expected values at mean grades 8, 9 and 10, respectively for cohorts 1, 2 and 3.

- b_{10} , $b_{10} + b_{11}$, $b_{10} + b_{12}$ represent the mean velocity for each cohort (rates of change at median grades, respectively for cohorts 1 to 3).

- b_{20} , $b_{20} + b_{21}$, $b_{20} + b_{22}$ represent acceleration at the mean grade for each cohort.

- u_{0j} is the random effect of person *i* on score at the mean grade after accounting for cohort differences.

- u_{1j} is the random effect of person *i* on the rate of increase in score after accounting for cohort differences.

- Note the omission of the random effect u_{2j} of person *i* on the rate of acceleration in score after accounting for cohort differences, due to too few degrees of freedom. The random effects (u_{0j}, u_{1j}) are assumed to have bivariate normal distribution with zero means and constant covariance.

American Cohort-Based Model. For the American data, cohorts 1 and 2 were centred at the mean grade as with the Australian sample. For cohort 3 however, it was necessary to centre at the initial grade (grade 10) to facilitate comparison of parameters with the Australian cohort 3, who are a school grade younger. This changes the interpretation of the intercept and slope parameters, which in the American cohort 3 refer to the expected value at initial grade and expected rate of increase at the initial grade respectively.

Another difference between the Australian and American models was due to there being no English data for American students at the second time point. Consequently it was not possible to include a quadratic term in the American English models, and the random effect had to be removed from the slope equation due to too few degrees of freedom.

Formulation of a Common Model for all Cohorts. A competing common model assumes that members of all three cohorts follow a single underlying age-trajectory within each country. One common growth model is estimated for all cohorts within each country. It is then possible to determine the extent to which cohort effects in the cohort-based model depart from those predicted by the common model in each case.

level-1 model: $Y_{ij} = h_0j + h_1j(grade_{GM})_{ij} + + h_{2j}(grade_{GM})_{ij}^2 + r_{ij}$ (3)

- $(grade_{GM})$ is the grand median centred grade of the student, being grade 9 in both countries.
- $(grade_{GM})^2$ is simply the square of the grand median centred grade, representing the quadratic component.

- $r_{ij} \sim N(0,s^2)$.

level-2 model: $h_0j = z_{00} + n_{0j}$ (4)

$h_1j = z_{10} + n_1j$

$h_{2j} = z_{20}$

- z_{00} represents the mean score at the median grade.
- z_{10} represents the mean rate of increase in score at median grade.
- z_{20} represents the mean rate of acceleration at median grade.
- n_0j represents the random effect of person *i* on score at median grade.

- n_1j represents the random effect of person *i* on rate of change in score at median grade.
- Note the omission of the random effect n_{2j} of person *i* on acceleration in score at median grade due to too few degrees of freedom.

Comparing the Cohort-Based and Common Models

The cohort-based and common models are compared using the likelihood ratio test, based on the fact that the common model is nested within the cohort-based model. The likelihood (*L*) is expressed as -2 times the log-likelihood, termed the 'deviance' (*D*). Let the likelihood of the cohort-based model be L_1 and of the common model be L_0, then $-2 \log (L_0/L_1) = D_0 - D_1$, where change in deviance is asymptotically equivalent to a chi-square distribution with degrees of freedom equal to the number of independent constraints imposed on the model.

Modelling Developmental Trajectories Incorporating Cohort Effects

In the event of comparison of the within-cohort and common models revealing a significant change in model deviance, a model incorporating cohort effects can be estimated. A significant change in model deviance would indicate that the model attributing differences in individual parameters to cohort membership fits the data better than the model assuming members of all cohorts follow a common age trajectory. In these cases, the contribution of cohort membership to individual growth cannot be ignored, and a model which estimates these effects along with development is required. Separate models are computed for Australia and America, so as not to constrain variances to be equal across two different cultures, resulting in 12 possible models altogether (2 countries by 2 academic domains by 3 attitudinal outcome variables).

level-1 equation: $Y_{ij} = p_{0j} + p_{ij}(grade_{GM})_{ij} + p_{ij}(grade_{GM})_{ij}^2 + e_{ij}$ (5)

level-2 equations: $p_{0j} = b_{00} + b_{01}(gender) + b_{02}(cohort) + u_{0j}$

$p_{1j} = b_{10} + b_{11}(gender) + b_{12}(cohort) + u_{1j}$ (6)

$p_{2j} = b_{20} + b_{21}(\text{gender}) + b_{22}(\text{cohort})$

- where grade_{GM} is the grand median centred grade as before.

- Cohort is a dummy variable centred around the grand median centred grade values for each cohort at the median occasion (-1,0,1 for Australia, -1,0,2 for America, respectively for cohorts 1 to 3).

- Gender is coded 0 for boys and 1 for girls.
- Note the omission of the u_{2j} term as before.

RESULTS

Results are presented in two main sections. The first compares the cohort-based model with the common model, to determine whether incorporating cohort effects improves the model fit, and consequently if it is necessary to model cohort membership for the final model. The second section describes the final models derived for each student attitude, which incorporate gender effects, and compares and contrasts findings from the Australian and the American samples.

Comparison of Cohort-Based and Common Hierarchical Linear Models

Descriptive statistics for each variable at each time point within Australian and American cohorts are shown in Table 5. Comparison of the cohort-based and the common model reveal a significant change of deviance in the Australian sample for subjective task-value and interest in both maths and English. For these four variables then, it was necessary to model cohort effects, as it was not possible to estimate a common growth trajectory across cohorts. For self-concept of maths and English ability in Australia, and for all variables in America, it was possible to model common growth trajectories without explicitly modelling cohort membership.

Final Models

For maths and English self-concept of ability in both samples, as well as subjective task-value and interest related to maths and English in the American sample, a common growth trajectory was estimated, with gender added as an explanatory variable at level-2. For Australian subjective task-value and interest in maths and English, cohort was an additional predictor at level-2. As grade was centred about the grand median grade (grade 9), intercept parameters refer to estimates at grade 9, linear slope refers to rate of change at grade 9, and quadratic slope refers to concavity at grade 9.

