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Parental Influences on Students' Perceptions of Talent in Relation to High School Mathematics: Effects on Mathematics Participation

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Boys' and girls' current perceptions of talent in relation to high school mathematics were tested for the effects of students' reported closeness of relationship with parent, reported parental knowledge about their performance, view of their child's talent as well as control and autonomy support, over the influence of prior mathematical performance and perception of talent. The study was conducted over a two-year period, with participants initially Advanced and Intermediate Year 10 students (N=113) from two coeducational Government schools in an upper-middle class metropolitan area of Sydney. Multiple regression analyses revealed different patterns of relations for boys and girls with their mothers and fathers. There was considerable similarity between mothers' patterns of influence for sons and daughters, with direct influences on students' perceptions of talent being warmth of relationship, mother's perception of child's talent, and child's previous perception of talent. There was little similarity, however, between fathers' patterns of influence for sons and daughters. With both sons and daughters, the only influence on student perception of talent additional to the child's previous perception of talent, was reported father perception of child's talent, although there were quite different indirect effects for boys and girls. Results are discussed in terms of the Identification and Information-Processing approaches for each of the four groups, and subsequent influences on mathematics participation tested.

Over the past few decades, there has been increasing recognition of the gender imbalance in participation in mathematical and technical fields. Two main perspectives have informed this imbalance: the first based on a concern for each individual to develop his or her talents in mathematics, the second based on a concern for national technological development. Both proponents, however, agree this is a robust phenomenon.

Recent studies have both identified (Eccles & Jacobs, 1986) and found (Watt & Bornholt, 1994) that one's perception of ability in mathematics is an important predictor of plans for participation in Higher School Certificate (HSC) mathematics, and hence planned participation in mathematics-related careers. Consequently it is important to investigate students' perceptions of mathematical talent and influential formative factors.

Parental Influences on Child Perceptions

Research into the impact of parent influences on children has moved

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away from the positivist focus on behaviour of the 1960s. There has been an increasing emphasis on cognitive processes and information-processing, the rationale being that it is likely to be the cumulative impact of parent views expressed in their verbal and non-verbal behaviours that influences the child, rather than isolated measured behaviours. Another factor in the shift to cognitive research is that to focus only on parent behaviours is to treat parents as unthinking beings, leading to the anomaly of paying close attention to children's interpretations of events, but attributing little cognitive life to the parents (Goodnow, 1988, p. 287).

Studies of the influence of parent cognitions on their children has had a strong implicit or explicit information-processing emphasis (Sigel, 1985). In the academic domain, there are two main bodies of research investigating the influence of parental views on child outcomes. The first is contextualised through the Expectancy-Value Theory of Achievement Motivation developed by Eccles and colleagues, and places particular emphasis on predicting mathematics participation in the form of course enrolments. The second is Cognitive Evaluation Theory developed by Grolnick, Ryan and colleagues, and is concerned with parent influences on achievement via children's motivational processes.

While each of the two theoretical frameworks examines factors other than parent influences on child perceptions, this paper focuses on precisely the common aspect of each perspective. Eccles and colleagues have found children's self-perceptions of their mathematics ability to differ for boys and girls, and have investigated the influence of parents' differential child perceptions dependent on the sex of their child on this outcome. Grolnick and colleagues examine the influence of parent autonomy support, control and involvement on children's school grades, via children's perceptions of competence, control understanding and self-regulation. Both perspectives thus incorporate study of parent variables (perceptions of child's ability, autonomy support, control and involvement) on children's perceptions of mathematical ability or competence.

Neither of these two bodies of literature have been reconciled with an earlier, but empirically disappointing emphasis on agreement in parent and child ideas as based on identification or the warmth of relationship between parent and child (Goodnow, 1988, p. 311). A synthesis has been proposed whereby warmth of relationship affects the child's acceptance or rejection of the received parental message (Cashmore & Goodnow, 1985; Furstenberg, 1971).

Research Findings of Parent Influences from an Information-Processing Perspective

There are many reported findings of gender differences in children's self-perceptions of mathematical ability (eg: Eccles, Jacobs, & Harold, 1990; Jacobs & Eccles, 1992; Bornholt, 1994) which are believed to impact on future mathematics participation in the form of high school

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course selection (Eccles, 1984, 1987, 1989; Watt & Bornholt, 1994) and hence participation in mathematics-related careers (Watt & Bornholt, 1994).

Eccles and her colleagues have posited that parental gendered perceptions of their child's mathematical ability are probable influences on students' gendered perceptions of their own ability. They reported findings to confirm this thesis in a study of 900 junior high school children and their parents (Jacobs & Eccles, 1992; Eccles, Jacobs, & Harold, 1990), but failed to detect the hypothesised gender effect on parent perceptions in a second group of 500 kindergarten to third grade children and their parents (Eccles, Jacobs, & Harold, 1990). Complex explanations for this reported developmental trend are in terms of parents' gender stereotypes regarding mathematical ability and their knowledge of individuating information which increases as the child develops. However, a close inspection of the study reporting parents' differences in perceptions of their child's mathematical ability on the basis of their child's gender, reveals that significance in this sample of 900 children and their parents, was only at the .05 level, with a mean difference of .26 on a 7-point scale. Thus we can have only limited confidence in a small difference, which is possibly an artifact of sample size. Consequently the evidence for the influence of gendered parent perceptions must be seen as relatively weak.

