Developmental Trajectories of Early to Middle Adolescents' Academic Achievement and Motivation

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INTRODUCTION

Even though there are both substantial individual variance and gender differences, the developmental trajectories of early adolescents' academic motivation and achievement show a downward trend (Wigfield, et al., 1991; Wigfield & Eccles, 1994). It is not clear, however, whether this grim trend in academic development marks a beginning of new era (i.e., discontinuous, qualitative shift), or an on-going change across childhood and adolescence (i.e., continuous, quantitative change).

Early adolescents' transition to junior high school poses an enormous challenge for developmentalists to tease out discontinuous shift from continuous development on one hand, and to untangle age-related individual development (Nicholls, 1990; Stipek & Mac Iver, 1989) from grade-related environmental change (Eccles, Midgley, & Adler, 1984; Eccles & Midgley, 1989; Feldlaufer, Midgley, & Eccles, 1989) on the other hand. Furthermore, this challenge is doubled when individual development and environmental change interact with each other (Eccles et al., 1984; Eccles et al., 1993).

RESEARCH QUESTIONS

From the life-span developmental perspectives (Baltes, 1987), we focus on the following important dimensions of developmental trajectories: (1) the multi-directionality and multi-dimensionality of development, (2) continuity (e.g., quantitative change in group mean level) and discontinuity (e.g., qualitative shift in academic standards), (3) stability and change in individual differences, and (4) differential rate and timing (i.e., onset and offset) of changes across different dimensions of academic achievement and for different groups of individuals. In line with perspectives on women's math achievement (Eccles, 1984, 1994; Kimball, 1989), we pay special attention to gender differences in various dimensions of achievement motivation (e.g., SCA, value, achievement goal orientation). In short, the main questions of the present study focus on whether there are parallel developmental trajectories (1) between achievement-related motivational beliefs and actual achievement outcomes, (2) between age-related developmental changes and grade-related environmental changes, and (3) between females and males.

PARTICIPANTS

Using the Michigan Study of Adult Life Transition (MSALT, headed by Jacquelynne S. Eccles) longitudinal data, we chart both short-term and long-term developmental trajectories of early adolescents. Approximately 1950 sixth grade study participants (52% females and 48% males) made a transition from elementary to junior high school (JHS) during the years of 1983-84. During these two years, we collected data from students and their parents and teachers at semester intervals. This data collection design allows us examine any changes occurring before, during, and shortly after the junior high transition. Among the study participants who made another transition to high school, we collected complete follow-up data on about 750 students at their 10th grade. These additional data allow us to investigate not only the short-term but also the long-term impact of the junior high transition.

MEASURES

From the theoretical perspectives of the social-cognitive approaches to achievement motivation (e.g., Deci et al., 1985; Dweck & Leggett, 1988; Eccles et al., 1983), we examine the following important dimensions of achievement motivation: self-concept of ability (SCA), intrinsic and extrinsic values, the modifiability of ability, perceived task difficulty, and mastery and performance goal orientations (see Appendix for the measures). In this study, we focus on math as a subject matter of academic development.

ANALYTIC FRAMEWORK

We adopt an analytic framework suitable for longitudinal data (Campbell, 1988). To take a full picture of developmental changes, we will examine the group mean level (i.e., central tendency) as well as the individual differences (i.e., dispersion) of longitudinal variables. Specifically, first, statistical procedures involving repeated measures MANOVA allow us to investigate not only the gender difference in terms of its overall group mean level but also any change over time in the mean level. In addition, the same statistical procedures enable us to test if there is any differential rate of change between gender. Second, covariance structure modeling procedures permit us to investigate the stability and change of individual differences over time. In this study, we employ graphic presentation of data to highlight the developmental trajectories of interest. Since our analysis is greatly assisted by the visual inspection of the graphic data, we plot appropriate values on a comparable scale over a comparable time frame to avoid any distorted view or unfair comparison. Finally, when we lack intervening data between the occasions of data collection, we use a method of extrapolation to estimate the most probable developmental trajectories.

RESULTS

Changes in Group Mean Level

Figure 1 displays a developmental pattern of change in students' math grades from the 6th to the 10th grade level. Consistent with Kimball's findings (1989), the females maintained their advantage over males in math grades throughout the school years. The students' grades were fairly high and stable in their mean level during the last year of elementary school (see also Table 1). Shortly, however, there was an abrupt and sharp decline in the mean level of math achievement during the first year of junior high school (JHS). This precipitous fall in the math grades discontinued by the end of the 7th grade, and then remained stable until 10th grade.

In contrast to the non-linear, discontinuous change in math grades, however, Figure 2 shows a linear, continuous decline in the mean level of students' self-concept of ability (SCA) in math during the period between the 6th and 10th grades. This decrement in SCA was relatively small and linear, although statistically significant, compared to the major setback in the math grades (see Table 2). Our data indicate that in spite of their consistently lower grades in math, males' SCA was higher than that of females throughout the years. There seems to be little sign that the mean level of SCA in math changed during the period of JHS transition despite the drop in math grades. In sum, as far as the mean level change especially during the JHS transition period is concerned, the developmental trajectory of the students' actual math achievement outcomes does not move in parallel with that of students' SCA. But what about students' other achievement-related motivational beliefs like values or goal orientations? Which one of the two divergent developmental trajectories is more characteristic of the changes in other achievement-related beliefs and attitudes during the period of early to middle adolescence? One with continuous, linear changes, or the other with discontinuous, non-linear changes? If there occurred any developmental discontinuity, was it triggered by JHS transition?

