

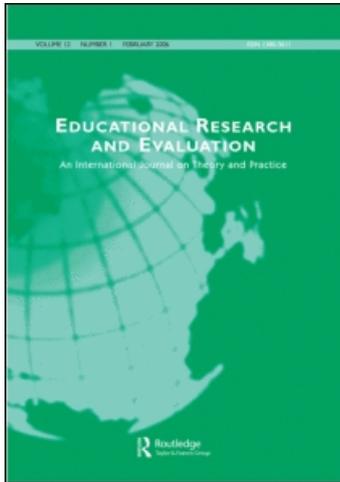
This article was downloaded by: [Watt, H]

On: 7 August 2008

Access details: *Access Details: [subscription number 901447244]*

Publisher *Routledge*

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## Educational Research and Evaluation

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t714592776>

### A latent growth curve modeling approach using an accelerated longitudinal design: the ontogeny of boys' and girls' talent perceptions and intrinsic values through adolescence

Helen M. G. Watt <sup>a</sup>

<sup>a</sup> Faculty of Education, Monash University, Melbourne, Victoria, Australia

Online Publication Date: 01 August 2008

**To cite this Article** Watt, Helen M. G.(2008)'A latent growth curve modeling approach using an accelerated longitudinal design: the ontogeny of boys' and girls' talent perceptions and intrinsic values through adolescence',*Educational Research and Evaluation*,14:4,287 — 304

**To link to this Article:** DOI: 10.1080/13803610802249316

**URL:** <http://dx.doi.org/10.1080/13803610802249316>

## PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

## **A latent growth curve modeling approach using an accelerated longitudinal design: the ontogeny of boys' and girls' talent perceptions and intrinsic values through adolescence**

Helen M.G. Watt\*

*Faculty of Education, Monash University, Melbourne, Victoria, Australia*

This article presents latent growth modeling, a particular application of multilevel modeling, to examine the development of adolescents' math- and English-related talent perceptions and intrinsic values which are emphasized by Expectancy-Value theory as important precursors to a range of achievement-related outcomes. The longitudinal cohort-sequential study included participants in 3 overlapping cohorts, together spanning Grades 7 to 11 ( $N = 1,323$ ). In this paper, I focus on the application of latent growth curve modeling to the accelerated longitudinal design and the interpretation of the growth parameters and their correlates in evaluating students' developmental trajectories across 2 key academic domains. Talent perceptions and intrinsic values were found to decline through adolescence in both math and English, and gender differences favored boys for math and girls for English consistent with gender stereotypes.

**Keywords:** latent growth curves; accelerated longitudinal design; academic motivations; gender differences; adolescent development; secondary school mathematics; secondary school English

### **Introduction**

Long-term longitudinal studies are invaluable to address developmental research questions, and certain kinds of questions can *only* be answered using longitudinal data. Such questions could relate to the developmental trajectories for certain phenomena over a specified time period, the strength of reciprocal effects between two related phenomena over time, or the causal sequencing among a group of factors. Longitudinal studies provide a real opportunity to explore and test out how processes unfold over time to produce certain outcomes. Longitudinal designs can be difficult to successfully implement for a number of reasons. Not least is the problem of expense and logistic challenges. Another common difficulty relates to sample attrition, which may be due to any number of reasons including relocation, illness, or boredom. Yet another problem is the sheer amount of time the researcher must take in order to collect data. Depending on the developmental period that is of interest, this can take many years.

---

\*Email: [helen.watt@education.monash.edu.au](mailto:helen.watt@education.monash.edu.au)

Such difficulties pose not only practical and logistic challenges but can further present problems regarding the validity of the findings. Systematic sample attrition will yield biased results and erroneous conclusions unless the researcher is able to identify and correct for patterns of missingness. For example, in a long-term study of student motivation through school years, the less motivated students may conceivably opt out of the study over time, leading to upwardly biased estimates of student motivation by senior high school and invalid conclusions that student motivation is uniformly high by the end of secondary schooling. Long-term study of a single cohort also runs the risk that the group studied may be characterized by special features making it *atypical* of the target population to which the researcher seeks to generalize. In this case, although internal validity may be high, the external validity of the findings will be poor. Still another problem encountered in long-term longitudinal programs of research is that by the time data collection is complete, the results analyzed, and conclusions published, the findings may no longer be timely and the researcher may have missed any opportunity to inform policy development or practical concerns. The developmental researcher faces a dilemma. Longitudinal data spanning a long time period may be necessary to address her/his research questions, but even supposing s/he obtains the resources needed to track participants over the required period of time, sample attrition may produce invalid findings, the cohort may be idiosyncratic in some way which limits the generality and usefulness of the findings, or the “use by” date of the data may have passed.

### *Accelerated longitudinal designs*

More than 50 years ago, Bell (1953, 1954) proposed the use of “convergence” as “a means of actually linking up individuals or sub-groups between adjacent segments of a developmental curve, each segment consisting of a limited longitudinal study on a different age group.” (Bell, 1954, p. 281). This approach is popularly referred to as the *cohort-sequential* design (Nesselroade & Baltes, 1979) or the *accelerated longitudinal* design (Tonry, Ohlin, & Farrington, 1991). Its clear advantage is that data spanning an extended developmental period can be collected within a shorter period of time, with smaller longitudinal timeframes within each sequential cohort together providing data to cover the full range for the developmental period which is of interest. Although the issues pertaining to longitudinal research will still apply *within* each cohort, the reduced timeframe for data collection will ameliorate the extent to which these may be problematic. A further advantage is the potential for between-cohort comparisons, which, if similar, can strengthen the researcher’s confidence in external validity.

The obvious potential drawback relates to the danger of making erroneous developmental inferences from between-cohort differences, in cases where time X cohort effects exist (Raudenbush & Chan, 1993). The schematic presented in Figure 1 illustrates this quite clearly: Here, Cohort 1 sampled at Time points 1 and 2 exhibits a steep decline on some hypothetical variable, Cohort 2 sampled at Time points 2 and 3 remains stable and low, while Cohort 3 sampled at Time points 3 and 4 shows a steady increase. The question is: Are we justified in “joining up” the three segments to represent the developmental trajectory from Time 1 through to Time 4? If we had sampled all three cohorts across all four time points, is this the trajectory we would have observed? Clearly we cannot answer this question in the depicted hypothetical scenario, because we simply do not have enough information to compare cohorts. To compare the slopes for adjacent cohorts, we would need ideally three (to avoid over-fitting) or at minimum two