There is evidence for a direct influence of parental perceptions regarding their child's ability on their child's perception of ability. A strong influence of mother's perception of child's ability on the child's own perception has been found (b=.47, Jacobs, 1987, cited in Eccles, Jacobs, & Harold, 1990). Although these large ongoing Michigan studies from which Eccles and her colleagues write collected mother and father data, as yet only results for mothers have been published, so the authors have no corresponding measure of father influence. They note, however, that there is a similar pattern of maternal influence on boys and girls, where mothers' perceptions of their child's ability impacts on both child perceptions of ability, and value judgements in the form of interest (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993), both of which then influence course enrolment (Eccles, Jacobs, & Harold, 1990).

Thus, the work by Eccles and colleagues suggests mothers' perceptions influence children's interest in mathematics and their gendered perceptions of mathematical ability, which in turn influence course enrolment. Their proposed implications are in terms of interventions to convince parents that their daughters are talented at maths (although it is a point of contention whether parents need convincing of this), which should then encourage participation in advanced mathematics courses and mathematics-related careers (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993).

Cognitive Evaluation Theory (CET), although also concerned with the impact of parent variables on student cognitions, is more broadly contextualised than the work of Eccles and colleagues which relates

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specifically to mathematics. CET focuses on the influence of parent autonomy support, control and involvement on students' genderal perceptions of academic competence, and is concerned ultimately with general school achievement.

Grolnick and colleagues working in the CET paradigm have found parental autonomy support (as perceived by the child) rather than control conducive to the child's perceptions of competence, along with parent involvement (Grolnick, Ryan, & Deci, 1991). Noteworthy also is their claim of evidence of parent consistency, in that there were higher correlations within autonomy and involvement domains across parent gender, than within parent correlations across domains (Grolnick, Ryan, & Deci, 1991, p. 512), although the effects of this were not explored. This parent consistency was interpreted as being due to either shared parent values, or the child's 'pull' for a certain degree of autonomy support and involvement from his or her parents.

Thus parental autonomy support and involvement influence children's perceptions of competence, although these explain only 13% of the variance in child perceptions (Grolnick, Ryan, & Deci, 1991, p. 514), suggesting there are other important influences on these perceptions not included in the model. Both proponents and critics of CET have argued for a clarification of the relation between parent autonomy support and children's perceptions of competence (Grolnick & Ryan, 1989; Butler, 1989), since the CET focus on autonomy may mask the possibility that it is not the most powerful or relevant influence on student motivation (Butler, 1989).

Synthesising the Information-Processing and Identification Approaches

Early ideas about parent-child agreement were in terms of the warmth of relationship between parent and child, resulting in agreement between parent and child perceptions. More recently, as a way of reconciling this view with the information-processing approach, it has been suggested that children in a warm relationship with their parents are more likely to accept perceived parent views, while children not in a warm parent relationship are more likely to reject such messages. Proposed also is the idea that warmth of relationship may impact on child efforts to hear parental messages (Goodnow, 1988).

There is some evidence of a direct link between warmth of relationship with parent and adolescent self-esteem, although these have typically been weak and inconsistent across studies (Allen, Hauser, Bell, & O'Connor, 1994). Warmth of relationship with parent has recently been incorporated into a conception of a parent variable termed

'autonomous-relatedness' (Allen, Hauser, Bell, & O'Connor, 1994). This research orientation appears compatible with the CET framework, with its emphasis on autonomy. The authors state that a common conceptualisation of the relation between autonomy and relatedness with parents is to see them as polarised. They argue that this need not be so, as it is possible for children to maintain high autonomy and relatedness with their parents, and find this is related to

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adolescents' psychosocial development in the case of fathers in the form of self-esteem and ego-development. It is argued that parent autonomy support is only conducive to adolescent development in the context of autonomous-relatedness.

Despite the virtual neglect of relationship warmth in relation to child perceptions, there are still allusions to this factor subsidiary to some studies. For example, Dix and Grusec (1985) suggest parent-child intimacy may alter how parent attributions regarding the child proceeds, although this is not tested. An earlier study, concerned with student achievement orientation rather than self-perceptions, found that moderate levels of parental warmth facilitate girls' achievement orientation, while high levels of parent warmth influence boys' achievement orientation (Stein & Bayley, 1973). This phenomenon may help explain the inconsistent findings in relation to warmth of relationship with parent, and certainly deserves further investigation.

Directionality of Parent-Child Influences

Although most studies have assumed the direction of influence in parent-child relations is from the parent to the child, cautions have been expressed about this, suggesting bi-directional influences to be most appropriate (eg: Bell, 1968).

Bi-directional models have been proposed and tested, finding that parent-child perceptions are reciprocally related over time. Over a long period, however, a study measuring maternal influences on girls found these to be more related to girls' perceptions of mathematical ability than vice versa (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993). Thus there is good reason to be concerned with parent perceptions as these do influence the child particularly over time.

Measuring Parent Perceptions

Defining the Parent. Studies in the area of parental influence have typically focused on the mother. In the studies reviewed above, note that although Eccles and colleagues collected data from both parents, only mother data have so far been analysed and reported. In studies including data concerning both mothers and fathers, there is little indication that children perceive their mothers as more influential than their fathers (Grolnick, Ryan, & Deci, 1991, p. 514).

Following recent calls for increased research on fathers' roles in adolescent development (Phares & Compas, 1992), and research suggesting the influence of fathers on motivational development may be complex and merits further study (Grolnick, Ryan, & Deci, 1991, p. 515), this paper examines both maternal and paternal influences on children's perceptions or mathematical ability.