We have longitudinal data to test if JHS transition triggered any developmental discontinuity in several important motivational constructs. First, in its inverse relation to SCA, students' perceived task difficulty in math rose gradually and continuously (see Figure 2). As was the case in SCA, JHS transition does not seem to be responsible for the slight increase in the math difficulty experienced by students. Second, students' beliefs about the modifiability of their own math ability decreased slightly over two years (see Figure 3). As time passed by, these youngsters felt less confident that they could do better in math if they worked harder. However, the decrement in the concept of modifiability was relatively small and linear, unaffected by JHS transition.

Third, based on the method of extrapolation on the intervening, missing data, we drew a similar conclusion on the value component of achievement motivation as we did on SCA, task difficulty, and the modifiability of ability; that is, in general there was a fairly gradual and linear decline in the students' perceptions of extrinsic value (i.e., usefulness and importance) and intrinsic value (i.e., liking and interest) in math (see Figure 3). Compared to ability-related self-perceptions, however, the rate of decline in the value-related self-perceptions was steeper. Furthermore, the rate of decline was uneven between females and males. Since females' extrinsic value decreased at a slightly more accelerated rate than that of males, a significant gender gap favoring males emerged by the end of 10th grade (see

Table 2 for the significant gender by time interaction effect). Figure 3 depicts basically the similar developmental trajectories involving a widening gender gap in students' intrinsic value (see also Table 2). It is unclear from Figure 3, though, if JHS transition had any significant impact on students' declining values, but other empirical evidence from previous research (e.g., Wigfield & Eccles, 1994) seems to suggest that the declining value was not necessarily prompted by the school transition in particular. Instead, students' academic values probably started to decrease from the earlier stage of schooling and continued to do so through the later stage of the schooling.

Fourth, similarly with intrinsic and extrinsic values, students' goal orientations can be mapped on generally declining trajectories (see Figure 4 and Table 2). Overall, the direction and the rate of change were similar between values and the goal orientations. However, the pattern and the rate of change were somewhat different between females and males and also across the type of goal orientation. For one, the decrease in males' mastery goal was temporarily interrupted in the midst of school transition, while the decrease in females' kept falling. But soon the downward trend of males' mastery goal resumed. Without narrowing the initial gender gap in the mastery goal, males remained in a disadvantaged position. For another, the downward trend in students' performance goal orientation was disrupted for both females and males. But while females soon continued their downward course, males stayed at the same level. Consequently, the initial gender gap grew widened, favoring females' adaptive motivation (i.e., lower performance goal orientation). In summary, there exists some evidence that JHS transition contributed to the non-linear, discontinuous changes in students achievement goal orientations. However, the changes in goal orientations were not as extreme as the dramatic change in math grades.

To recapitulate, while the mean level change in math grades was characterized by an abrupt, discontinuous, and non-linear change most likely triggered by JHS transition, the mean level changes in several different measures of students' motivational beliefs were marked by more or less a gradual, continuous, and linear change, largely unscathed by the JHS transition. These motivational beliefs seem to experience an on-going process of gradual deterioration across the most part of students' academic career.

Changes in Individual Differences

Thus far we have examined the mean level of the longitudinal data. However, developmental analysis is not complete until we consider changes in individual differences (i.e., relative class standing and inter-individual variance in grades). When we took into account the variance/covariance structure of the same longitudinal data (see Yoon, 1996 for full details), a hidden picture of the dramatic impact of JHS transition on the students' academic developmental trajectories emerged. Figure 5 illustrates the differential stability of individual differences in grades, SCA and intrinsic value in math during three successive points of time in JHS transition: before transition (within the year of 6th grade), during transition (between the years of 6th and 7th grades), and after transition (within the year of 7th grade). The stability of individual difference in math grades was very high (.87 for females and .90 for males) before the transition, but declined sharply (.41 for females and .50 for males) during the transition. Apparently, students' relative class standing in math performance was substantially shuffled. Therefore, their earlier grades during the elementary school year was much less predictable of later grades at the first semester of 7th grade. Those who used to be at the top of their class could have slipped down to somewhere in the middle. Or the opposite could have happened to those who have always remained at the bottom of the echelon. However, the great de-stabilization of individual ranks in math achievement is immediately followed by their re-stabilization. As Figure 5 shows, the stability of individual differences in math grades was fully recovered among females (.89), but only partially recovered among males (.62). When the dust of transition settled, students found themselves in a new and different position in academic performance where students are likely to stay for a while. In short, JHS transition triggered a major re-alignment of individual students' relative class standing in math performance. Putting together, JHS transition not only lowered the mean level of math grades significantly and substantially, but at the same time it also rearranged students' relative rank in math achievement in a massive scale.