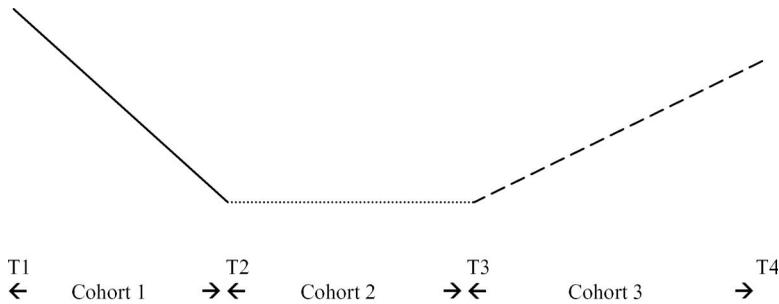


Figure 1. Schematic to illustrate potential time X cohort effects.

overlapping time points. For more complex developmental trajectories, the number of overlaps between cohorts will necessarily increase.<sup>1</sup>

### *The latent growth curve modeling (LGCM) approach*

Latent growth curve modeling (LGCM) has been developed by Raudenbush and his colleagues in the USA (e.g., Raudenbush, 1988) and Goldstein and his colleagues in the UK (e.g., Goldstein, 1989) as a flexible framework for tracing nonlinear developmental trajectories and assessing the existence and pathways of separate trajectories for subgroups of interest. Within the hierarchical linear modeling (HLM) or multilevel modeling framework for LGCM, another advantage for developmental researchers is that missing data can easily be accommodated, as can unequal measurement occasions (unlike LGCM within the structural equation modelling approach, see Byrne, 2008). Techniques such as MANOVA which are frequently implemented in short-term longitudinal studies have mostly been limited to measuring linear change and are less elegant, flexible, and parsimonious to apply to multiple waves of data.

The implementation of accelerated longitudinal designs within the LGCM approach has been clearly explicated by Raudenbush and Chan (1993). The approach has recently been adopted by motivation researchers interested in the developmental trajectories of students' ability-related beliefs and task values (see Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Watt, 2004). The contribution of the present study is to set out the steps in this process and highlight the interpretation of the relevant parameters. The focus is about the *process* rather than the substantive questions which drove the investigation. Some of the developmental trajectories presented in this paper have been published previously (the four "common" growth models, Watt, 2004), although that article focused on the substantive questions regarding gendered developmental trajectories, included a broader set of motivation factors, and did not describe the analyses in detail, nor issues pertaining to accelerated longitudinal designs including approaches to testing for time X cohort effects. I begin by contextualizing the analyses in relation to the substantive questions, describing the dataset, and then move to the application and interpretation of the LGCM approach to the accelerated longitudinal design.

### *Motivational trajectories through adolescence*

Recently, there has been considerable attention to charting the development of ability-related beliefs and values through adolescence. This interest has been prompted by

findings that these factors predict a range of student achievement-related behaviors and choices. Much of this evidence has come from research within the Expectancy-Value framework of Eccles and colleagues (see Eccles, 2005; Eccles (Parsons) et al., 1983; Wigfield & Eccles, 2000) and the self-concept perspective of Marsh and colleagues (Marsh, 1986, 1989; Marsh & Hau, 2004; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Marsh & Yeung, 1997). Eccles and her colleagues have demonstrated the impact of individuals' ability-related beliefs and their values on both their subsequent achievement and their achievement-related choices operationalized as course enrollments (e.g., Eccles (Parsons), 1984; Eccles, 1985; Eccles, Adler, & Meece, 1984; Eccles (Parsons) et al., 1983; Meece, Eccles (Parsons), Kaczala, Goff, & Futterman, 1982; Meece, Wigfield, & Eccles, 1990; Wigfield, 1994; Wigfield & Eccles, 1992). In the Australian context, individuals' talent perceptions (related to but distinct from ability beliefs as measured in the Expectancy-Value framework, see Watt 2002, 2004, for discussion) and intrinsic values have been found to exert the strongest influences on senior high course enrollments and vocational aspirations (e.g., Watt, 2005, 2006, 2008). These factors are consequently those which are the focus in the present study.

The two long-term longitudinal studies in the USA (Fredricks & Eccles, 2002; Jacobs et al., 2002) were both based on the "Childhood and Beyond" (CAB) program of research (Eccles, Wigfield, Harold, & Blumenfeld, 1993). Both of these studies modeled the development of ability-related beliefs and composite "values" perceptions from Grades 1 to 12. The present study extends on that work by utilizing a new talent perception measure, and the disaggregated intrinsic value "values" component, given evidence of factorial separability (e.g., Eccles & Wigfield, 1995; Watt, 2002), distinct pathways of development (Watt, 2004), and different patterns of gender influence (Fredricks & Eccles, 2002). The need to document trends for ability-related beliefs and values in samples from other contexts has been emphasized (Jacobs et al., 2002; Volet, 1999), and the present study is based on a dataset from a different country and school system but collected close to the same time as the CAB dataset on which the two earlier studies were founded.

Other relevant studies during the 1980s and 1990s were cross-sectional, or encompassed a short time-frame, and did not implement the LGCM approach. While those studies are highly important to the substantive question regarding how different kinds of motivations develop through adolescence, they have been reviewed elsewhere (Jacobs et al., 2002; Watt, 2004) and are not further discussed in this paper, which aims to illustrate the application of the LGCM approach within the accelerated longitudinal design. Collectively, the main findings have been that motivations decline through adolescence, with gender differences favoring boys in math and girls in English, where gender differences occur.

### *The illustrative data*

#### *Setting*

The study was located in the State of New South Wales (NSW) in Australia, where students attend secondary school Grades 7 through 12. Two academic domains were included to explore the extent to which developmental patterns were domain specific. Math and English are compulsory school subjects during Grades 7 to 10. Senior Grades 11 and 12 lead up to a major external examination supplemented by within-school assessment results called the Higher School Certificate (HSC). For these final 2 years of secondary school, students elect which subjects they wish to study. Further, they select the difficulty

level they wish to undertake within each. English is compulsory and math is not, although most students choose to undertake it still. There are five math courses (“Maths in Practice” [MIP], “Maths in Society” [MIS], 2-unit, 3-unit, and 4-unit maths), which range from the least difficult (MIP) to the hardest (4-unit); similarly, there are four difficulty levels of English (see MacCann, 1995).<sup>2</sup>

### Sample

Participants spanned Grades 7 to 11 in a longitudinal overlapping cohort-sequential design containing 1,323 students in three cohorts. This developmental span encompasses the NSW Australian secondary school period with the exception of the final year. Occasion 1 mean ages were 13.19, 12.36, and 14.41 years, when participants were at the end of Grade 7, early Grade 7, and early Grade 9, respectively, for Cohorts 1 through 3. Table 1 depicts the sample size for each cohort, the grade of participants at each year of data collection, gender, and whether or not English was their home language. Participants were from three upper-middle class coeducational secondary schools in northern metropolitan Sydney, matched for socioeconomic status according to the Index of Education and Occupation (Australian Bureau of Statistics, 1991). All three cohorts were assessed at Grade 9, Cohorts 1 and 2 overlapped for three measurement occasions, and Cohorts 1 and 3 overlapped for two occasions. As a consequence of the relatively small number of overlapping time points between adjacent cohorts, detection of cohort effects on the growth parameters may not be optimally reliable.<sup>1</sup> Approximately half the participants in each cohort were present for all administrations, and approximately one quarter missed only one. Because LGCM utilizes all of the available information for each respondent, under the missing at random (MAR) assumption, participants were not excluded on the basis of missing administrations.