Whose Perception? The overriding majority of studies have obtained parent reports of parent perceptions. It has been suggested, however, that individuals filter their experience through a net of expectations and attributions such that similar phenomena are reported differently by different people (Sameroff & Feil, 1985). This seems to imply that a child's understanding of parent perceptions may differ from parents'

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reported perceptons, and it has indeed been found that especially before adolescence, children tend to project their own perceptions onto their parents (Goodnow, 1988).

The impact of child-reports of parent perceptions on the child's own perception has been largely unexplored (Grolnick, Ryan, & Deci, 1991),

even though some theorists (eg: Blyth, 1982; Bronfenbrenner, 1977) have suggested children's phenomenal view of their socialising environment is of considerable importance. Goodnow (1988) goes so far as to say the critical feature may not even be the 'actual' parent variables, but rather the child's interpretation of them.

There is a sizeable body of data demonstrating that children's views on several issues are better predicted by their perceptions of parent positions than by the positions parents report for themselves (Goodnow, 1988, p. 311). Grolnick, Ryan and colleagues working in the CET paradigm have found interviewer ratings of father involvement, which are surely a step closer to accuracy than child reports, to be unrelated to the child's inner resources, whereas child reports of father involvement were positively associated with children's inner resources (Grolnick, Ryan, & Deci, 1991; Grolnick & Ryan, 1989). It has also been found that while projection by the child of his or her own perceptions onto the parent may be likely before adolescence, there is increasing accuracy in child perceptions after adolescence (Goodnow, 1988).

Modelling Parent Influences. Given that both maternal and paternal perceptions are important influences on the child, and that the influence of child-reported parent perceptions on child perceptions merits closer attention, how should these parent influences be modelled? Systems theory would suggest that mothers' and fathers' roles are interwoven and hence warrant simultaneous consideration (Bell & Bell, 1983).

The drawback to such an approach is that, using classical regression analyses, simultaneous inclusion of mother and father variables into a model may mask the existence of important causal paths. This problem would occur when one parent exerts a greater influence than the other parent from any particular variable, which is more than likely to occur. Additionally, since there is no theoretical reason to expect parents to exert the same patterns of influence on child perceptions, it was decided to test separate models for mother and father perceptions. Boys and girls are also considered separately on the hypothesis that while gender differences in child perceptions are likely, and so could be accounted for in the model, it also seems likely that patterns of influence may vary according to child gender.

Influence of Child Perceptions on Mathematics Participation

The rationale for studying formative influences on children's perceptions of mathematical ability or talent was that these perceptions have been found to influence planned participation in mathematics, both for the Higher School Certificate (an externally

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moderated State-wide examinaton in New South Wales, determining access to tertiary courses), and hence in mathematics-related careers (Watt & Bornholt, 1994). The work of Eccles and colleagues suggests value judgements such as interest also influence participation in mathematics courses.

Hypothesised Model

Influences on Student Perception of Mathematical Talent. On the basis of previous findings, it was posited that the main influence of parents on child perceptions, which may or may not be based on their mathematical performance, would be from child-reported parent perceptions of child's talent. There is suggestive evidence only that warmth of relationship with parent may directly impact on child perceptions, although it may predict whether or not the child accepts parents' views. It may also affect child disclosure or parent efforts to hear about children's mathematics performance. CET suggests a direct path from parent autonomy support to child perceptions of talent, although such links have been found to explain little of the variance in child perceptions of competence, and may operate via other processes. The work on autonomy-relatedness suggests autonomy support may only be influential in the context of a warm relationship with the parent.

Gender differences are expected in children's perceptions of mathematical talent, and tentatively suggested for parent perceptions of their child's talent. It is proposed that patterns of parent influences will vary according to both student and parent gender.

The model incorporates previous measures both of students' mathematical performance and perception of talent, so that parent effects over and above these are of substantive significance. Also included is a child-report measure of how much parents know about the child's mathematical performance, which a strongly information-processing based approach would suggest influences parent perceptions of the child's talent.

Influences on Planned Participation in Mathematics. The variables expected to influence mathematics participation for the Higher School Certificate (HSC) are students' perceptions of mathematical talent (Watt & Bornholt, 1994) and interest in mathematics (Eccles, Jacobs, & Harold, 1990). To my knowledge, there are no studies other than an earlier one by the author that have empirically demonstrated the links between perception of talent, planned HSC level, and planned participation in a mathematics-related career (Watt & Bornholt, 1994), suggesting that perception of talent mediated by HSC plans, and HSC plans predict participation in mathematics-related careers. This study, however, did not fit different models for boys and girls, so some variation in either causation or strength of causation is possible in such models.

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METHOD

Design

The relative influences of child-reported parent autonomy support, control, warmth of relationship with child, perception of child's mathematical talent, and knowledge of child's mathematical performance on students' own perceptions of mathematical talent were measured, compared with students' previous (T1) performance and perception of talent, for boys, girls, mothers and fathers. Further, the influence of students' perceptions of mathematical talent and interest in mathematics on their intended mathematics participation in both the HSC and career plans were measured for boys and girls. The theoretical model to be tested is illustrated in Figure 1.

The model tests influences on students' current perceptions of mathematical talent, apart from their previous performance and perceptions of talent. There is strong evidence for a path from parent to child perception of child's talent, from the work of Eccles and colleagues. The link from parent autonomy support to child's perception of mathematical talent is suggested by CET. The association between parent autonomy and control has been found to be weak (Grolnick, Ryan, & Deci, 1991), but this association will be measured for girls and boys with their mothers and fathers. A strongly information-processing approach suggests links from parent knowledge about performance to parent perceptions of the child's talent, while an identification approach suggests a direct path from warmth of relationship to perception of talent. The proposed synthesis of the two approaches suggests a link from relationship warmth to parent knowledge about performance, while the work on autonomous-relatedness may imply an indirect influence of parent autonomy support on perception of talent via warmth of relationship. Parent perceptions of their child's talent are believed by Eccles and colleagues to impact on child interest as well as perception of talent, both of which are then proposed to influence student mathematics participation (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993).