But the pattern of stability of individual differences in SCA runs again in an unparalleled fashion against that of grades. For example, the modest stability of females' SCA before the transition (.46) remained at about the same level (.48) even in the midst of the turbulent period of JHS transition which accompanied the steep fall of grades and the tremendous shake-up of relative position in math achievement. Instead, a major setback in the stability of SCA among females (.17) came only after the transition. The somewhat shaky SCA at the 6th grade was totally shattered by the end of the 7th grade. In other words, the major changes in math grades during the JHS transition did not have a concurrent and direct impact on students' SCA. The large disturbance in SCA followed after students experienced a series of setbacks in their status of math achievement not only in the absolute sense (i.e., the mean level of grades) but also in the relative sense (i.e., individual's rank in the classroom). Interestingly, the major re-alignment of individual differences in SCA was taking place at the same time when the major re-stabilization of individual differences in performance was occurring. Even though less dramatic, males' SCA showed basically the similar pattern of change in the stability of individual differences (see Figure 5). Finally, even if not shown in Figure 5, we have additional evidence indicating that the stability of individual differences in intrinsic value was similarly affected by JHS transition (see Yoon, 1996).

DISCUSSION

How can we characterize the developmental trajectories of early to middle adolescents' academic achievement and motivation? A continuity or a discontinuity? Our answer is, it depends.

First, students' math grades can be characterized by a discontinuous, non-linear change which represents an abrupt, sharp decline at the time of JHS transition. This sudden downward shift in JHS math grades took place independent of relatively gradual and linear decline in achievement-related beliefs and attitudes. This independent (or unparalleled) developmental trajectories suggest some qualitative difference between them. Consistent with the findings of previous research (Blyth, Simmons, & Bush, 1978; Eccles, et al., 1984 for a review), we believe that the discontinuity in students' achievement outcomes resulted from systematic, grade-related changes that were accompanied by a transition to the new junior high school environment. Junior high school teachers, especially math teachers, seemed to adopt stricter and more normative grading criteria than elementary teachers do (Eccles, et al. 1984). As a result, fewer students attain the highest standard of excellence, and far more students receive lower grades on the average than they got during their elementary school. More specifically, the stricter grading standards may have lowered the mean level, while the more prevalent normative grading practices may have increased the individual variance in the math grades (see Table 1). The resultant wholesale grade deflation exemplifies a discontinuity in educational experiences that early adolescents gained with the inception of junior high schooling.

However, the mean level change does not show us the real disturbances under the surface. What was not apparent on the surface was the major re-alignment of relative class standing in math grades. Below the surface level, then, a more fundamental, turbulent current was felt. When the individual differences in math grades regained their stability, the major shock wave of disturbance spilled over to the SCA side of the water. What was the real cause of these series of disturbance? We suspect that ability grouping at JHS might be particularly responsible for the shock wave. When all smartest kids were put in the same class, some of the A students are likely slip down. When all low performing students were tracked in the same class, some of the C students are likely to get A's. This shuffling of grades, in combination with the wholesale grade deflation, is likely to create a significant change in adolescents' self-perception of their own ability.

Second, despite all these disturbances at the onset of junior high school, the mean levels of many achievement-related beliefs declined only gradually and linearly. The change in the mean level of SCA probably exemplifies a continuous, linear change occurring during early to middle adolescence. The pattern of change in students' SCA was quite independent of the the pattern of change in their grades. It is quite possible that these adolescents concluded that their lower grades in math did not reflect their true performance level, but reflect the changes in teacher's grading criteria. Furthermore, the mean levels mask all the fluctuations within and across different ability-grouped math classes.

Did the JHS transition leave a permanent mark (i.e., a long-term effect) on early adolescents' developmental trajectories of academic motivation and achievement? Does JHS transition mark a beginning of a new era? Our answer is, again, it depends. With regard to the impact of JHS transition on self-concept in particular, our finding is somewhat at odds with that of Simmons, Rosenberg, and their colleagues (e.g., Rosenberg, 1979; Simmons, et al., 1979). These researchers insist that JHS transition is the primary cause of the decline in SCA. They also maintain that the school transition can directly and immediately affect students' self-appraisals. Instead, our findings suggest that the decline in the mean levels of SCA takes place in continuation of earlier developmental trajectory. When a profound change in individual differences in SCA took place, it was not the direct and immediate result of the JHS transition per se. Instead, it came only indirectly and with a time lag through the massive destabilization of individual differences in math grades.

But, however the impact of JHS transition was transmitted, there is no question that its impact was profound. Most fundamentally, for example, the dramatic and massive change of the relative class standing in students' grades and subsequently SCA (and intrinsic value as well) left a permanent mark on their academic career. It is in this relative sense (repositioned class rank) rather than in absolute sense (lower grades per se) that the JHS transition lead to a new era for many adolescents.

Finally, some gender difference found in this study deserves comment. By the end of 7th grade, compared to their female peers, males held higher SCA in the face of lower grades, maintained higher performance orientation and lower mastery goal orientation, and attached about the same level of intrinsic and extrinsic values to math. This pattern suggests that males are in a less favorable position than females as far as adaptive goal orientations are concerned. But by the time males reach 10th grade, their relative disadvantage in academic and motivational profile is somewhat mitigated by their slightly higher intrinsic and extrinsic values. Females' greater loss of intrinsic and extrinsic values in math between 7th and 10th grades should alarm, because this decline comes exactly when they are making important educational and career decisions. However, due to our lack of data at the intervening years between the 7th and 10th grades, we cannot point to the timing of the onset of this risk factor. Further developmental research involving more inclusive longitudinal is needed.