### Measures

Questionnaires assessed students’ talent perceptions and intrinsic values in relation to math and English. Items for values were based on those used by Eccles and colleagues (see Wigfield & Eccles, 2000; three items: e.g., How much do you like maths/English, compared with your other subjects at school?); and talent perceptions were assessed instead of their perceptions of ability factor (seven items: e.g., Compared with other students in your class, how talented do you consider yourself to be at maths/English?; for discussion regarding the talent construct, see Watt, 2002, 2004). All items were answered on 7-point Likert-type scales ranging from (1) *not at all* to (7) *very*. Subscale scores have been demonstrated to have good reliability and construct validity (Watt, 2004), with moderate correlations between factors ( $r = .49$  for math,  $.55$  for English). Measures were sufficiently reliable, with alpha coefficients from  $.72$  to  $.94$ .

Table 1. Cohort sample size, grade, gender, and home language spoken.

	1995 grade	1996 grade	1997 grade	1998 grade	%girls	%ESB <sup>a</sup>
Cohort 1 (n = 428)	7 (Dec)	8 (June)	9 (Feb)	10 (Feb)	44.9	78.6
Cohort 2 (n = 436)	N/A	7(Feb,Dec)	8 (June)	9 (Feb)	43.6	82.4
Cohort 3 (n = 459)	N/A	9 (Feb)	10 (Feb)	11 (Feb)	42.9	73.1

<sup>a</sup>Note: “ESB” refers to students who nominated English as their home language.

### Applying the LGCM approach

In applying LGCM to longitudinal data, one conceives of repeated occasions as nested within individuals, such that change is decomposed into *within-* and *between-*individual change. Within-individual change characterizes the shape of the growth trajectory (e.g., linear, quadratic, cubic, or any other form), while between-individual change implies different growth trajectories for different groups of individuals (e.g., gender or cohort differences). Between-individual differences could manifest as differently shaped trajectories (e.g., increases for girls, decreases for boys) or as a “shifted” trajectory of the same shape, but with a differently located intercept (e.g., increases at the same rate for girls and boys, but girls start out and remain a certain amount higher than boys).

Separate models were estimated for each construct of interest, in this case four models, one for each of talent perceptions and intrinsic values related to math and English. MLwiN multilevel modeling software was used (version 1.10.0007), although other software such as HLM or MPlus could instead have been employed. To begin, each model was built from a baseline variance components model, fitting a constant only as an explanatory variable, estimating both fixed and random parameters for each of occasions and individuals. This model partitions the variance into within- and between-individual components and consequently provides a baseline with which to compare subsequent models. Subsequent models added explanatory variables sequentially, in order to evaluate the associated improvement in model fit. First within-individual parameters were modeled (the growth functions), followed by the addition of between-individual parameters (the grouping variables).

It was possible to compare the improvement in model fit associated with the addition of each sequential parameter, based on the fact that each model was nested within the preceding one. Models were estimated using full maximum likelihood, so that model fits could be compared using the likelihood ratio test: Change in the deviance statistic (i.e.,  $-2 \times \log(\text{likelihood})$ ) is asymptotically equivalent to a chi-square distribution with degrees of freedom equal to the number of independent constraints imposed on the model. At any stage where the addition of a parameter did not significantly improve the model fit based on change in the deviance statistic ( $p < .05$ ), the parameter was not retained in the model. Predictions for each time point were then made from the fixed parameters of each final model, these predicted values were graphed against grade, and 95% confidence intervals were appended. If the confidence intervals for a pair of estimates did not overlap, then the point estimates were significantly different at  $p < .05$ . Overlapping confidence intervals suggest that analyses which omit cohort and school effects could fruitfully clarify boys' and girls' patterns of change, which were the substantive impetus for the study.

### *Within-individual change*

Cubic patterns were hypothesized for the shape of the growth trajectories, due to the curricular changes at the end of Grade 7 and on commencement of Grade 11 in the NSW Australian context. I speculated that, once students select which subjects they wish to study for the HSC and choose which difficulty levels of these subjects they will undertake, it may be that their talent perceptions or intrinsic values *increase*. Alternatively, HSC assessment pressures throughout Grades 11 and 12 may heighten *negative* changes. To assess such possible patterns of change involving two turning points, I posited growth models based on *cubic* patterns of change. The two previous studies (Fredricks & Eccles, 2002; Jacobs et al., 2002) relied upon the estimation of quadratic change, precluding the

potential to identify more complex developmental patterns which may occur. Clearly, the complexity of the growth function which can be estimated is restricted by the number of time points which are assessed. The six time points included in the present study imply a polynomial form of up to order five (a quintic) could be estimated. However, because of the cohort-sequential design, no participants were assessed across all six occasions. Estimation of a quintic polynomial would presume the absence of any cohort effects at the outset, and was not the hypothesized form of growth in any case. There were four measurement occasions for Cohort 1, which overlapped three time points with Cohort 2, and two with Cohort 3, each measured across three occasions. A cubic growth function was consequently estimated.

Specification of a cubic growth trajectory involves four fixed parameters: an intercept, linear slope, quadratic curvature, and the cubic term. A *fixed* parameter indicates that individuals follow the estimated growth trajectory at the same rate. It is possible to additionally include a *random* parameter for each growth term, so as not to impose this constraint. For the present study, both fixed and random growth parameters were included. Any time that the addition of a more complex growth term did not significantly improve the model fit, the simpler form was retained, except in cases where, for example, some quadratic but not linear term was significant, in which case the linear term would also be retained. First linear change was added (i.e., grade, using standard linear polynomial contrasts to represent Grades 7 at the start of the year, 7 at the end of the year, 8, 9, 10, and 11, respectively), next quadratic, and then cubic change. Grade was centered about the middle Grade 9, which was also the grade at which there was most information when all three cohorts were assessed. Consequently, intercept (denoted "Cons" for constant) parameters refer to estimates at Grade 9, linear parameters ("grade") refer to rate of change at Grade 9, quadratic parameters ("grade\_q") refer to concavity at Grade 9, and cubic parameters ("grade\_c") refer to cubic growth at Grade 9. Linear trajectories indicate consistent increase or decrease over time, quadratic trajectories indicate acceleration or deceleration in the rate of change over time, and cubic trajectories could indicate a decrease followed by a plateau and then a further decrease, for example.