Participants

The participants were from two coeducational Government secondary schools in an upper middle-class northern metropolitan region of Sydney, matched for socio-economic status (ABS, 1990). In the first year of the study (T1) Year 10 students were drawn from both the Advanced and Intermediate course levels, but not the lowest General level due to the stress of the test section of the study. In the second year of the study (T2) all Year 11 students participated, although for the purposes of this paper only students who were present over both years are included in the analyses (N=113). Distribution of students by gender and their current Year 11 course options is shown in Table 1.

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Figure 1. Theoretical model.

Table 1
Distribution of Students by Gender and Year 11 Course Option

	Course Option:M.I.P.a	M.I.S.b	2-unit	3-unit
Boys (n=58)	2	15	26	15
Girls (n=55)	5	16	18	16
Total (N=113)	7	30	44	31

a Maths in Practice
b Maths in Society

Materials

Year 10 (T1). Mathematics performance: a Progressive Achievement Test (ACER, 1984) measured students' mathematical task performance. Alternate items were chosen (i=28) so it could be administered within a 40 minute lesson. The multiple choice test included number, computation, measurement and money, statistics and graphs, spatial relations, relations and functions, and logic and sets. Perception of mathematical talent: this was measured by four items as part of a questionnaire investigating a broader range of student perceptions and possible influential factors on these. The four items were measured on 7-point Likert-type scales anchored at both ends, and are presented in Table 2. The latent variable 'perceived talent' constructed from these items using LISREL had high internal consistency (R=.990) and construct validity (c2(2)=1.57, p=.457; GFI=.990, AGFI=.950; RMSR=.029). The relative contributions of items to the variable are shown in Figure 2.

Table 2
Items Measuring Students' Perception of Mathematical Talent

Item	Question	Anchors
1	How talented do you consider yourself to be at maths?	1(not at all)-7(very talented)
2	Compared to students your age of the same sex, how talented are you at maths?	1(not at all)-7(very talented)
3	Compared to students your age of the opposite sex, how talented are you at maths?	1(not at all)-7(very talented)
4	If you were to order the students in your class from the least to the most talented, where would you put yourself?	1(least talented)-7(most talented)

Figure 2. Perception of talent composition T1.

Year 11 (T2). Perception of mathematical talent: at T2, perception of talent was measured by the same four items as the preceding year, but

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as part of a different questionnaire again measuring a broad range of student perceptions and attributions. The relative contribution of items to the underlying variable at T2 is shown in Figure 3. Once again, the variable had high internal consistency (R=.907) and construct validity (c2(2)=.21, p=.899; GFI=1.000, AGFI=.999; RMSR=.006). Value Judgements: students' interest in mathematics was assessed as part of the same T2 questionnaire, by three items presented in Table 3. The items contributed to the latent variable 'interest' as shown in Figure 4 (R=.907; c2(3)=.00, p=1.000; GFI=1.000, AGFI=1.000; RMSR=.002).

Figure 3. Perception of talent composition T2.Figure 4. Interest composition T2.

Table 3
Items Measuring Students' Interest in Mathematics

Item	Question	Anchors
1	How much do you like maths, compared with your other subjects at school?	1(much less)-7(much more)
2	How interesting do you find maths?	1(not at all)-7(very interesting)
3	How enjoyable do you find maths, compared with your other school subjects?	1(not at all)-7(very enjoyable)

Child-reported relations with parent: child reports of parental autonomy support, control and warmth of relationship were measured as part of the larger T2 questionnaire. The items measuring autonomy and control were anchored at 1 (hardly ever) to 7 (very often), and are depicted in Table 4. The composition of the two variables differed for mothers and fathers, with Item 3 loading on to both variables for mothers, and both variables being associated for mothers but not fathers. The composition of each variable for each parent is illustrated in Figure 5. Warmth of relationship with parent was measured by a single item, 'How well do you and your mother/father relate to each other?' from 1 (not at all well) to 7 (extremely well). Child-reported parent perceptions: child reports of parent's knowledge of the child's mathematics performance was measured by one item 'How much does your mother/father know about your school maths performance?' from 1 (very little) to 7 (very much), while child reports of parent's perception of the child's own mathematical talent was measured by the item 'How talented does your mother/father think you are at maths?' from 1 (not at all) to 7 (very talented). Planned participation in mathematics: planned HSC mathematics course levels and intended careers were asked about in the T2 questionnaire. Career plans were grouped according to the extent mathematics is required in each from 0 (no maths required) to 10 (extremely high level of maths involved), as rated by six teacher educators from two universities in Sydney (see

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Watt & Bornholt, 1994 for details).

Table 4
Items Measuring Sudent-Reported Parental Autonomy and Control

Item	Scale	Question
1	autonomy	How often does your mother/father encourage you to develop your own ideas?
2		"How often does your mother/father encourage you to do what you want?
3		"How often does your mother/father like you to decide for yourself what you should do?
4	control	How often does your mother/father tell you what to do?
5		"How often does your mother/father expect you to do what s/he thinks is best?
6		"How often does your mother/father tell you what you should think about things?