Self-Concept of Ability. For self-concept of maths ability in Australia, there were gender effects on the intercept, indicating that at grade 9 (since grade was centred about this) boys have higher self-concept of maths ability than girls. There was a marginal effect of gender on the quadratic term ($p=.058$), indicating that boys exhibit a convex, and girls a concave pattern of change (see Figure 1). In America, for maths self-concept of ability, gender effects were evident for all parameters (only marginally so for the quadratic term, with $p=.059$). This is due to boys having higher maths self-concept than girls at grade 9, and girls experiencing a decline in self-concept that is initially steep then flattens out, while boys exhibit a convex pattern, with an initial increase followed by a decrease in self-concept (see Figure 1).

English self-concept of ability in Australia had a significant gender effect on the quadratic parameter. Inspection of Figure 4 reveals this is due to a concave curvature for girls and a convex one for boys, indicating that girls have a dip in their English self-concept at grade 9, while boys have a peak. Girls have higher self-concept than boys both at the beginning of secondary school (grade 7) and in senior years (grades 10 and 11), but in grades 8 and 9 their self-concept declines. Boys conversely experience an increase in English self-concept from grades 7 to 9, then a decrease through grades 10 and 11. American students' English self-concept increases over grades 7 to 12, as shown by a significant linear slope. Girls and boys follow similar linear trajectories, but girls are higher in their English self-concept than boys, as represented by a significant gender effect on the intercept (see Figure 4).

Subjective Task-Value. Australian subjective task-value of maths had significant linear and quadratic terms, indicating a convex trend. Cohort membership was significant for linear slope, meaning that at grade 9 the rate of change in students' task-value perceptions is dependent on cohort membership. Inspection of Figure 2 shows a marginal decline for cohort 1, a steeper decline for cohort 2, and a decline somewhere in between the two for cohort 3, which appears to flatten out halfway along. There were no significant gender effects. American students followed a common trajectory for maths task-value. A significant linear term indicates a general decline in valuation of maths from grades 7 to 12, which plateaus out at around grade 10, as evidenced by a marginally significant quadratic term ($p=.053$) (see Figure 2).

In Australia there was a significant gender effect on the intercept term for English value, showing that girls value English more highly than boys at grade 9 (see Figure 5), and that perceptions are stable across grades for boys and girls. Students in the American sample increasingly value English with age, as shown by a significant linear term. Girls and boys follow similar slopes, but girls have higher subjective task-value than boys, as shown by a significant gender effect on the intercept (see Figure 5).

Interest. For maths interest of Australian students, linear and quadratic slope were significant, indicating a concave tendency (see Figure 3). Cohort effects were evident for intercept and quadratic terms, indicating maths interest at grade 9 is dependent on cohort membership, and also that curvature differs for each cohort. Inspection of the graph reveals a marginal decline for cohort 1, a steeper decline for cohort 2, and a concave pattern for cohort 3. This characterised boys' and girls' trajectories, except that boys had higher maths interest than girls, evidenced by a significant effect of gender on the intercept parameter. Neither the slope or quadratic parameter for interest in maths in the American sample reached statistical significance, implying that students' interest in maths remains stable over grades 7 to 12, independently of gender or cohort membership (see Figure 3).

Australian students experienced a general increase in English interest through secondary school, as evidenced by a significant linear slope. This increase was not constant however, plateauing out over time, as shown by a significant quadratic term. Girls were more interested in English than boys at grade 9, as represented by a significant effect of gender on the intercept parameter. Trajectories were strongly cohort dependent, with effects evident for the intercept, slope and quadratic parameters. Intercept effects were due to cohort 1 having the highest and cohort 3 the lowest interest estimates. Quadratic effects were due to differing curvatures among the three cohorts, as shown in Figure 6. For American students, there is a general increase in English interest evidenced by a significant linear slope, with girls having consistently higher interest than boys, evidenced by a significant effect of gender on the intercept term (see Figure 6). This linear increase with girls having more positive perceptions than boys is similar for English self-concept and task-value of American students.

DISCUSSION

Surprisingly, declines in student perceptions are not much in evidence, with most perceptions becoming more positive through secondary school. Where declines occur, they are more evident for maths than English. Linear declines in maths related perceptions occur for American students' task value, and American girls' self-concept of ability. For English, there are no linear declines in perceptions. Quadratic (convex) declines occur for Australian students' maths valuation, and Australian boys' self-concept of maths and English ability. Patterns of change are mainly quadratic in both samples for maths. For English, Australian patterns again are mainly quadratic in form, while all American patterns are linear. Gender effects appear in the expected direction where these occur.

There was scant evidence for the 'recovery' post-transition hypothesis, with the only groups exhibiting an initial decline followed by a subsequent recovery being Australian students for maths interest, Australian girls for self-concept of maths and English ability, and American girls for self-concept of English ability. This lends support to the notion suggested earlier, that self-perceptions are more susceptible to contextual change than task-perceptions, since self-concept of ability (a self-perception) was the most prone to a decline through the first year of secondary school.

Similarly, there was little support for the gender intensification hypothesis. The only maths variable where boys developed increasingly positive, and girls increasingly negative perceptions, was self-concept of maths ability for American students. The only English variable where girls developed increasingly positive, and boys increasingly negative perceptions, was self-concept of English ability among Australian students. The lack of consistency in either subject domain or country here makes these findings difficult to interpret. The simplest explanation would seem to discount the gender intensification hypothesis, and conclude that self-perceptions are more susceptible to change than task-perceptions.