### ***Between-individual change***

#### *Formulation of a cohort-based model*

Because of the danger of interpreting cohort differences as developmental changes, it was necessary to first test whether the addition of cohort parameters significantly improved model fit, and if so, whether 95% confidence intervals did not overlap. This would indicate that a model attributing differences in individual parameters to cohort membership fitted the data better than the model assuming members of all cohorts followed a common developmental trajectory. Because three schools were involved in the study, school effects were examined in a similar fashion. For these "full" models including cohort and school effects, the order and entry of between-individual parameters was gender (coded 1 for girls and 0 for boys) and next the interaction of gender with linear, quadratic, and cubic change, testing for improvement to model fit at each step. School was then added (effect coded -1, 0, 1 for Schools A through C) and interactions of school with linear, quadratic, and cubic change. Finally, cohort was added, effect coded -1, 0, 1 for Cohorts 2, 1, and 3, respectively (Cohort 2 spanned start of Grade 7 to Grade 9, Cohort 1 spanned end of Grade 7 to Grade 10, Cohort 3 spanned Grades 9 to 11), and interactions of cohort with

linear, quadratic, and cubic change. This general model form is presented in Equation (1) below.

$$\begin{aligned}
 Y_{ij} = & \beta_{0ij}\text{constant} + \beta_{1j}\text{grade}_{ij} + \beta_{2j}\text{grade}_{ij}^2 + \beta_{3j}\text{grade}_{ij}^3 \\
 & + \beta_4\text{gender}_{ij} + \beta_5\text{gender} * \text{grade}_{ij} + \beta_6\text{gender} * \text{grade}_{ij}^2 + \beta_7\text{gender} * \text{grade}_{ij}^3 \\
 & + \beta_8\text{school}_{ij} + \beta_9\text{school} * \text{grade}_{ij} + \beta_{10}\text{school} * \text{grade}_{ij}^2 + \beta_{11}\text{school} * \text{grade}_{ij}^3 \\
 & + \beta_{12}\text{cohort}_{ij} + \beta_{13}\text{cohort} * \text{grade}_{ij} + \beta_{14}\text{cohort} * \text{grade}_{ij}^2 + \beta_{15}\text{cohort} * \text{grade}_{ij}^3 + \varepsilon_{ij}
 \end{aligned} \tag{1}$$

#### *Formulation of a ‘‘common’’ model*

In the event that cohort and school parameters did not significantly improve model fit, or that confidence intervals overlapped, a ‘‘common’’ model was estimated, which estimated a single trajectory across the six time points. A common model assumes that members of all three cohorts follow a single underlying developmental trajectory. The only between-individual parameters in this case were gender, and the interactions of gender with linear, quadratic, and cubic change, again testing for improvement to model fit at each step. This general model form is presented in Equation (2).

$$\begin{aligned}
 Y_{ij} = & \beta_{0ij}\text{constant} + \beta_{1j}\text{grade}_{ij} + \beta_{2j}\text{grade}_{ij}^2 + \beta_{3j}\text{grade}_{ij}^3 + \beta_4\text{gender}_{ij} \\
 & + \beta_5\text{gender} * \text{grade}_{ij} + \beta_6\text{gender} * \text{grade}_{ij}^2 + \beta_7\text{gender} * \text{grade}_{ij}^3 + \varepsilon_{ij}
 \end{aligned} \tag{2}$$

- $Y_{ij}$  is the math or English talent perception or intrinsic value score for subject  $i$  at occasion  $j$  ( $j = 1, \dots, 6$  and  $i = 1, \dots, n$ ).
- $\text{grade}_{ij}$  represents the linear component of the growth curve, centered about Grade 9 using standard polynomial contrasts ( $-5, -3, -1, 1, 3, 5$ ).
- $\text{grade}_{ij}^2$  is the square of  $\text{grade}_{ij}$ , representing the quadratic component of the individual growth curve.
- $\text{grade}_{ij}^3$  is the cube of  $\text{grade}_{ij}$  and represents the cubic component of the growth curve.
- $\beta_{0j}$  is the intercept parameter, representing the mean score for boys at Grade 9 (since gender was coded 0 = boys 1 = girls, and growth parameters were centered about Grade 9). The random component ‘‘j’’ allows for individual variation about the mean.
- $\beta_{1j}$  is the expected rate of increase per year in scores for male subject  $i$  at Grade 9. This corresponds to the slope of the tangent at Grade 9, which can be interpreted as the mean velocity for each male subject  $i$ . The random component ‘‘j’’ again allows for individual variation about the slope.
- $\beta_{2j}$  is the quadratic parameter, representing the rate of acceleration per year for male subject  $i$ . The random component ‘‘j’’ allows for individual variation in rate of acceleration.
- $\beta_{3j}$  is the cubic parameter, per year for male subject  $i$ . The random component ‘‘j’’ allows for individual variation about the cubic parameter.
- $\beta_4$  is the extent to which the intercept for girls is above that for boys at Grade 9.
- $\beta_5$  is the extent to which the linear slope for girls is steeper than that for boys.

- $\beta_6$  is the extent to which the quadratic curvature for girls is greater than that for boys at Grade 9.
- $\beta_7$  is the extent to which the cubic parameter for girls exceeds that for boys at Grade 9.
- $\varepsilon_{ij}$  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  $\sigma^2$  (i.e.,  $\varepsilon_{ij} \sim N(0, \sigma^2)$ ).

## Results

### *Use of the accelerated longitudinal design to estimate common developmental trajectories*

The “full” LGCM models including cohort and school effects showed that linear trajectories best described the negative changes in individuals’ talent perceptions, both in math and English; while a quadratic growth trajectory best described intrinsic value in math and a cubic trajectory best described intrinsic value in English. Gender effects were evident in each case, impacting the intercept term only for math talent perceptions and intrinsic value, the slope for English talent perceptions, and the curvature for English intrinsic value. The inclusion of cohort parameters significantly improved model fits in each case, and there was one effect of school membership on the intercept for math intrinsic value. Table 2 presents all parameter estimates whose addition significantly improved model fit. Given the evidence from Table 2 that some of the intercept and growth parameters varied across schools and cohorts, at this point the goal of estimating a single developmental trajectory per construct based on an accelerated longitudinal design looked somewhat unpromising – suggesting rather that separate models might be needed for individuals who came from different cohorts and schools.

The next step involved graphing the estimated trajectories and appending 95% confidence intervals, to determine whether and where these might overlap. Although the statistics reported in Table 2 tell us whether there are statistically significant group differences for each of the growth parameters, overlapping confidence intervals for pairs of estimates at any particular grade provide us with the additional information that a group difference is not statistically significant at that particular time point. Figures 2A and 3A depict cohort-specific trajectories for math talent perceptions and intrinsic values, and Figures 4A and 5A for English talent perceptions and intrinsic values. Inspection of these Figures shows that in all cases but one, confidence intervals overlapped for cohorts within gender groups. In Figure 2A, it is difficult to even see the cohort-specific trajectories for boys and girls, which appear to be two continuous lines (one for each of boys and girls) because of the high amount of overlap between cohorts, strongly suggesting the viability of the common trajectory model. The only instance of non-overlapping confidence intervals was for English intrinsic value at Grade 8, here, the youngest Cohort 2 had significantly higher predicted values than the middle Cohort 1, although these effects did not involve the displacement of gender patterns which are the substantive focus of the study. As a consequence, analyses were repeated omitting the cohort and school<sup>3</sup> terms to improve clarity of interpretation.