R=.981; c2(7)=13.26, p=.066; R=.990; c2(8)=2.80, p=.946;
GFI=.993, AGFI=.980;GFI=.999, AGFI=.997;
RMSR=.002RMSR=.025
Figure 5. Parent autonomy and control composition T2.

Procedure

The study was conducted with informed student and parent consent, and the approval of the School Principal. Testing was in the regular mathematics classroom under examination conditions. In the first year of the study, questionnaires were completed before the Achievement Test, in order to obtain internalised attitudes rather than short-term reaction to the test. There was no test section in the second year of the study.

Analyses

Preliminary analyses yielded no school effects, so results for the two schools were combined. Multiple Analyses of Variance (MANOVAs) were used to determine gender effects where they occurred. Multiple regression analyses modelled patterns of influence on students' perceptions of mathematical talent, and planned participation in mathematics, for boys and girls with their mothers and fathers. A

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correlational analysis was used to determine the effects of parent warmth on child acceptance of parental views.

RESULTS

Results are presented in three sections. The first reports gender effects where they occur. Second, patterns of influence on students' perceptions of talent and further influences on planned mathematics participation are presented, for girls and mothers, boys and mothers, girls and fathers, and boys and fathers. The final section tests whether the information-processing and identification approaches can be synthesised via the proposal that relationship warmth facilitates child acceptance of the received parental message, and conversely that lack of relationship warmth is likely to result in rejection of the parental view.

Effects of Student Gender

Child Variables. Gender effects on mathematical performance at T1 were, as expected, absent ($F(1,75)=.65$, $p=.42$). Surprisingly, there were no gender effects on perception of mathematical talent at T1 ($F(1,71)=1.30$, $p=.26$) or T2 ($F(1,107)=2.33$, $p=.13$), although there was a significant gender effect on interest in mathematics at T2, with boys finding mathematics more interesting than girls ($F(1,111)=3.79$, $p=.05$; boys $M=4.09$, $SD=1.76$; girls $M=3.45$, $SD=1.68$). The hypothesised gender effect on mathematics-related career plans was found ($F(1,78)=14.75$, $p<.001$; boys $M=7.73$, $SD=2.13$; girls $M=6.10$, $SD=1.61$), although this gender imbalance was not evident for students' planned Higher School Certificate (HSC) course levels ($F(1,112)=.96$, $p=.33$).

Child-reported Parent Variables (T2). The effect of gender on child-reported mother and father perceptions of the child's own mathematical talent suggested by Eccles and colleagues was not found (mothers $F(1,106)=.25$, $p=.62$; fathers $F(1,103)=.47$, $p=.49$). Other gender effects were in terms of child-reported warmth of relationship with mothers ($F(1,110)=7.57$, $p<.01$; boys $M=4.80$, $SD=1.59$; girls $M=5.61$, $SD=1.48$) but not fathers, and child-reported mother knowledge about the child's mathematics performance ($F(1,110)=3.98$, $p<.05$; boys $M=4.48$, $SD=1.92$; girls $M=5.61$, $SD=1.48$) but not father knowledge. Gender also affected both maternal and paternal autonomy support, with girls reporting greater autonomy support from both parents than boys (maternal autonomy $F(1,110)=8.45$, $p<.01$, boys $M=4.73$, $SD=1.66$; girls $M=5.55$, $SD=1.29$; paternal autonomy $F(1,108)=15.31$, $p<.001$, boys $M=4.52$, $SD=1.74$; girls $M=5.65$, $SD=1.20$). There were no gender effects on child-reported maternal or paternal control.

Influences on Perception of Talent (T2) and Planned Mathematics Participation

For both girls and boys and their mothers and fathers, child-reported parent perception of the child's talent as well as the child's T1 perception of talent were important influences on the child's T2 perception of talent. In all cases also, there was a strong path from

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child's T1 perception of talent to child-reported parent perception of the child's talent at T2, indicating reciprocal causality in parent-child perceptions across time. The final feature common to all groups is that parent autonomy support is a strong predictor of warmth of relationship between parent and child. With mothers, boys' and girls' reported warmth of relationship was also a moderate predictor of perceived talent. There were no parent influences on student interest in mathematics in any of the four groups. Further influences are noted separately for girls and boys and their mothers and fathers, since there is some variation across groups, particularly in relation to fathers.

Girls and their Mothers. The patterns of influence for girls and their mothers are shown in Figure 6. The strongest influence on perception of talent at T2 was child-reported mother perception of child's mathematical talent (b=.53), followed equally by previous perception of talent at T1 (b=.30), and reported warmth of relationship (b= -.27). There was also an indirect influence of perception of talent at T1 via reported mother's perception of child's talent (b=.20), and of mathematical performance at T1 via perception of talent at T1 (b=.11), and via both perceived talent T1 and reported mother perception regarding talent (b=.07). Other indirect influences were of reported mother autonomy via warmth of relationship (b= -.12), and it is possible that some influence of reported mother control may operate via mother autonomy and warmth of relationship, due to the association of mother autonomy and control (r= -.45). These variables together explained 53% of the variance in girls' perceptions of mathematical talent.

Influences on HSC course participation are interest (b=.44), an indirect effect of perception of talent T2 (b=.24) and other smaller indirect effects mediated by perception of talent at T2 and interest. These influences account for 32% of the variance in girls' HSC plans. Influences on career plans involving mathematics are interest (b=.42), an indirect effect of perceived talent T2 (b=.23), and smaller indirect effects mediated by perceived talent T2 and interest, together explaining 18% of the variance in girls' intended participation in mathematics-related careers.