There was no support for the hypothesis that American students would be negatively affected at grade 9, the American transition to senior high school. American maths related perceptions followed smooth quadratic curves through grades 7 to 12, with no marked peaks or troughs evident at grade 9. American English related perceptions were all positively linear, again with no peaks or troughs at grade 9. Although Australian patterns of development were different in all cases from these American patterns, the lack of any internal inconsistency in American growth trajectories at grade 9 makes the negative effect of grade 9 transition extremely unlikely. These findings challenge the interpretation of Eccles and Midgley, of the declines in student perceptions at the transition to junior high as due to a mismatch in person environment fit (e.g. Eccles & Midgley, 1989; 1990). Surely in this case we would also expect a disjunction for American students at grade 9 as they again shift school contexts? If the junior and senior high environments are very similar in America, then we would not expect a negative transitional impact, and the person-environment fit explanation would still be plausible for the transition to junior high, given that the junior high setting is markedly different from the elementary context. Alternatively, adolescents may have developed increased resilience by grade 9 (approximate ages 14-15), perhaps as a result of the junior high transition, or perhaps as a function of increased age and life experience.

Australian boys had more positive maths self-concept of ability and interest in maths than girls. This is hardly surprising given the wealth of literature about boys' versus girls' ability perceptions in maths (e.g. Eccles, Adler, & Meece, 1984; Marsh, 1989; Watt & Bornholt, in press), and the literature on how the methods of learning, instruction and assessment in maths favour boys (e.g. Leder, 1988; Leder & Forgasz, 1992). There were no gender effects for subjective task-value, indicating that male and female students see maths as equally important. This finding could be interpreted in terms of adolescents' task related perceptions being less vulnerable to social forces than their self-perceptions. Negative changes in attitude occurred for self-concept of maths ability, with students feeling less able with age. This may be due to a range of possible factors, including increasingly normative assessment feedback, competitive goal structures where only a few can succeed, ability streaming and social categorisation (see Watt & Bornholt, in press), and increasingly less 'caring' teachers with greater emphasis on academic achievement, as students progress through high school. The points of decline differed for boys and girls, with girls suffering a slight initial decline followed by a recovery, and boys having a slight initial increase followed by a decline. This may be due to the social expectations about boys' and girls' maths abilities and aptitude, with a supportive cultural wash for boys initially inflating their ability perceptions, and a negative climate for girls initially depressing their ratings. Perhaps these changes in ability perceptions on the basis of social context may be ameliorated by increased objective performance feedback and streaming indicators by mid secondary school, resulting in more 'accurate' (less discrepant) perceptions of maths ability for boys and girls. For interest in maths there was an initial decline, followed by a recovery of interest halfway through secondary school. This could be due to the nature of the junior years' maths curriculum, which is largely consolidation of material learned in primary school (Board of Secondary Education, 1988), and hence less interesting to students than the more unfamiliar material presented from grade 9 onwards. Conversely, for maths subjective task-value, there was an initial increase, followed by a decline. It is possible the initial increase may be due to the emphasis placed on maths achievement by the school culture in general, and the maths teacher in particular. The subsequent decline may be due to students rationalising this emphasis against other domains they consider important, and in the light of proposed study or work plans. It is particularly interesting to contrast this convex pattern with the concave pattern for maths interest. One might expect that high valuation would correspond to high interest, and low valuation to low interest. The finding is the exact opposite to this, however. It may be that valuation influences interest, and hence there is a time delay between the two corresponding.

For American students' attitudes related to maths, gender effects favouring boys were also evident for self-concept of ability. This was due to boys perceiving themselves as increasingly able in maths, while conversely girls perceived themselves as increasingly less able. This pattern is supportive of the gender intensification hypothesis, wherein boys come to increasingly value and define themselves in terms of male stereotyped activities, such as maths, while the converse is true for girls. Valuation of maths generally declined with age, but the extent of decline became less over time. This is in contrast to the concave pattern evident in Australia. Perhaps in America there is not the initial emphasis placed on maths achievement that occurs in Australia. Boys' and girls' interest in maths remained stable over time, at odds with the monotonic decline in task value. Perhaps the American curriculum is not repetitive in junior years as in Australia, and so material is consistently unfamiliar and hence interesting to students. It is unclear why there seems no relation between valuation of and interest in maths however. It may be that if there is not the emphasis placed on maths achievement that exists in Australian schools, students' interest levels are not tied to their task valuation in America. In Australia, teachers' stressing the value and importance of maths is frequently used as a motivational tactic, which if not occurring in American schools, could explain the lack of relationship between these two variables for American students.

For English related perceptions, Australian girls have more positive attitudes than boys. Although there is no difference between girls' and boys' English self-concept at grade 9, the changes in students' self-concept of ability are gender dependent. The concave pattern for girls and convex one for boys shows that girls' self-concept suffers an initial decline and then recovers. Conversely, boys' English self-concept of ability experiences an initial increase followed by a decline. The second half of this pattern, from grade 9, is consistent with the gender intensification hypothesis. The first half of the pattern cannot be explained by gender intensification (since the pattern is the reverse of what we would expect), nor by social gendered stereotypes. Neither does it seem likely that the English curriculum content is less interesting to girls than boys in the early years of secondary school. Subjective task-value of English remains stable across grade, with girls consistently valuing English more highly than boys. This may be due to identified social pressures emphasising maths and science achievement for boys, while girls are relatively freer to pursue their interests (e.g. Yee, Jacobs, & Goldsmith, 1986). Also, cultural norms tend to value and encourage being fluent and literate in expression for girls and women. Girls were more interested in English than boys, which may also stem from the reasons above. Interest in English increased over grade, with the extent of increase becoming less over time. This increase may be related to students' natural processes of maturation involving increased literary skills, exposure to expressive media, and experience in self-expression. Interestingly, increasing interest was not accompanied by increased valuation of English. It is plausible that the relative lack of emphasis on achievement in English as a motivational tactic, results in students not basing their interest on the perceived importance of English as a school subject. In America, as in Australia, for all of self-concept of ability, subjective task-value and interest related to English, girls had more positive perceptions than boys. There was a general linear increase over time for all American English variables, at odds with the quadratic forms evident for Australian students. In particular, increases in English interest corresponded to increased task valuation, which is at odds with earlier suggestions that correspondence between these perceptions occurs when the school culture overly emphasises achievement in a particular domain, and uses this as a motivational tactic. It is worth noting, however, that the availability of only two time points for each American cohort's English perceptions may well mask more complex changes occurring over this period.