### *Estimated common developmental trajectories*

For parsimony and interpretability, “common” models were estimated which omitted school and cohort effects. The same growth forms best described developmental

Table 2. Full explanatory models for the development of boys' and girls' talent perceptions and intrinsic values through Grades 7 to 11.

	math		English	
	Talent b est (se)	Intrinsic value b est (se)	Talent b est (se)	Intrinsic value b est (se)
<b>Fixed Effects</b>				
Cons <sup>c</sup>	4.810 (.034)	3.765 (.071)	4.533 (.036)	4.083 (.073)
grade <sup>b</sup>	-.012 (.008)	-.052 (.013)	.014 (.010)	-.031 (.030)
grade <sub>q</sub> <sup>b</sup>	-	.010 (.012)	-	.030 (.017)
grade <sub>c</sub> <sup>b</sup>	-	-	-	-.041 (.009)
gender	-.489 (.047)	-.395 (.074)	.066 (.049)*	.597 (.064)
genderXgrade	-	-	-.024 (.011)	-.023 (.015)*
genderXgrade <sub>q</sub>	-	-	-	.030 (.012)
genderXgrade <sub>c</sub>	-	-	-	-
school	-	-.253 (.052)	-	-
schoolXgrade	-	-	-	-
schoolXgrade <sub>q</sub>	-	-	-	-
schoolXgrade <sub>c</sub>	-	-	-	-
cohort	-.046 (.039)	.122 (.060)	-.116 (.040)*	-.049 (.084)
cohortXgrade	-.005 (.007)*	.024 (.022)*	.006 (.008)*	-.010 (.027)*
cohortXgrade <sub>q</sub>	-.013 (.005)	-.019 (.009)	-.012 (.006)	-.065 (.023)
cohortXgrade <sub>c</sub>	-	-	-.009 (.003)	-.030 (.007)
<b>Random Effects</b>				
<i>Between-student variance</i>				
Cons/Cons	.631 (.032)	1.403 (.082)	.675 (.034)	.939 (.055)
Cons/grade	-.015 (.004)	-.019 (.010)	-.009 (.005)	.000 (.000)
Cons/grade <sub>q</sub>	-	-.024 (.010)	-	-.011 (.007)
Cons/grade <sub>c</sub>	-	-	-	.012 (.004)
grade/grade	.008 (.002)	.013 (.005)	.007 (.002)	.000 (.000)
grade/grade <sub>q</sub>	-	-.001 (.001)	-	.000 (.000)
grade/grade <sub>c</sub>	-	-	-	.000 (.000)
grade <sub>q</sub> /grade <sub>q</sub>	-	.002 (.002)	-	.005 (.002)
grade <sub>q</sub> /grade <sub>c</sub>	-	-	-	.000 (.001)
grade <sub>c</sub> /grade <sub>c</sub>	-	-	-	.002 (.001)
<i>Within-student variance</i>				
Cons/Cons	.394 (.013)	1.069 (.038)	.407 (.014)	1.006 (.042)

Notes: <sup>a</sup>Unless otherwise indicated (\*), all b coefficients statistically significantly improved the model fit as indicated by the change in deviance test.

<sup>b</sup>Random at the individual student level

<sup>c</sup>Random at both student and occasion levels

- variable did not significantly improve model fit

“\_q” refers to quadratic and “\_c” to cubic terms.

trajectories in the re-estimated LGCM models with similar gender effects as previously (see Table 3). Girls' and boys' developmental trajectories based on the common model specification are presented in Figures 2B and 3B for math, and Figures 4B and 5B for English. In general, changes were negative over time, with some indication that transitions at Grades 7 and 11 heightened negative development. Gender differences favored boys in math and girls in English with little evidence for gender intensification or gender convergence, because the magnitude of gender difference was generally stable.

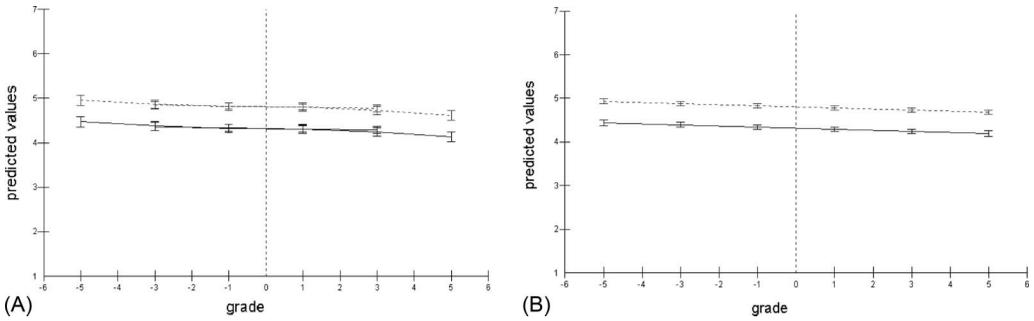


Figure 2. A. Cohort-based growth models for boys' and girls' math talent perceptions. B. Common growth models for boys' and girls' math talent perceptions. Note: For Figures 2A through 5B (1) girls are represented by solid and boys by dashed lines and (2) polynomial contrasts represent early Grade 7, late Grade 7, mid Grade 8, early Grades 9, 10, and 11.

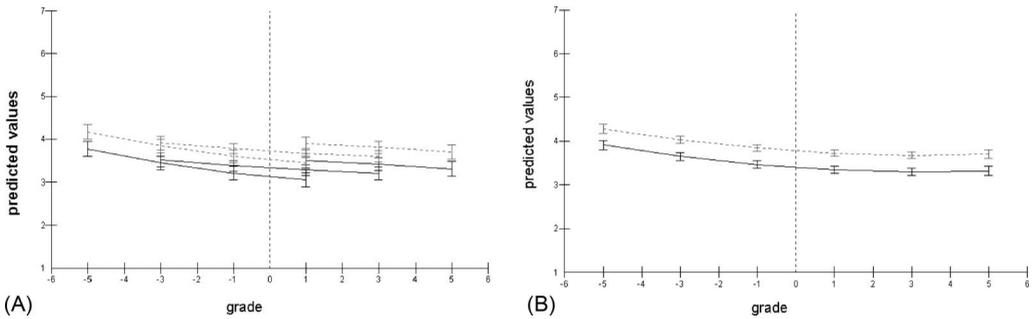


Figure 3. A. Cohort-based growth models for boys' and girls' math intrinsic value. B. Common growth models for boys' and girls' math intrinsic value.