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APPENDIX

The Measures of the Study

Self-concept of ability

- How good at math are you?
  (1) not at all good ... (7) very good
- If you were to rank all the students in your math class from the worst to the best in math, where would you put yourself?
  (1) the worst ... (7) the best
- Compared to most of your other school subjects, how good are you at math?
  (1) much worse ... (7) much better
- How well do you think you will do in math this year?
  (1) not at all well ... (7) very well

Perceived task difficulty

- How hard is math for you?
  (1) not at all difficult ... (4) very difficult
- Compared to most other school subjects you have taken or ar taking, how hard is math for you?
  (1) my easiest course ... (4) my hardest course

Perceived modifiability of ability

- Anyone can be good at math if they work hard enough.
  (1) not at all true ... (4) very true
- Anyone could do well in math if they really wanted to.
  (1) not at all true ... (4) very true
- I can be good at any type of math if I work on it hard enough.
  (1) not at all true ... (4) very true
- I could learn to do any type of math problem if I really wanted to.
  (1) not at all true ... (4) very true

Intrinsic value

- In general, I find working on math assignments:
  (1) very boring ... (7) very interesting.
- How much do you like doing math?
  (1) a little ... (7) a lot

Extrinsic value

- For me, being good at math is:
  (1) not at all important ... (7) very important
- In general, how useful is what you learn in math?
  (1) not at all useful ... (7) very useful

Mastery goal orientation

- I feel good when I can solve a problem in math now that I was not able to solve before.
  (1) not very true of me ... (7) very true of me
- When my teacher corrects my work in math, I like to see if my work has improved.
  (1) not very true of me ... (7) very true of me
- Doing better in math than I have done before is important to me.
  (1) strongly disagree ... (7) strongly agree
- Doing the best I can in math is important to me.
  (1) strongly disagree ... (7) strongly agree
- I try to do the best I can in math.
  (1) not much of the time ... (7) all of the time.
- Trying as hard as I can in math is important to me.
  (1) strongly disagree ... (7) strongly agree

Performance goal orientation

- I compare my math ability to other students in my math class.
  (1) never ... (7) very often
- I like to know how my math ability compares to other students in my math class.
  (1) not at all true ... (7) very true
- Doing better in math than other students in my classroom in important to me.
  (1) strongly disagree ... (7) strongly agree
- I compare how hard I try in math to how hard other students try in my classroom.
  (1) never ... (7) very often
- Trying harder in math than other students in my classroom is important to me.
  (1) strongly disagree ... (7) strongly agree

Table 1
Means and S.D.s of the Study Variables

	N	6th Grade Fall	6th Grade Spring	7th Grade Fall	7th Grade Spring	9th Grade Fall	9th Grade Spring	10th Grade Fall	10th Grade Spring[§]
Math Grades-Females	394	12.24	12.15	11.15	10.58	10.59	10.04	10.18	9.82
		(2.23)	(2.33)	(2.71)	(2.99)	(2.82)	(3.18)	(3.06)	(3.30)
Math Grades-Males	322	11.70	11.71	10.27	9.82	9.87	9.52	9.67	9.18
		(2.41)	(2.67)	(3.12)	(3.14)	(3.05)	(3.29)	(3.26)	(3.53)
SCA-Females	388	5.20	5.10	5.06	4.94				4.58
		(1.10)	(1.11)	(1.13)	(1.18)				(1.33)
SCA-Males	303	5.30	5.33	5.29	5.24				4.95
		(1.11)	(1.10)	(1.17)	(1.21)				(1.24)
Task difficulty-Females	896	3.35	3.31	3.38	3.39				
		(1.37)	(1.35)	(1.35)	(1.38)				
Task difficulty-Males	785	3.14	3.06	3.26	3.27				
		(1.40)	(1.36)	(1.34)	(1.35)				
Modifiability-Females	886	3.73	3.64	3.56	3.49				
		(0.41)	(0.49)	(0.51)	(0.59)				
Modifiability-Males	784	3.67	3.59	3.50	3.46				
		(0.47)	(0.53)	(0.56)	(0.59)				
Extrinsic value-Females	387	6.23	6.07	5.87	5.76				5.04
		(1.02)	(1.06)	(1.20)	(1.28)				(1.52)
Extrinsic value-Males	306	6.08	6.06	5.89	5.73				5.56
		(1.09)	(1.10)	(1.20)	(1.22)				(1.34)
Intrinsic value-Females	388	4.85	5.06	4.77	4.45				3.70
		(1.69)	(1.61)	(1.58)	(1.70)				(1.83)
Intrinsic value-Males	304	5.09	5.10	4.79	4.56				4.04
		(1.57)	(1.65)	(1.62)	(1.69)				(1.78)
Mastery goal-Females	884	6.16	5.95	5.79	5.58				
		(0.86)	(1.00)	(1.10)	(1.18)				
Mastery goal-Males	778	5.99	5.69	5.67	5.38				
		(0.98)	(1.16)	(1.14)	(1.19)				
Performance goal-Females	891	3.88	3.53	3.51	3.37				
		(1.42)	(1.45)	(1.50)	(1.44)				
Performance goal-Males	786	3.98	3.71	3.74	3.70				
		(1.41)	(1.39)	(1.48)	(1.37)				

Note: S.D.s in parentheses.

§ Only math grades were collected at the Spring semester. The rest of the variables were collected by the year end of the 10th grade.