In conclusion, developmental growth curves were dissimilar in form for maths and English related perceptions across Australian and American students. These differences may be explained in part by curricular differences in the two countries in the junior grades, and by differential emphasis placed on maths versus English achievement. The international study of which the present research forms a part, will identify culturally specific factors responsible for differences where these occur. The lack of internal inconsistency in American students' perceptions at grade 9 provides a tantalising challenge to the person-environment fit hypothesis (Eccles & Midgley, 1989; 1990), requiring further investigation to determine whether extent of similarity between American junior and senior high, versus elementary and junior high, is a plausible explanation.

Gender effects favouring girls were evident for all English related perceptions, but differences favouring boys were less apparent for maths related perceptions. These findings are supportive of the notion that maths is increasingly seen less as a masculine domain, while English is still strongly sex-typed (see Wigfield *et al*., 1991; Watt, in review). Perhaps the plethora of research on girls' perceptions and achievement in maths, has focused public awareness on the sex-typing of maths as a masculine domain and unattractive or hostile to girls, and eventually begun to change this climate through policy implementation.

Helen M. G. Watt Jacquelynne S. Eccles

Lecturer and PhD Candidate Professor and Chair

School of Educational Psychology, Department of Psychology

Literacies and Learning University of Michigan

Faculty of Education

University of Sydney

h.watt@edfac.usyd.edu.au

Table 1

Cohort Sample Size, Grade and Gender Composition

		T1 grade	T2 grade	T3 grade	% girls
Australia	Cohort 1 (n=428)	7	8	9	44.9
	Cohort 2 (n=436)	8	9	10	43.6
	Cohort 3 (n=459)	9	10	11	42.9
USA	Cohort 1 (n=185)	7	8	9	47.6
	Cohort 2 (n=190)	8	9	10	52.6
	Cohort 3 (n=276)	10	11	12	51.8

Table 2

Fit Indices Demonstrating Comparability of Australian-American Measures

		T1	T2	T3
maths	chi-square	c(18)=53.20	c(17)=70.43	c(19)=52.31
	RMSEA	0.05	0.06	0.05
	GFI	0.98	0.97	0.98
	PGFI	0.84	0.78	0.89

NFI 0.99 0.98 0.99

English chi-square c(11)=47.65 _ c(11)=43.08

RMSEA 0.06 _ 0.06

GFI 0.98 _ 0.98

PGFI 0.72 _ 0.72

NFI 0.98 _ 0.98

_

_

_

Table 3

Outcome Measures and Sample Items

	Australia	USA
perceived ability	How talented do you think you are at maths/English? (1=not at all 7=very talented)	How good at math/English are you? (1=not at all 7=very good)
	Compared with other students in yourclass, how talented do you consider yourself to be at maths/English? (1=not at all 7=very talented)	If you were to list all the students in your grade from the worst to the best in math/English, where would you putyourself? (1=one of the worst 7=the best)
value	How useful do you believe maths/English is? (1=not at all 7=very useful)	In general, how useful is what you learn in math/English? (1=not at all 7=very useful)
	How important is doing well in maths/English to you? (1=not at all 7=very important)	For me, being good at math/English is (1=not at all important 7=very important)
interest	How much do you like maths/English, compared with your other subjects at	Compared to most of your other activities, how much do you

	school? (1=much less 7=much more)	likemath/English? (1=not as much as other activities 7=a lot more than other activities)
	Do you enjoy studying for maths? (1=never 7=always)	In general, I find working on math assignments (1=very boring 7=very interesting)

Table 4

Scale Reliabilities

T1 alpha T2 alpha T3 alpha

Australia / USA Australia / USA Australia / USA

maths S-C ability .73 / .88 .68 / .91 .73 / .89

maths value .76 / .64 .81 / .66 .75 / .70

maths interest .82 / .78 .81 / .84 .81 / .80

English S-C ability .78 / .88 .73 / - .72 / .88

English value .75 / .68 .79 / - .79 / .73

Table 5

Descriptive Statistics for Maths and English Perceptions by Country, Cohort and Grade

Country Perception Cohort grade 7 grade 8 grade 9 grade 10 grade 11 grade 12

Subject M M M M M M

(SD) (SD) (SD) (SD) (SD) (SD)