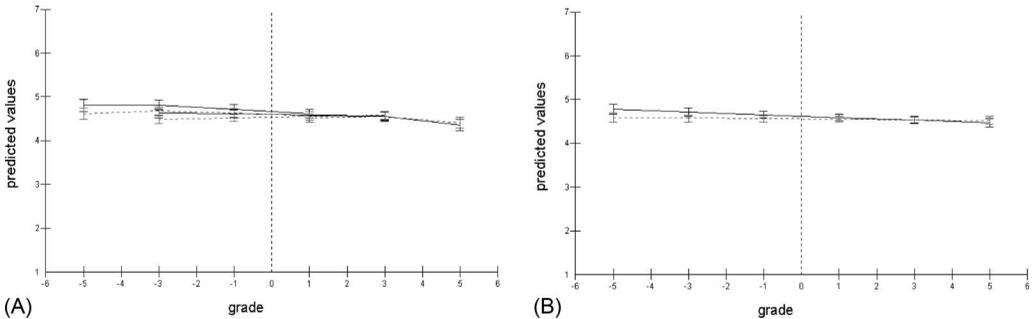


Figure 4. A. Cohort-based growth models for boys' and girls' English talent perceptions. B. Common growth models for boys' and girls' English talent perceptions.

*Trajectories for math*

Developmental trajectories were explained by different combinations of variables for each construct, summarized in Table 3. Math talent perceptions were characterized by gender differences favoring boys of magnitude around 0.5 on the 7-point scales, and these

Downloaded By: [Matt, H] At: 22:45 7 August 2008

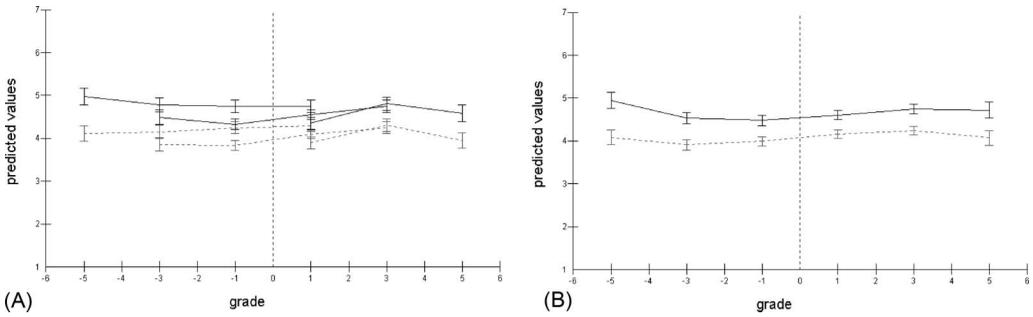


Figure 5. A. Cohort-based growth models for boys' and girls' English intrinsic value. B. Common growth models for boys' and girls' English intrinsic value.

exhibited a linear decline for both boys and girls (see Figure 2B). Intrinsic value for math was characterized by a gender difference of similar magnitude favoring boys: Boys' and girls' intrinsic value declined through junior secondary school and flattened out during senior years (see Figure 3B).

*Trajectories for English*

English talent perceptions declined for girls and remained relatively stable for boys through secondary school (see Figure 4B); however, overlapping confidence intervals indicated that these estimates did not statistically significantly differ between boys and girls at any grade point. English intrinsic values declined through Grade 7 and again between Grades 10 and 11 (see Figure 5B). Some "recovery" occurred from the end of Grade 7 through to Grade 10, although not to initial Grade 7 levels. Gender differences favored girls and were statistically significant: Girls suffered a slightly greater decline for intrinsic value than boys on commencement of Grade 7, while boys showed some decline between Grades 10 and 11 and girls remained relatively stable. The magnitude of gender difference was greater for English intrinsic value than for any other construct, reaching a maximum of approximately 1.

*Between-individual variability*

Because all growth parameters were estimated both as fixed and random effects, it is also possible to interpret *between*-individual variability. As an example, I consider between-individual variability in the rate of change for math talent perceptions. These declined linearly, and the absence of any gender X grade interaction implied the rate of change (or decline) was similar for boys and girls. While the results show that there is a sample-wide decline in talent perceptions through secondary school, they do *not* imply that all individuals come to perceive themselves as progressively less talented in math. Table 3 shows the estimated variance in rate of change across individuals was .008, and so the standard deviation is  $\sqrt{.008}$ . To interpret this, we could consider two individuals who are each two standard deviations from the mean rate of change, one above and one below. The mean rate of change  $\beta_{10}$  is  $-.025$  (see Table 3), meaning that the predicted growth rates for these two individuals are  $-.025 \pm 2 \sqrt{.008} = (-.204, .154)$ . It would therefore be possible to locate individuals who show no change in their talent perceptions during this period, and also individuals who come to perceive themselves as *increasingly* talented at math up to the rate of .154 per year.

Table 3. Common explanatory models for the development of boys' and girls' talent perceptions and intrinsic values through Grades 7 to 11.

	math		English	
	Talent b est (se)	Intrinsic value b est (se)	Talent b est (se)	Intrinsic value b est (se)
<b>Fixed Effects</b>				
Cons <sup>c</sup>	4.806 (.032)	3.877 (.051)	4.555 (.033)	4.076 (.043)
grade <sup>b</sup>	-.025 (.005)	-.059 (.008)	-.007 (.007)	.016 (.011)
grade <sub>q</sub> <sup>b</sup>	-	.023 (.006)	-	.000 (.008)
grade <sub>c</sub> <sup>b</sup>	-	-	-	.017 (.004)
gender	-.490 (.047)	-.377 (.075)	.067 (.049)*	.595 (.064)
genderXgrade	-	-	-.024 (.011)	-.022(.015)*
genderXgrade <sub>q</sub>	-	-	-	.032 (.012)
genderXgrade <sub>c</sub>	-	-	-	-
<b>Random Effects</b>				
<i>Between-student variance</i>				
Cons/Cons	.631 (.032)	1.450 (.084)	.676 (.034)	.941 (.056)
Cons/grade	-.016 (.004)	-.020 (.010)	-.009 (.005)	.000 (.000)
Cons/grade <sub>q</sub>	-	-.027 (.010)	-	-.014 (.007)
Cons/grade <sub>c</sub>	-	-	-	.013 (.004)
grade/grade	.008 (.002)	.014 (.005)	.007 (.002)	.000 (.000)
grade/grade <sub>q</sub>	-	-.001 (.001)	-	.000 (.000)
grade/grade <sub>c</sub>	-	-	-	.000 (.000)
grade <sub>q</sub> /grade <sub>q</sub>	-	.002 (.002)	-	.005 (.002)
grade <sub>q</sub> /grade <sub>c</sub>	-	-	-	.000 (.001)
grade <sub>c</sub> /grade <sub>c</sub>	-	-	-	.002 (.001)
<i>Within-student variance</i>				
Cons/Cons	.395 (.013)	1.067 (.038)	.408 (.014)	1.016 (.042)

Notes: <sup>a</sup>Unless otherwise indicated (\*), all b coefficients statistically significantly improved the model fit as indicated by the change in deviance test.