Table 2

F Statistics of Repeated Measures MANOVAs: Gender, Time, Gender by Time Design

	Between-Subject Effect			Within-Subject Effects					
	Gender			Time			Gender by Time		
	df	*F*	*p*	*df*	*F*	*p*	*df*	*F*	*p*
Math Grades	1, 714	15.69	***	7, 708	87.34	***	7, 708	0.98	ns
SCA §	1, 689	11.94	***	5, 685	51.43	***	5, 685	1.92	†
Task difficulty	1, 1679	12.51	***	3, 1677	6.08	***	3, 1677	1.36	ns
Modifiability	1, 1668	6.34	*	3, 1666	87.86	***	3, 1666	1.09	ns
Extrinsic value §	1, 691	4.45	*	5, 687	77.66	***	5, 687	7.17	***
Intrinsic value §	1, 690	4.42	*	5, 686	82.87	***	5, 686	2.51	*
Mastery goal orientation	1, 1660	20.38	***	3, 1658	121.01	***	3, 1658	2.60	†
Performance goal orientation	1, 1675	14.62	***	3, 1673	37.45	***	3, 1673	2.85	*

Note: ns: not significant, † $p<.10$, * $p<.05$, ** $p<.01$, *** $p<.001$

§ Values at the 12th grade were included in MANOVA, but they were exclued from the Table 1 and all the Figures.