Australia

Maths S-C Ability 1 4.68 4.60 4.64 - - -

(1.28) (1.14) (1.15) - - -

2 - 4.61 4.54 4.47 - -

- (1.30) (1.20) (1.22) - -

3 - - 4.61 4.49 4.52 -

- - (1.66) (1.11) (1.07) -

Task Value 1 5.67 5.52 5.54 - - -

(1.31) (1.39) (1.29) - - -

2 - 5.76 5.36 5.33 - -

- (1.28) (1.45) (1.42) - -

3 - - 5.80 5.35 5.31 -

- - (1.17) (1.35) (1.38) -

Interest 1 3.40 3.25 3.24 - - -

(1.63) (1.63) (1.60) - - -

2 - 3.46 3.22 3.20 - -

- (1.75) (1.69) (1.53) - -

3 - - 3.62 3.46 3.57 -

- - (1.68) (1.62) (1.57) -

English S-C Ability 1 4.75 4.82 4.69 - - -

(1.15) (1.17) (1.18) - - -

2 - 4.70 4.60 4.56 - -

- (1.22) (1.20) (1.12) - -

3 - - 4.73 4.63 4.43 -

- - (1.03) (1.06) (1.11) -

Task Value 1 5.73 5.74 5.73 - - -

(1.27) (1.23) (1.21) - - -

2 - 5.58 5.43 5.61 - -

- (1.30) (1.30) (1.32) - -

3 - - 5.78 5.68 5.55 -

- - (1.15) (1.07) (1.34) -

Interest 1 4.17 4.49 4.32 - - -

(1.60) (1.54) (1.58) - - -

2 - 3.88 4.11 4.38 - -

- (1.75) (1.49) (1.50) - -

3 - - 3.93 4.38 4.09 -

- - (1.55) (1.46) (1.53) -

America

Maths S-C Ability 1 4.88 4.75 4.71 - - -

(1.28) (1.26) (1.23) - - -

2 - 5.10 5.13 4.90 - -

- (1.15) (1.25) (1.34) - -

3 - - - 4.89 4.89 4.87

- - - (1.39) (1.57) (1.56)

Task Value 1 5.29 4.94 4.65 - - -

(1.20) (1.32) (1.43) - - -

2 - 5.21 5.05 4.77 - -

- (1.28) (1.30) (1.42) - -

3 - - - 4.71 4.68 4.63

- - - (1.37) (1.53) (1.51)

Interest 1 3.66 3.52 3.37 - - -

(1.57) (1.49) (1.48) - - -

2 - 3.73 3.59 3.41 - -

- (1.52) (1.50) (1.55) - -

3 - - - 3.43 3.37 3.43

- - - (1.55) (1.66) (1.70)

English S-C Ability 1 4.60 - 4.75 - - -

(1.27) - (1.32) - - -

2 - 4.67 - 4.94 - -

- (1.33) - (1.16) - -

3 - - - 5.04 - 5.03

- - - (1.27) - (1.24)

Task Value 1 4.77 - 4.99 - - -

(1.36) - (1.24) - - -

2 - 5.02 - 5.30 - -

- (1.30) - (1.24) - -

3 - - - 5.24 - 5.40

- - - (1.33) - (1.32)

Interest 1 3.39 - 3.87 - - -

(1.58) - (1.60) - - -

2 - 3.62 - 3.89 - -

- (1.62) - (1.61) - -

3 - - - 3.95 - 4.03

- - - (1.76) - (1.70)

- indicates that data are not available at that grade for the cohort

References

Anderman, E.M. & Midgley, C. (1997). Changes in achievement goal orientations, perceived academic competence, and grades across the transition to middle-level schools. Contemporary Educational Psychology, 22, 269-298.

Australian Bureau of Statistics (1995). Index for Education and Occupation. Socioeconomic Index for Areas. Sydney: ABS.

Bandura, A., Barbaranetti, C., Caprara, G.V., & Pastorelli, C. (1996). Multifaceted impact of self-efficacy beliefs on academic functioning. Child Development,67, 1206-1222.

Blyth, D.A., Simmons, R.G., & Carlton-Ford, S. (1983). The adjustment of early adolescents to school transitions. Journal of Early Adolescence, 3, 105-120.

Board of Secondary Education (1988). Mathematics Syllabus: Years 7 and 8. North Sydney, NSW: Board of Secondary Education.

Bornholt, L.J. (1991). High school students' perceptions of achievement in mathematics and English. Unpublished doctoral dissertation, Macquarie University, Australia.

Bornholt, L.J., Goodnow, J.J., & Cooney, G.H. (1994). Influences of gender stereotypes on adolescents' perceptions of their own achievement. American Educational Research Journal, 31, 675-692.

Bryk, A.S. & Raudenbush, S.W. (1992). Hierarchical Linear Models. Newbury Park, CA: Sage Publications.

Cauce, A. M. (1987). School and peer competence in early adolescence: A test of domain-specific self-perceived competence. Developmental Psychology, 23,287-291.

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. Psychology of Women Quarterly, 11, 135-172.

Eccles, J.S., Adler, T., & Meece, J.L. (1984). Sex differences in achievement: A test of alternate theories. Journal of Personality and Social Psychology, 46, 26-43.

Eccles, J.S. & Midgley, C. (1989). Stage/environment fit: Developmentally appropriate classrooms for early adolescents. In R. E. Ames & C. Ames (Eds.),Research on motivation in education (Vol. 3, pp. 139-186). New York: Academic Press.

Eccles, J.S. & Midgley, C. (1990). Changes in academic motivation and self-perceptions during early adolescence. In R. Montemayor, G.R. Adams, & T.P. Gullotta (Eds.), Advances in adolescent development: From childhood to adolescence (Vol. 2, pp. 134-155). Newbury Park, CA: Sage.

Eccles, J.S. & Jacobs, J.E. (1986). Social forces shape maths attitudes and performance. Signs: Journal of Women in Culture and Society, 11, 367-380.

Friedman, L. (1989). Mathematics and the gender gap: A meta-analysis of recent studies on sex differences in mathematical tasks. Review of Educational Research, 59, 185-213.

Halpern, D.F. (1986). Sex differences in cognitive abilities. Hillsdale, NJ: Erlbaum.

Harter, S. (1982). The perceived competence scale for children. Child Development, 53, 87-97.

Harter, S., Whitesell, N. R., & Kowalski, P. (1992). Individual differences in the effects of educational transitions on young adolescents' perceptions of competence and motivational orientation. American Educational Research Journal, 29, 777-807.

Hill, J. P. & Lynch, M. E. (1983). The intensification of gender-related role expectations during early adolescence. In J. Brooks-Gunn & A. C. Petersen (Eds.),Girls at puberty (pp. 201-228). New York: Plenum Press.

Hyde, J.S., Fennema, E., & Lamon, S.J. (1990). Gender differences in mathematics performance: A meta-analysis. Psychological Bulletin, 107, 139-155.

Kavrell, S.M. & Petersen, A.C. (1984). Patterns of achievement in early adolescence. In M.L. Maehr (Ed.), Advances in motivation and achievement (Vol. 4, pp. 1-35). Greenwich, CT: JAI Press.