<sup>b</sup>Random at the individual student level

<sup>c</sup>Random at both student and occasion levels

-variable did not significantly improve model fit

"\_q" refers to quadratic and "\_c" to cubic terms.

## Discussion and conclusions

Although cohort-based models showed a significant improvement over "common" models which estimated a growth trajectory across the three cohorts, given the substantive impetus for the study and findings that confidence intervals for point estimates overlapped in all but one instance, the three cohorts were combined in an accelerated longitudinal design. The more parsimonious models which omitted cohort effects are considered valuable in clarifying the developmental patterns of change in individuals' talent perceptions and intrinsic values through Grades 7 to 11. In these "common" models, estimates are based on information from across the three cohorts, and the unsampled grades for each cohort are treated simply as missing data based on the missing at random (MAR) assumption.

As anticipated, developmental changes were negative with indications that transitions at Grades 7 (for math and English intrinsic values) and 11 (for English intrinsic value)

heightened negative impacts. English intrinsic value was the only construct which exhibited the speculated cubic growth trajectory. Linear declines for talent perceptions in math and English showed that negative changes did not coincide with changes in school curricular structures and may therefore be normative as students engage in increased social comparisons and develop more “realistic” views of their abilities over time (Nicholls, 1978).

Declines in intrinsic values, on the other hand, coincided with changes in curricular structures. Math intrinsic value declined most through Grade 7, which is the first year of secondary school, and negative changes in motivations post-transition to junior high school have been well established (e.g., Anderman & Midgley, 1997; Midgley, Feldlaufer, & Eccles, 1989a, 1989b; Seidman, Allen, Aber, Mitchell, & Feinman, 1994; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991). In NSW Australia, the junior secondary school math curriculum focuses on consolidation of previously learned material from primary school (Grades 3 to 6), which may partly account for a dropoff in student interest. English intrinsic value similarly declined through Grade 7, but also between Grades 10 and 11, when structural changes in the NSW Australian school environment occur. Perhaps the increased assessment pressures leading to the final major HSC examination may produce a decline in students’ interest in English due to a greater focus on outcomes and performance. One might ask why this would not also be the case in math? Some part of the explanation may relate to English being compulsory, although further research across multiple academic domains is needed to identify where and why trajectories are domain specific.

Some theorists have suggested that negative changes on transition to junior high school are a consequence of concurrent physiological and psychological pubertal changes (e.g., Blyth, Simmons, & Carlton-Ford, 1983; Hill & Lynch, 1983; Rosenberg, 1986; Simmons, Blyth, Van Cleave, & Bush, 1979). This view has been challenged by research showing how differences in the pre- and post-transition classroom and school environments relate to declining motivations (Eccles & Midgley, 1989, 1990), instead positing a model of “person-environment fit” whereby the needs of young adolescents are not met by the new junior high school environment. Findings from the present study are consistent with predictions from this model, although importantly for intrinsic values but not talent perceptions.

Gender differences favored boys in math and girls in English in line with gender stereotypes. Gender effects were evident in each case except English talent perceptions, which may be due to boys’ tendency to overrate their capabilities (e.g., Bornholt, Goodnow, & Cooney, 1994), since English performance with the present sample favored girls (Watt, 2002, 2008). There was little evidence for a gender intensification (e.g., Eccles, 1987; Hill & Lynch, 1983; Maccoby, 1966) or gender convergence hypothesis (Fredricks & Eccles, 2002; Jacobs et al., 2002), with remarkably stable magnitudes of gender difference in all cases except English intrinsic value, for which girls showed greater declines than boys earlier, and the reverse occurred later. Such findings emphasize the importance of retaining a focus on girls’ academic well-being alongside current emphases on boys’ academic progress. Generally stable gender differences could imply that boys’ and girls’ perceptions diverge at an earlier age than commencement of secondary school. Because gender differences in ability beliefs and values have been identified in early school years (e.g., Eccles et al., 1993; Marsh, 1989; Wigfield et al., 1997), it seems that boys and girls begin school already having those gendered perceptions. In the USA, these have been attributed to socialization experiences in the home and the wider society, such as portrayals of men and women in the media (e.g., Jacobs et al., 2002).

Future research should investigate how structural curricular changes may bring about declining motivations across multiple academic domains. Greater attention to between-

individual variability may also yield new directions, through a closer examination of individuals who demonstrate *positive* motivational changes through secondary school and the factors which promote this. A focus on these “off diagonal” individuals may assist in further identifying personal and social factors which promote adolescents’ academic resilience and well-being. Another useful direction will be to examine within-individual explanatory processes for developmental trajectories through the use of time-varying covariates: for example, the extent to which values may bring about negative changes in ability-related perceptions (Jacobs et al., 2002). First, however, there is a need to clarify the causal sequencing among correlated motivation constructs. Further studies from a range of cultures are also needed to assess which trajectories may be tied to particular school systems. The present study was conducted with a fairly homogeneous sample, and future research could fruitfully sample different ethnic and socioeconomic groups which may demonstrate other patterns of gender influence than among this upper-middle class Anglo-Australian group.

The LGCM approach with accelerated longitudinal designs will be an important vehicle in these endeavours. A limitation of the present study is the small number of overlapping time points between cohorts. Two time points provide very limited information about change (Rogosa, 1988), and one time point provides none (Anderson, 1993). In this study, adjacent cohorts shared between two and three overlapping time points. In designing accelerated longitudinal studies, care needs to be taken to plan overlaps between cohorts which are adequate to test for the hypothesized developmental patterns: The more complex the predicted pattern of growth, the greater the number of overlapping time points will be needed.

### Acknowledgements

Thank you to Ray Debus, Mike Bailey, Herb Marsh, Stephen Raudenbush and Kai Schnabel Cortina for their helpful input in the early stages of this study.

### Notes

1. Tests of cohort effects on the intercept are sensitive even in cases where there are small numbers of overlapping time points. However, tests of cohort effects on linear, quadratic, and cubic parameters show substantial loss of power and unacceptable multicollinearity when the number of overlapping time points is fewer than six (Raudenbush & Chan, 1993).
2. This system was in place 1991 through 1999, with a new system of senior high HSC course levels being introduced in 2000.
3. School A students were more interested in math than School B students, who were more interested than School C students. However, the confidence intervals between Schools A and B, and Schools B and C overlapped, indicating point estimates did not significantly differ. Because of this, and also because the effect of school was on the intercept only and therefore did not displace patterns of gender effect, the model was re-estimated omitting school parameters.