Figure 1. **Change in Math Grades by Gender**

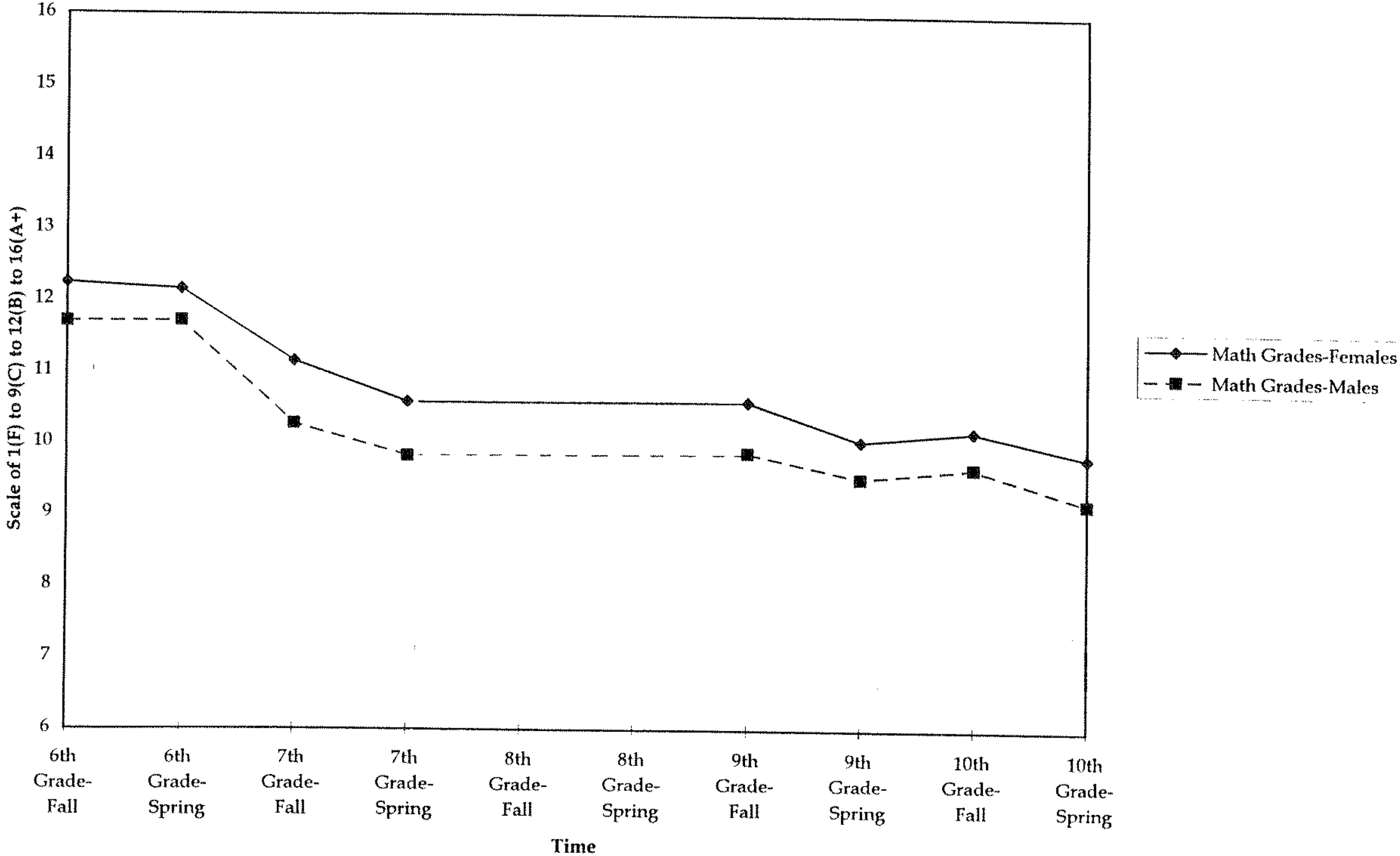


Figure 2. **Changes in SCA and Perceived Task Difficulty by Gender**

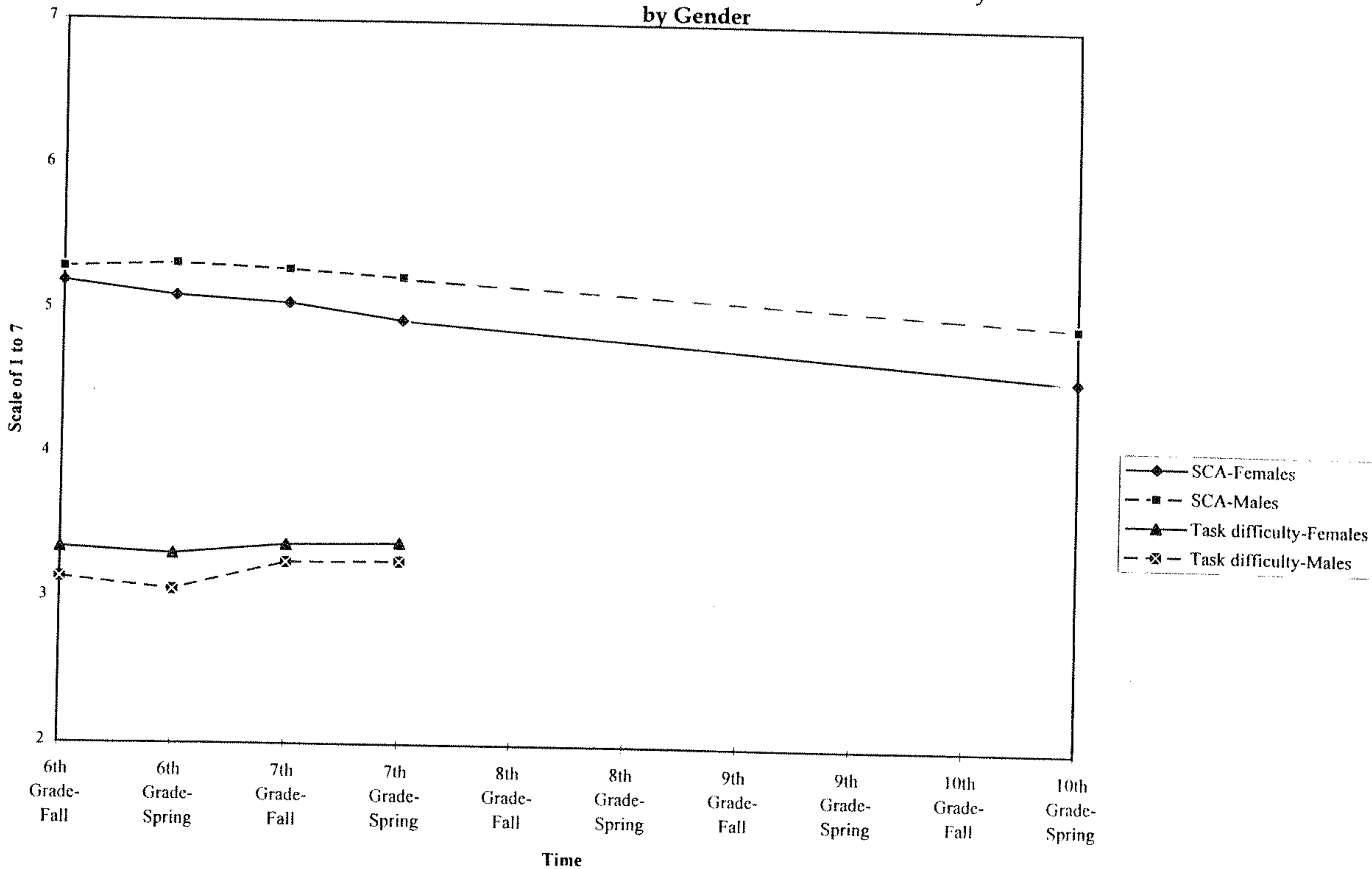


Figure 3. **Changes in Intrinsic and Extrinsic Values and the Modifiability of Math Ability by Gender**