Leder, G. (1988). Teacher-student interaction: The mathematics classroom. Unicorn, 14(2), 107-111.

Leder, G. & Forgasz, H. (1992). Gender: A critical variable in mathematics education. In D. Grouws (Ed.), Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics (pp. 597-622). New York: Macmillan.

Marsh, H.W. (1989). Age and sex effects in multiple dimensions of self-concept: Preadolescence to early adulthood. Journal of Educational Psychology, 81,417-430.

Parsons, J.E., Adler, T.F., Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L., & Midgley, C. (1983). Expectancies, values and academic behaviors. In J.T. Spence (Ed.), Perspectives on achievement and achievement motivation (pp. 75-146). San Francisco: Freeman.

Raudenbush, S.W. & Chan, W.-S. (1993). Application of a hierarchical linear model to the study of adolescent deviance in an overlapping cohort design. Journal of Consulting and Clinical Psychology, 61, 941-951.

Rosenberg, M. (1986). Self-concept from middle childhood through adolescence. In J. Suls & A. Greenwald (Eds.), Psychological perspectives on the self (Vol. 3, pp. 107-136). Hillsdale, NJ: Erlbaum.

Seidman, E., Allen, L., Aber, J.L., Mitchell, C., & Feinman, J. (1994). The impact of school transitions in early adolescence on the self-system and perceived social context of poor urban youth. Child Development, 65, 507-522.

Simmons, R.G., Blyth, D.A., Van Cleave, E.F., & Bush, D. (1979). Entry into early adolescence: The impact of school structure, puberty, and early dating on self-esteem. American Sociological Review, 44, 948-967.

Skaalvik, E.M. & Rankin, R.J. (1994). Gender differences in mathematics and verbal achievement, self-perception and motivation. British Journal of Educational Psychology, 64, 419-428.

Watt, H.M.G. (1997). Changes in student beliefs and perceived social context in relation to maths across the first year of high school. 1997 AARE Annual Conference Papers [Online]. Available http://www.swin.edu.au/aare/watth.293 [April 1998].

Watt, H.M.G. (1995). Parental influences on students' perceptions of talent in relation to high school mathematics: Effects on mathematics participation. 1995 AARE Annual Conference Papers [Online]. Available http://www.swin.edu.au/aare/watth.332 [April 1996].

Watt, H.M.G. (in review). Measuring attitudinal change in mathematics and English over the first year of junior high school: A multidimensional analysis.Journal of Experimental Education.

Watt, H.M.G. & Bornholt, L.J. (in press). Social categories and student perceptions in high school mathematics. Journal of Applied Social Psychology.

Watt, H.M.G. & Bornholt, L.J. (1994). Gendered perceptions of talent and planned participation in mathematics. Australian Journal of Career Development,3(3), 43-50.

Wigfield, A., Eccles, J.S., MacIver, D., Reuman, D.A., & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. Developmental Psychology, 27, 552-565.

Yee, D.K., Jacobs, J., & Goldsmith, R. (1986, April). Sex equity in the home: Parents' influence on their children's attitudes about mathematics. 1986

AERA Annual Meeting, San Francisco, C.A. [ERIC Document Reproduction Service No. ED 280717].

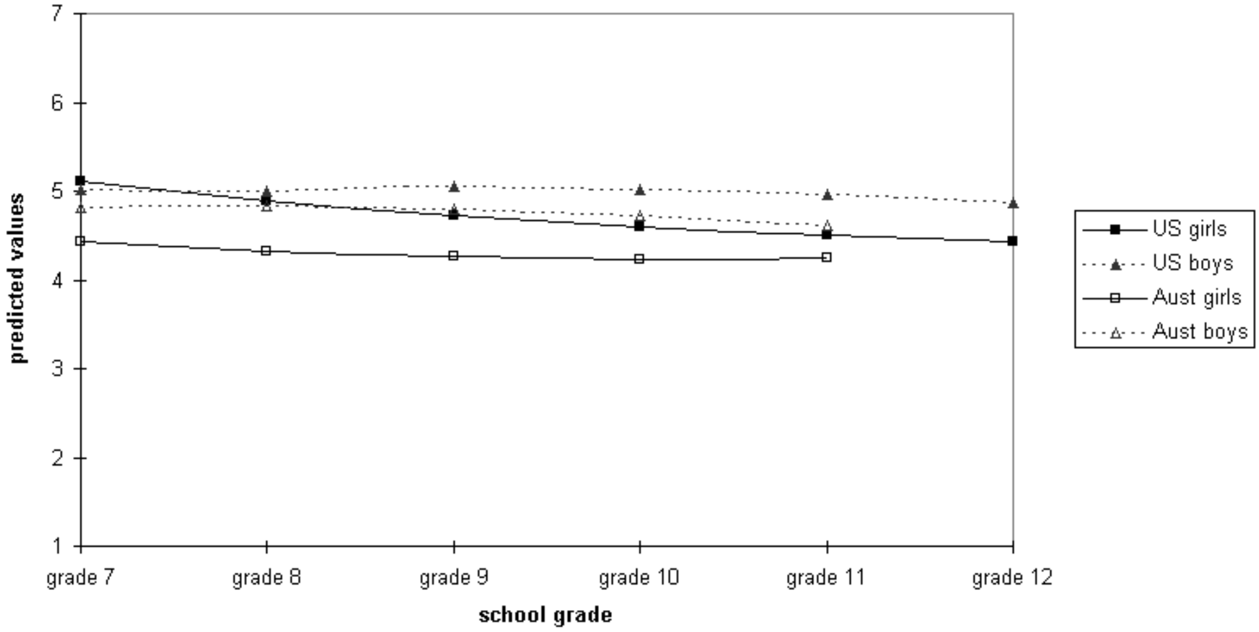

Figure 1. Maths self-concept of ability.