### 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.
- Anderson, E.R. (1993). Analyzing change in short-term longitudinal research using cohort-sequential designs. *Journal of Consulting and Clinical Psychology*, 61, 929–940.
- Australian Bureau of Statistics. (1991). *Index of education and occupation* (No. Catalogue No. 2912.0). Sydney: Author.
- Bell, R.Q. (1953). Convergence: An accelerated longitudinal approach. *Child Development*, 24, 145–152.

- Bell, R.Q. (1954). An experimental test of the accelerated longitudinal approach. *Child Development*, 25, 281–286.
- 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.
- 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.
- Byrne, B.M. (2008). Testing for time-invariant and time-varying predictors of self-perceived ability in math, language arts, and science: A look at the gender factor. In H.M.G. Watt & J.S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 145–169). Washington, DC: APA books.
- Eccles (Parsons), J.S. (1984). Sex differences in mathematics participation. In M.W. Steinkamp & M.L. Maehr (Eds.), *Advances in motivation and achievement. Vol. 2. Women in science* (pp. 93–137). Greenwich, CT: JAI Press.
- Eccles, J.S. (1985). A model of student enrolment decisions. *Educational Studies in Mathematics*, 16, 311–314.
- Eccles, J.S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly*, 11, 135–172.
- Eccles, J.S. (2005). Subjective task value and the Eccles et al. model of achievement-related choices. In A.J. Elliot, C.S. Dweck, & M.V. Covington (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York: Guilford Press.
- Eccles (Parsons), J., Adler, T.F., Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L., et al. (1983). Expectancies, values, and academic behaviors. In J.T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75–146). San Francisco: W.H. Freeman.
- Eccles, J.S., Adler, T.F., & 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 young adolescents. In R. Ames & C. Ames (Eds.), *Research on motivation in education* (Vol. 3, pp. 139–181). 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., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin*, 21, 215–225.
- Eccles, J.S., Wigfield, A., Harold, R., & Blumenfeld, P.B. (1993). Age and gender differences in children's self- and task-perceptions during elementary school. *Child Development*, 64, 830–847.
- Fredricks, J.A., & Eccles, J.S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology*, 38, 519–533.
- Goldstein, H. (1989). Models for multilevel response variables with an application to growth curves. In R.D. Bock (Ed.), *Multilevel analysis of educational data* (pp. 107–125). San Diego, CA: Academic Press.
- 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.
- Jacobs, J.E., Lanza, S., Osgood, D.W., Eccles, J.S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development*, 73, 509–527.
- MacCann, R. (1995). Sex differences in participation and performance at the NSW Higher School Certificate after adjustment for the effects of differential selection. *Australian Journal of Education*, 39, 163–188.
- Maccoby, E.E. (1966). *The development of sex differences*. Stanford, CA: Stanford University Press.
- Marsh, H.W. (1986). Verbal and math self-concepts: An Internal/External Frame of Reference Model. *American Educational Research Journal*, 23, 129–149.
- 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.

- Marsh, H.W., & Hau, K.-T. (2004). Explaining paradoxical relations between academic self-concepts and achievements: Cross-cultural generalizability of the Internal/External Frame of Reference predictions across 26 countries. *Journal of Educational Psychology, 96*, 56–67.
- Marsh, H.W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*, 397–416.
- Marsh, H.W., & Yeung, A.S. (1997). Causal effects of academic self-concept on academic achievement: Structural equation models of longitudinal data. *Journal of Educational Psychology, 89*, 41–54.
- Meece, J.L., Eccles (Parsons), J.S., Kaczala, C., Goff, S.B., & Futterman, R. (1982). Sex differences in math achievement: Toward a model of academic choice. *Psychological Bulletin, 91*, 324–348.
- Meece, J.L., Wigfield, A., & Eccles, J.S. (1990). Predictors of math anxiety and its consequences for young adolescents' course enrollment intentions and performances in mathematics. *Journal of Educational Psychology, 82*, 60–70.
- Midgley, C., Feldlaufer, H., & Eccles, J.S. (1989a). Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. *Journal of Educational Psychology, 81*, 247–258.
- Midgley, C., Feldlaufer, H., & Eccles, J.S. (1989b). Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. *Child Development, 60*, 981–992.
- Nesselroade, J.R., & Baltes, P.B. (1979). *Longitudinal research in the study of behavior and development*. San Diego, CA: Academic Press.
- Nicholls, J.G. (1978). The development of the concepts of effort and ability, perception of own attainment, and the understanding that difficult tasks require more ability. *Child Development, 53*, 310–321.
- Raudenbush, S.W. (1988). Educational applications of hierarchical linear models: A review. *Journal of Educational Statistics, 13*, 85–116.
- 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.
- Rogosa, D.R. (1988). Myths about longitudinal research. In K.W. Schaie, R.T. Campbell, W. Meredith, & S.C. Rawlings (Eds.), *Methodological issues in aging research* (pp. 171–210). New York: Springer.
- 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.
- Tonry, M., Ohlin, L.E., & Farrington, D.P. (1991). *Human development and criminal behavior: New ways of advancing knowledge*. New York: Springer-Verlag.
- Volet, S. (1999). Motivation within and across cultural-educational contexts: A multi-dimensional perspective. In T. Urdan (Ed.), *Advances in motivation and achievement* (Vol. 11, pp. 185–231). Stamford, CT: JAI Press.
- Watt, H.M.G. (2002). *Gendered achievement-related choices and behaviours in mathematics and English: The nature and influence of self-, task- and value perceptions*. Unpublished PhD, University of Sydney, Australia.
- Watt, H.M.G. (2004). Development of adolescents' self perceptions, values and task perceptions according to gender and domain in 7th through 11th grade Australian students. *Child Development, 75*, 1556–1574.
- Watt, H.M.G. (2005). Explaining gendered math enrollments for NSW Australian secondary school students. *New Directions for Child and Adolescent Development, 110*(Winter), 15–29.
- Watt, H.M.G. (2006). The role of motivation in gendered educational and occupational trajectories related to math. *Educational Research and Evaluation, 12*, 305–322.

- Watt, H.M.G. (2008). What motivates females and males to pursue sex-stereotyped careers? In H.M.G. Watt & J.S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 87–113). Washington, DC: APA books.
- Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review*, 6, 49–78.
- Wigfield, A., & Eccles, J. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review*, 12, 265–310.
- Wigfield, A., & Eccles, J.S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, 25, 68–81.
- Wigfield, A., Eccles, J., Mac Iver, D., Reuman, D., & Midgley, C. (1991). Transitions at 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.
- Wigfield, A., Eccles, J.S., Yoon, K.S., Harold, R.D., Arbreton, A., Freedman-Doan, K., et al. (1997). Changes in children's competence beliefs and subjective task values across the elementary school years: A three-year study. *Journal of Educational Psychology*, 89, 451–469.