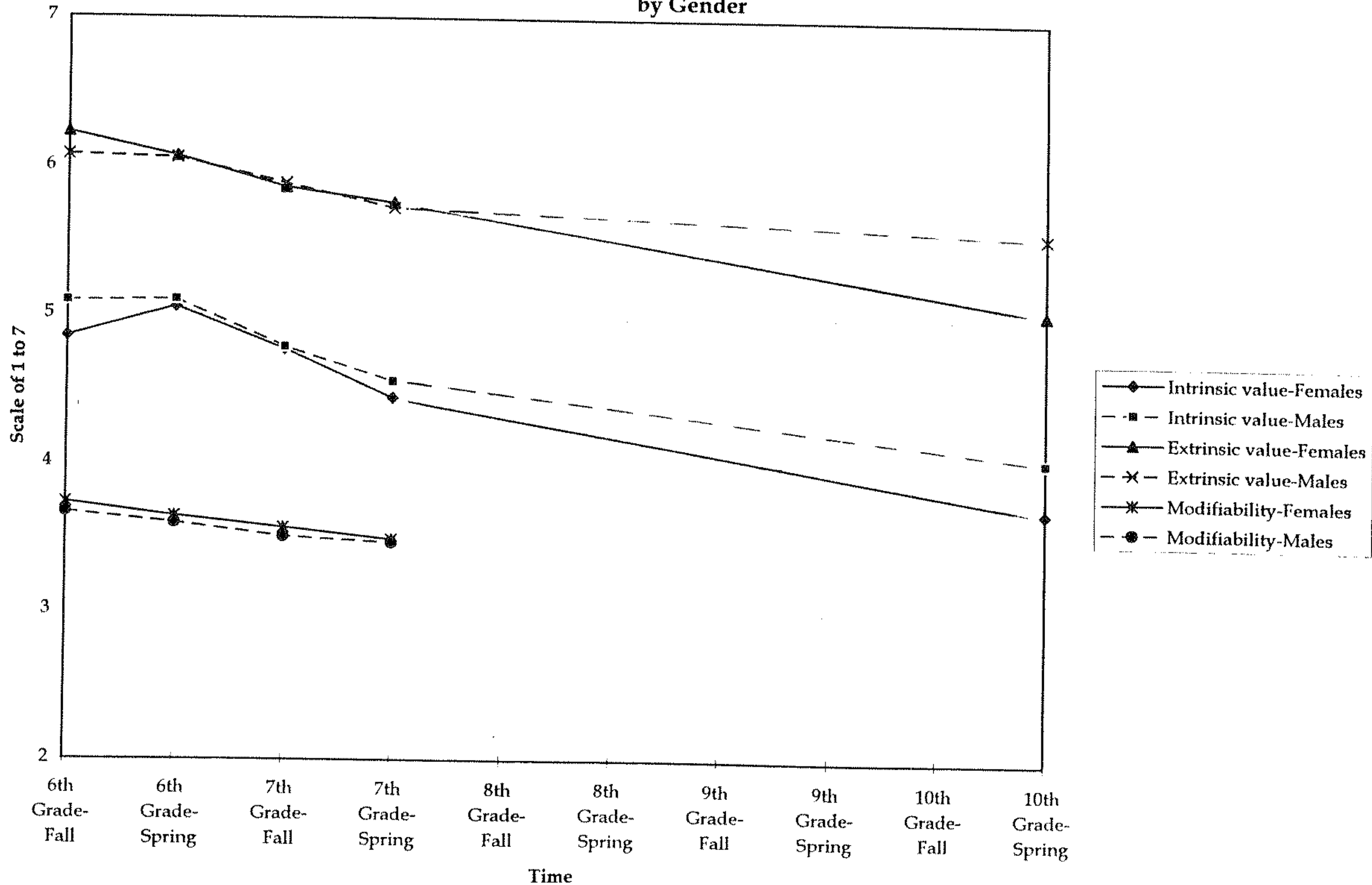
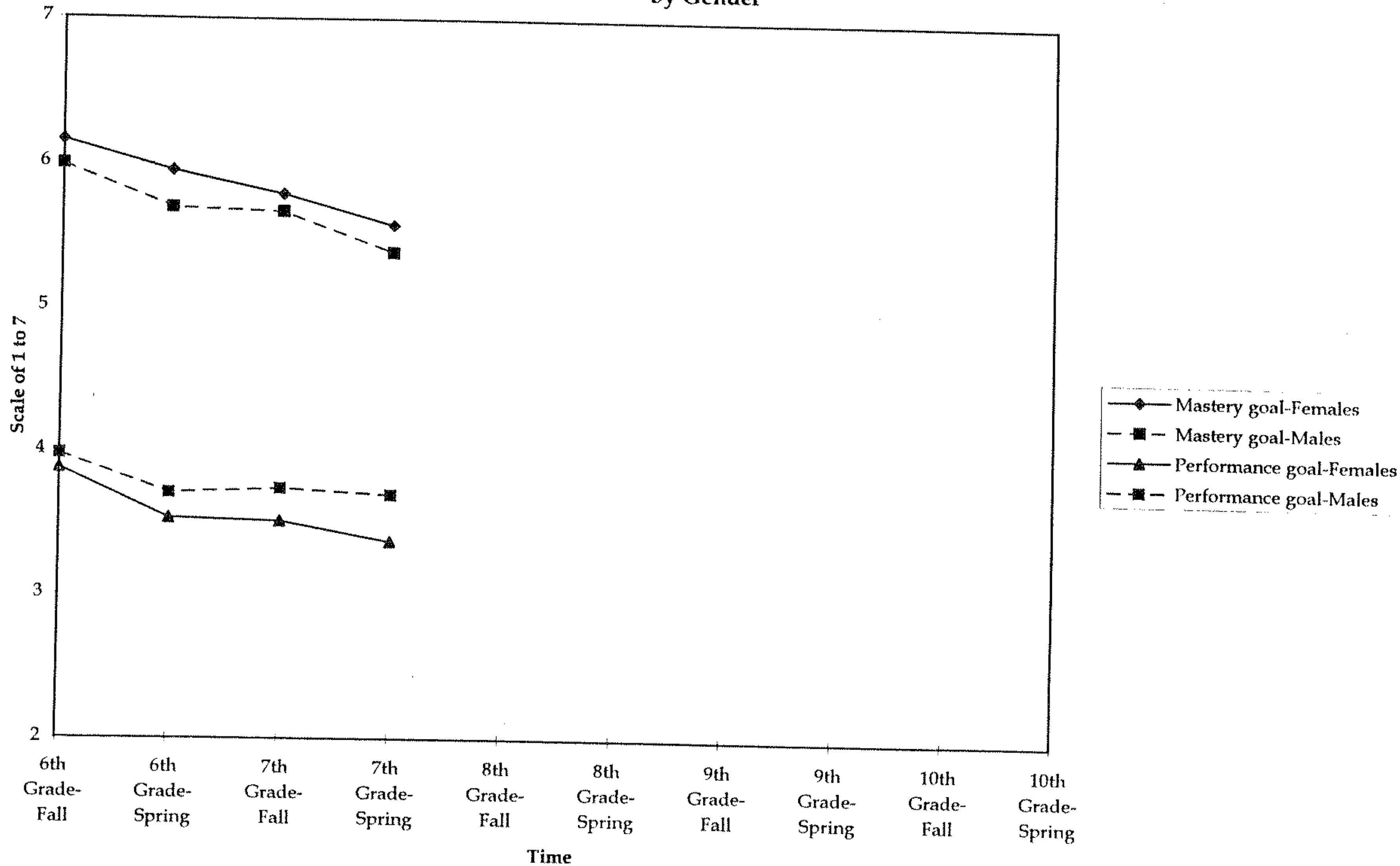