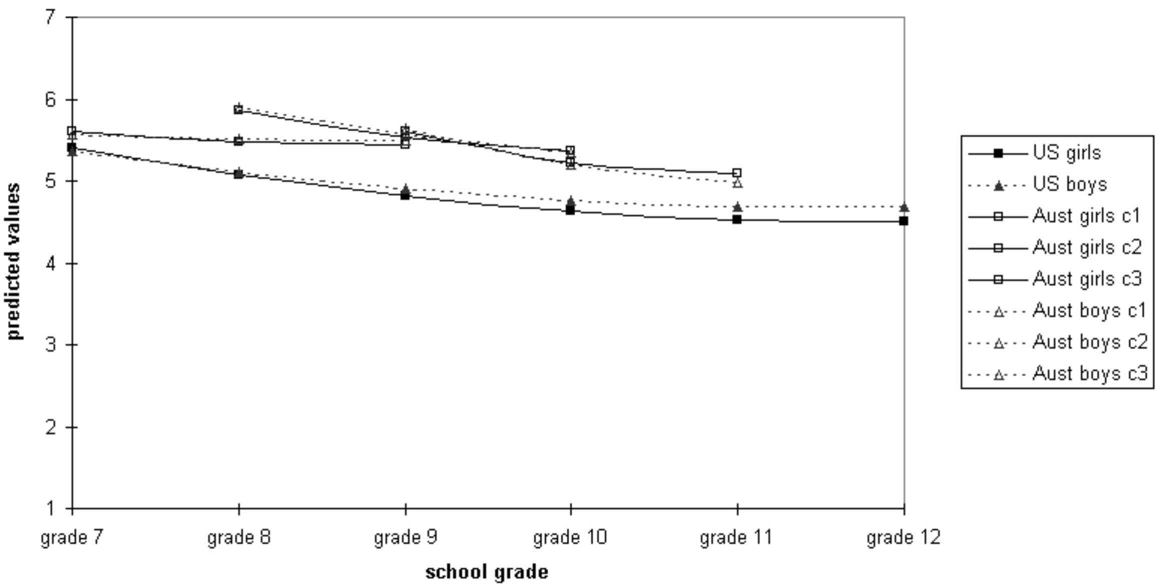

Figure 2. Maths valuation.

Note. Australian cohort 1 spans grades 7-9, cohort 2 spans grades 8-10, cohort 3 spans grades 9-11.

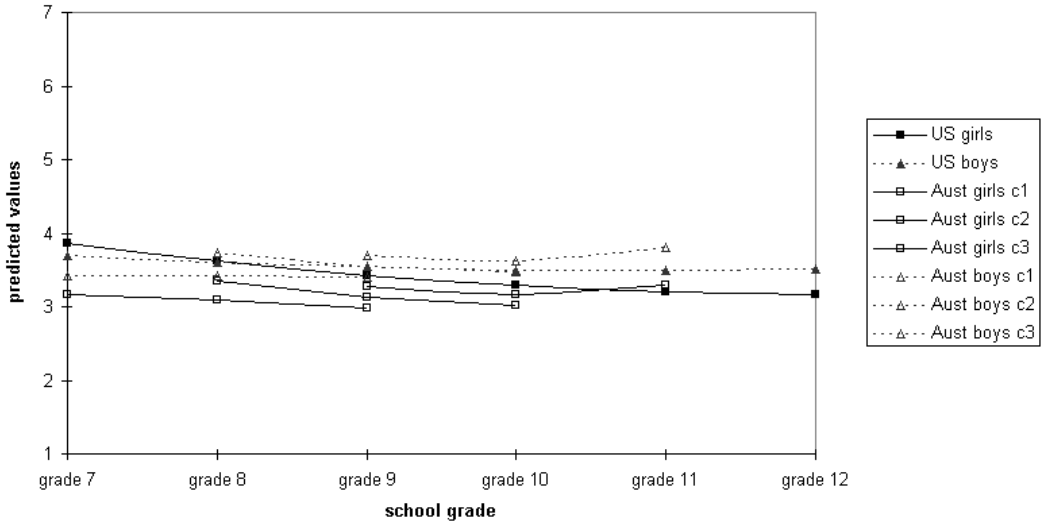

Figure 3. Maths interest.

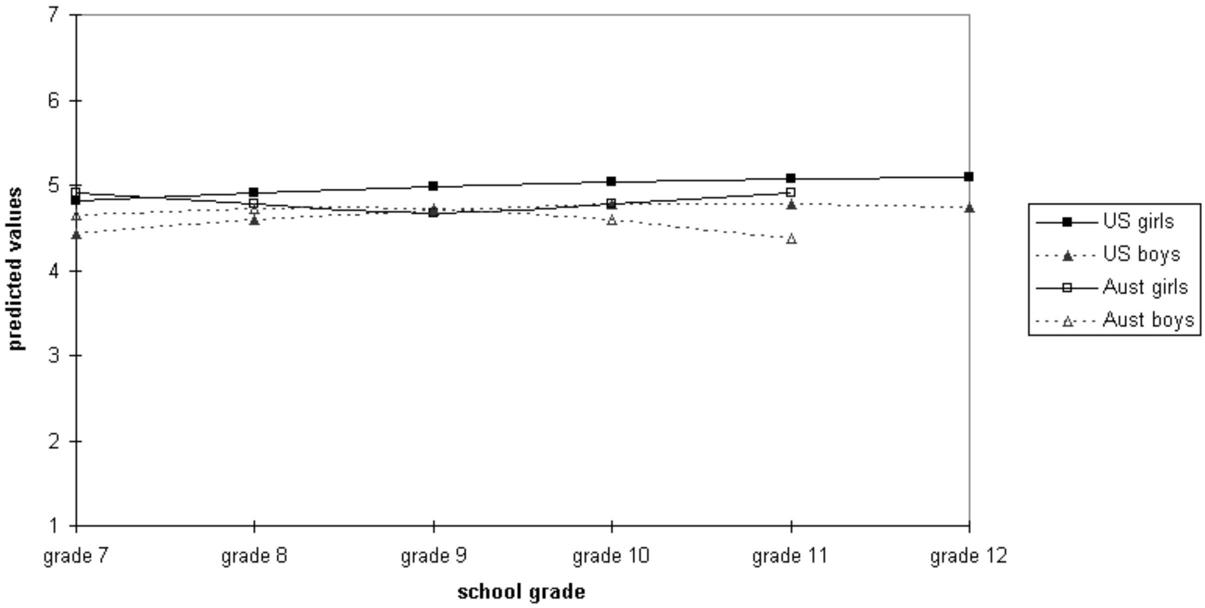

Figure 4. English self-concept of ability.