Boys and their Mothers. Influential paths for boys and their mothers are shown in Figure 7. Perception of talent at T1 and reported mother perception of child's mathematical talent exerted equal influence on perception of talent at T2 (b=.43), followed by reported warmth of relationship (b=.18). There was also an indirect influence of perception of talent at T1 via reported mother's perception of child's talent (b=.20) and reported mother autonomy via warmth of relationship (b=.08). These variables together explained 58% of the variance in boys' perceptions of mathematical talent. Interesting, but not influential on perception of talent or mathematics participation, is a strong path from warmth of relationship to mother knowledge about

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mathematics performance (b=.48).

The sole influence on HSC course participation is perception of talent at T1 (b=.41), alone explaining 24% of the variance in this variable. Equal influences on career plans involving mathematics are perception of talent at T2, and HSC course participation (b=.30 and .28). There is an indirect effect of perceived talent T1 via HSC plans (b=.11), and smaller indirect effects mediated by perceived talent T2, altogether explaining 20% of the variance in boys' intended participation in mathematics-related careers.

Girls and their Fathers. Causal paths for girls and their fathers are shown in Figure 8. The strongest influence on perceived talent T2 is reported father perception of child's talent (b=.43), followed by perception of talent at T1 (b=.32). There was also an indirect effect of perceived talent T1 moderated by reported father's perception of child's talent (b=.15), and mathematical performance at T1 via perception of talent T1 (b=.12), and via both perceived talent T1 and father perception of child's talent (b=.05). These influences accounted for 38% of the variance in girls' perceptions of talent in mathematics. Although reported father autonomy affected warmth of relationship (b=.42), it had no effect on perception of talent at T2. As for boys and their mothers, reported warmth of relationship influenced reported father knowledge about performance (b=.64), as did father autonomy via relationship warmth (b=.27). Influences on planned mathematics participation were interest (directly) and perception of talent T2 (indirectly) as explained above, as well as indirect influences moderated by perceived talent T2 and interest, again explaining 32% of the variance in girls' HSC plans and 18% of the variance in their career plans.

Boys and their Fathers. Influential paths for boys and their fathers are shown in Figure 9. The strongest influence on perception of talent at T2 was perception of talent at T1 (b=.50), followed by reported father perception of child's mathematical talent (b=.30). There was again an indirect influence of perception of talent at T1 via reported father's perception of child's talent (b=.10). Two interestingly different paths emerged for this group. The first was that reported father knowledge about performance exerted an influence on child perceptions via reported father perception about talent (b=.07), the second that both reported relationship warmth and father autonomy exerted weak influences via this variable (b=.04 and .01). A minor indirect effect of perception of talent at T1 also operated via reported father knowledge about performance (b=.02). These variables together explained 47% of the variance in boys' perceptions of mathematical talent. Influences on planned mathematics participation were as for boys and their mothers.

Figure 6. Mother-daughter influences on perceived talent and participation in mathematics.

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Figure 7. Mother-son influences on perceived talent and participation in mathematics.

Figure 8. Father-daughter influences on perceived talent and participation in mathematics.

Figure 9. Father-son influences on perceived talent and participation in mathematics.

Suggested Synthesis of Information-Processing and Identification Approaches

The suggested synthesis for the information-processing and identification approaches was in terms of relationship warmth influencing the child's acceptance or rejection of the received parental message. To test this idea, the warmth of relationship variable was dichotomised, with ratings greater than 4 indicating a warm relationship with the parent, and ratings below 4 indicating a non-warm parent relationship. Correlations between reported parent and measured child perceptions tested whether associations existed only for the warm relationship group. The low number of boys and girls indicating a non-warm relationship with their mother (n=10) precluded the possibility of conducting correlations separately for boys and girls. Correlations across the sample are shown in Table 4. As expected, there were significant and strong relations between parent and child perceptions in the context of a warm relationship. However, despite the small number of students reporting a non-warm father relationship (n=25), there was still a significant association between father and child perceptions. There was no similar association for mothers, although note the small n.

Table 4
Relation Between Reported Parent Perception and Measured Child Perceptions for Children with Warm and Non-Warm Mother and Father Relationships

	rep. mother percept. of child's talent		rep. father percept. of child's talent	
Relationship with parent:	non-warm	warm	non-warm	warm
Correlation with child perception of talent	p=n.s. (n=10)	.69, p<.001 (n=72)	.52, p=.008 (n=25)	.66, p<.001 (n=53)

DISCUSSION

As expected, reported parental perception of their child's mathematical talent exerted sizeable direct influences in all cases. It seems that

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girls are more influenced by these reported parent perceptions than boys, and also that mothers exert a slightly stronger influence than fathers. The child's T1 perception of talent was the other strong predictor of perception of talent at T2, being as strong or stronger than reported parent perceptions in the cases of boys and mothers (b=.43) and boys and fathers (b=.50 and .30).

Although Eccles and colleagues found the influence of maternal perceptions on daughter perceptions to outweigh the reverse influence over time (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993), a pattern which this study confirms for girls and their mothers and fathers, the reverse was actually true for boys and their parents, suggesting perhaps that mothers and fathers come to accept their son's view of his mathematical talent, rather than the reverse. A longer time frame would be needed to disentangle directionality of influence for boys.

Warmth of relationship with mother exerted a strong influence on perception of talent at T2, being a strong negative influence for girls (b= -.27), and a moderate positive one for boys (b=.18). Relationship warmth also affected reported parent knowledge about performance, indicating that there are either differences in child disclosure or parent efforts to hear, dependant on warmth of relationship, except in the case of girls and their mothers. Parent autonomy support exerted a weak indirect influence on perception of talent in all cases except girls and their fathers, in which case it was unrelated to perceived talent.