Figure 4. **Changes in Mastery and Performance Goal Orientations by Gender**



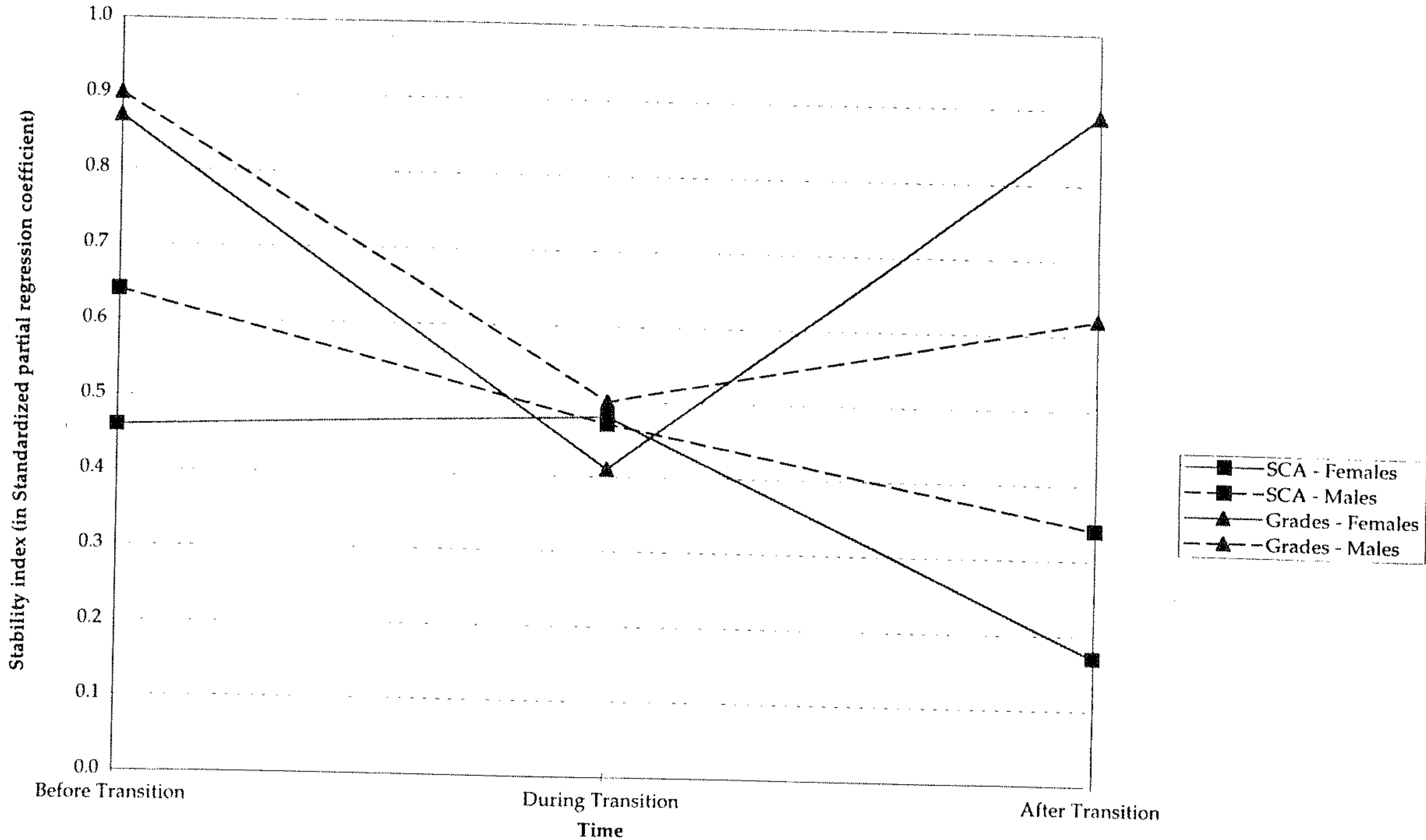


Figure 5. **Change in the Stability of Individual Differences in SCA and Math Grades by Gender**