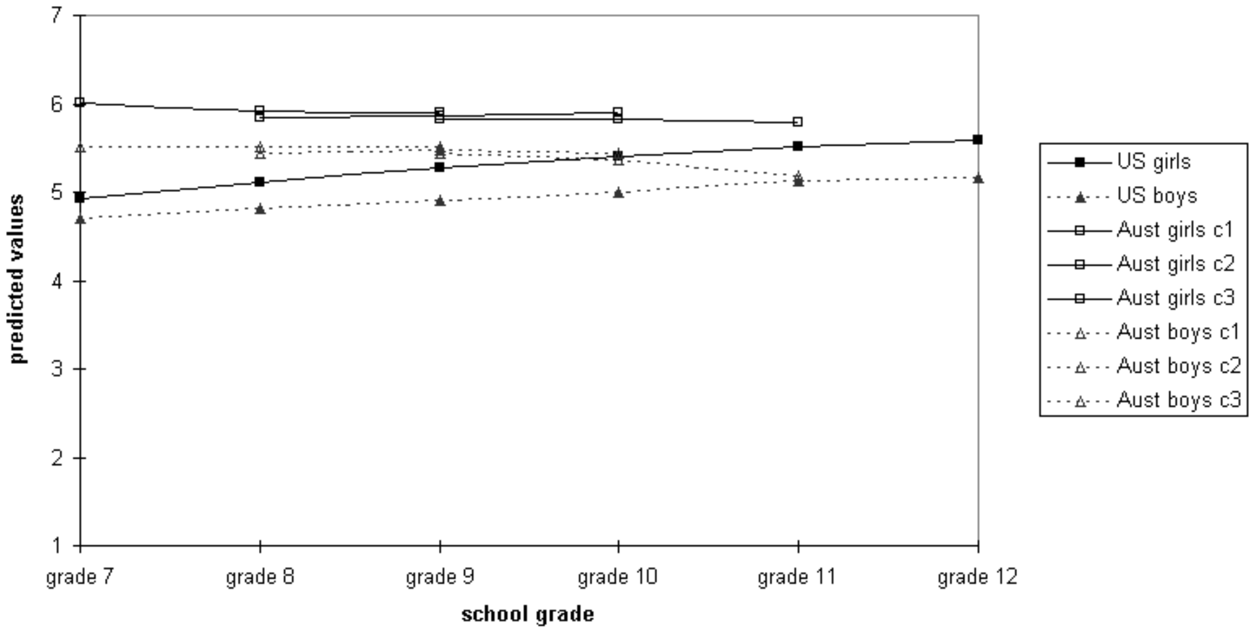

Figure 5. English valuation.

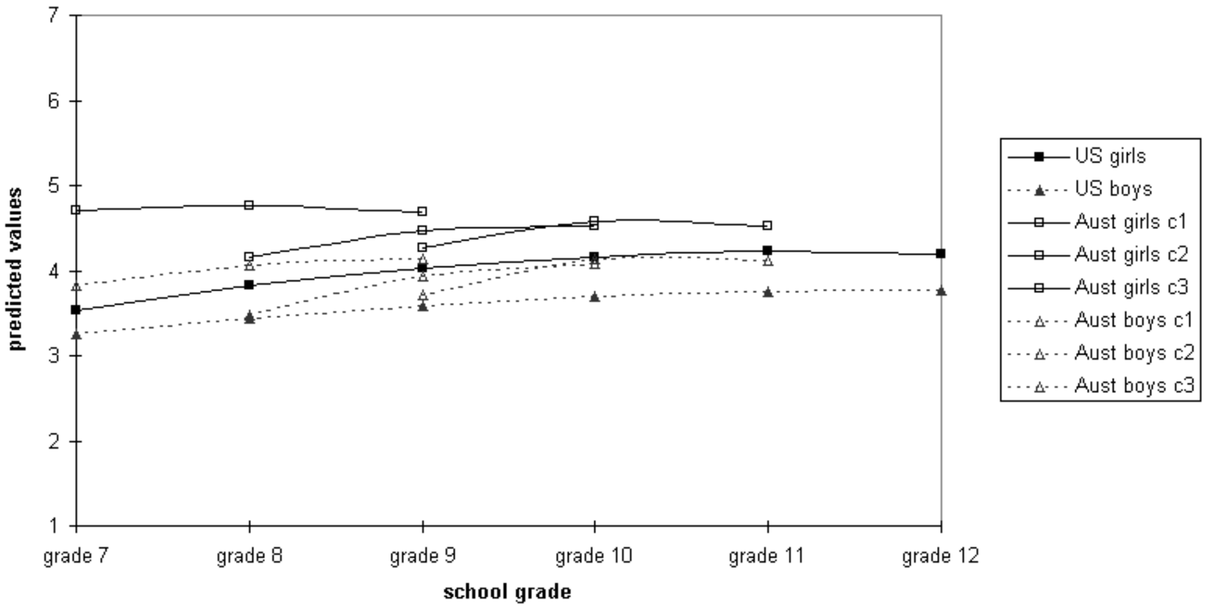

Figure 6. English interest.