Current perception of talent was unrelated to previous mathematical performance for boys, and moderately related for girls. It is vital then to consider what other bases perception of talent has.

Perceived talent was strongly related to interest in mathematics. In the case of girls, this interest then predicted HSC and career plans. For boys, however, although perceived talent was just as strongly related to interest, it was Year 10 perception of talent (T1) that predicted HSC plans, which makes sense since students' Year 11 course selection virtually determines their HSC mathematics course. Year 11 perception of talent (T2) along with intended level of HSC mathematics determined their planned participation in mathematics-related careers.

In the following section, results are discussed in terms of influences on perception of talent for girls and mothers, boys and mothers, girls and fathers, and boys and fathers. Influences on planned mathematics participation for girls and boys are then addressed, followed by discussion of the proposed synthesis of the information-processing and identification approaches.

Influences on Perception of Talent

Surprisingly, there were no effects of gender on perceived mathematical talent at either T1 or T2. This is contrary to the work of Eccles (e.g. Eccles, Jacobs, & Harold, 1990; Jacobs & Eccles, 1992; Bornholt, Goodnow, & Cooney, 1994). This does not invalidate concern with

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differential patterns of influence on perception of talent for boys and girls, however, since it can be seen that perception of talent and interest in mathematics are predictors of mathematics participation, and there is a socially and statistically significant effect of gender on participation in mathematics-related careers.

There was, however, a gender effect on students' interest in mathematics, although this was influenced equally by perception of talent for boys and girls (b=.55), explaining the same amount of variance (R2=.30). This suggests that interest in mathematics is either influenced by some additional gendered variable, or that the residual in influenced by different variables for boys and girls.

There was no effect of gender on reported parent perception of the child's talent, although such was not strongly expected on the basis of the weak and limited supportive evidence (Jacobs & Eccles, 1992; Eccles, Jacobs, & Harold, 1990). Mothers' and fathers' perceptions thus did not differ on the basis of their child's gender. Other gender effects were for warmth of relationship with mother, reported mother knowledge about mathematics performance, and mother and father autonomy support, with girls scoring higher than boys in each case.

Girls and Mothers. Stronger effects of mother perceptions were found for girls than from their own T1 perception of talent, or past mathematical performance. There was a moderate negative effect of warmth of relationship with mother on girls' current (T2) perception of talent, perhaps due to moderate and not high levels of parent warmth being beneficial for girls (Stein & Bayley, 1973). A larger sample would be needed to test this explanation, since responses would need to be grouped into high, moderate and low levels of relationship warmth, and separate analyses performed for each group. It is possible then that girls having warmer relationships with their mothers than boys may in fact be detrimental to their perceptions of mathematical talent. Alternative explanations are that mothers of girls who think themselves highly talented at mathematics do not develop as warm a relationship with their daughters, perhaps through feelings of inadequacy or dissimilarity if they themselves are not mathematically inclined. Ratings of mothers' perceptions of their own mathematical talent and judgements on female pursuit and success in mathematics would be needed to determine if this were the case. It is also possible that mothers of girls who consider themselves less talented at mathematics develop warmer relationships with them, perhaps to be supportive, or perhaps due to feelings of similarity and approval if the mothers value the traditionally sex-typed female role and perceive their daughter as fulfilling this. The first proposed explanation would require data on maternal support, while the second would require parent data on desired daughter outcomes and priorities.

As hypothesised, parent autonomy operated in the context of a warm relationship to influence students' perceptions of talent. It did not influence perceived talent independently of the path via warmth of relationship. Reported autonomy support was moderately related to

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control in this instance only (r= -.45), indicating that girls perceive their mothers' autonomy and control behaviours as relatively polarised. Relationship warmth had no effect on reported parent knowledge about performance in this instance only. This explains the gender effect on mother knowledge about performance, as clearly mothers are either being told by their daughters or finding out for themselves about their daughters' mathematics performance regardless of the warmth of relationship between mother and daughter.

Boys and Mothers. Boys were influenced equally by reported mother perceptions of their talent and their T1 perception of talent. Warmth of relationship with mother had a moderate positive effect for boys (b=.18), possibly due to high levels of parent warmth benefiting boys (Stein & Bayley, 1973). Other possible reasons could be that mothers of boys who think themselves highly talented at mathematics develop warmer relationships with their sons, perhaps out of admiration for their cleverness, or approbation that they are fulfilling the traditionally sex-typed notion of success for males. Alternatively, it is possible that mothers of sons who consider themselves less talented at mathematics do not develop as warm a relationship with their sons, perhaps seeing them as deviant or unworthy of admiration or approbation.

In this case, and all cases except girls and their mothers, warmth of relationship had a strong effect on reported parental knowledge about mathematics performance, probably due to differences in child disclosure or parental efforts to hear, dependent on warmth of relationship. Mother autonomy support influenced perception of talent indirectly via warmth of relationship, suggesting that for boys and girls mother autonomy support is only conducive to increased perceptions of talent in the context of a warm relationship, or autonomous relatedness (Allen, Hauser, Bell, & O'Connor, 1994). It is interesting that although reported mother autonomy and control were related for girls, they are unassociated for boys, perhaps reflecting differences in how mothers relate to their sons and daughters.

Girls and Fathers. As for girls and their mothers, girls' reported father perceptions of talent exerted a stronger influence on their T2 perception of talent than did their T1 perception. Warmth of father relationship had no effect on girls' perception of talent, although it did affect reported father knowledge about performance (b=.64). Although father autonomy support again influenced warmth of relationship, this influence did not flow on to affect girls' perception of talent. Reported father autonomy and control were again unrelated.

Boys and Fathers. The pattern of relations for boys and their fathers was markedly different from any of the other three groups. Reported father perception regarding their son's talent was less influential than boys' T1 perception of talent on their current perception of

talent. It is conceivable that boys influence parent perceptions over time rather than the reverse, as elaborated above. No studies seem to

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have focused on disentangling parent-son as distinct from parent-daughter influences over time, but it is possible that the directionality of the cumulative influence of parent perceptions on child perceptions may differ for boys and girls.

There was no direct effect of warmth of relationship on perception of talent, although it exerted a weak indirect influence mediated by reported father knowledge about mathematics performance and reported father perception regarding son's talent (b=.04). Autonomy support again operated via warmth of relationship moderated further by the path from warmth of relationship to T2 perception of talent, although the influence was very slight (b=.01).

Warmth of relationship again affected reported father knowledge about performance. New here is a path from reported father knowledge of performance to reported father perception regarding son's talent (b=.24), which a strongly information-processing based perspective would suggest. This is the only instance, however, in which this path occurred. The other interesting path for this group was from T1 perception of talent to reported father knowledge of performance, indicating that fathers of sons who consider themselves highly talented at mathematics know more about their sons' performance. This is quite possibly because these sons enjoy telling their fathers about their mathematical performance, whereas boys who think themselves less talented at mathematics quite possibly avoid telling their fathers about their performance. Alternatively, the fathers may not wish to hear about these students' performance. It is interesting that the only instance of this path was for the father-son group, which notions of traditional sex-typing would suggest to be the group most concerned with male mathematical success. Possibly fathers are more rigid than mothers in their academic expectations of boys than they are with girls. Parent data on (gendered) conceptions of success and expectations for their sons and daughters would need to be addressed to clarify this difference.

Proposed Synthesis of Information-Processing and Identification Approaches

The proposed synthesis of the information-processing and identification approaches whereby warmth of relationship is believed to affect the child's acceptance or rejection of the received parental message (Cashmore & Goodnow, 1985) was not supported by the data. There were insufficient numbers of students reporting a non-warm relationship with their mothers to enable valid testing of the hypothesis in the case of mothers. However, in the case of fathers, there was a strong association between reported father and measured child perceptions, even in the absence of a warm relationship (r=.52, p=.008). We cannot assume that the same would be true for mothers, and this needs to be tested with a much larger sample.

Influences on Planned Participation in Mathematics

Girls. Contrary to suggestions from the literature, perception of talent had no effect on girls' HSC or career plans (Eccles, Jacobs, &

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Harold, 1990; Watt & Bornholt, 1994). It is possible, however, that since students were in Year 11 at T2, thus having their HSC course levels virtually determined at this stage, that the point of influence may have been earlier (although perception of talent at T1 does not influence HSC plans either). It was the research design that enabled the current study to tease out different patterns of influence for boys and girls which a more systems-oriented model could not have accounted for. Although perception of talent was strongly related to interest (b=.55), it was interest that predicted both HSC (b=.44) and career plans (b=.42), with moderate indirect effects of perceived mathematical talent (b=.24 and .23). Contrary to the suggestion of Eccles and colleagues (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993) that mother perceptions of the child's talent influence the child's interest in mathematics, the present study found parent perceptions had only an indirect influence on interest via the child's own perception of talent.

Boys. Boys' planned participation in HSC mathematics was predicted by T1 perception of talent, at which time students were required to elect their Year 11 course options, which virtually determine their HSC course level. Although interest and perception of talent at T2 were as strongly related as for girls, interest exerted no effect on plans for participation. Intended participation in mathematics-related careers was predicted equally by perceived mathematical talent (T2) and HSC plans for boys.

Conclusion

Clearly parents exert a powerful influence on children's perceptions of mathematical talent which, in the case of boys determines future participation in mathematics and, in the case of girls influences interest in mathematics which then impacts on plans for mathematics participation. The role of fathers is indeed complex and merits further study (Grolnick, Ryan, & Deci, 1991). The CET focus on autonomy and involvement does seem to have masked important mediating variables (Butler, 1989), particularly warmth of relationship with parent, the differential effects of which deserve closer study for boys and girls.

The present study has revealed the different patterns of influence for girls, boys, mothers and fathers on students' perceptions of mathematical talent, and further, on plans for participation in mathematics. Results at Year 11 show that perception of talent and interest in mathematics do not influence mathematics participation for both boys and girls (Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993), but rather that perception of talent affects boys' plans, and interest girls' plans. This means that intervention strategies aimed at increasing girls' participation in mathematics should redirect their emphasis from self-esteem variables, to take more account of targeting students' interest in mathematics. Further, strategies of explicitly advising girls to study high levels of HSC mathematics will not be useful, since HSC mathematics course plans are

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unrelated to career plans for girls. It is fruitless then to work on parents' (non-gendered) perceptions of their daughters' mathematical talent if the goal is to increase girls' participation in advanced mathematics courses and mathematics-related careers (as suggested by Eccles, Jacobs, Harold, Yoon, Arbreton, & Freedman-Doan, 1993), since the effect of parent perceptions on plans for participation is small, and operates indirectly via perception of talent and interest in mathematics. It should be both easier and more fruitful to target girls' interest in mathematics which has both a strong and direct effect on plans for mathematics participation, if the goal is to address the gender imbalance in mathematics-related careers.

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