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Expectancy-value in mathematics, gender and socioeconomic background as predictors of achievement and aspirations: A multi-cohort study ☆

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ABSTRACT

This study drew on expectancy-value theory (EVT) to examine the relations between mathematics motivation (academic self-concept and task values) and student background variables in predicting educational outcomes. Using latent-variable models with latent interactions, we investigated the multiplicative effect of self-concept and value, which is central to classic EVT. The mediating role of motivation and gendered patterns was also explored. Hong Kong's TIMSS dataset for three cohorts (1999, 2003, and 2007) was used over a period where the education system had experienced considerable changes, providing a strong test of the robustness of these findings. The results suggested: (a) self-concept is more important for students with lower utility values in predicting their educational outcomes; (b) while boys and girls had similar levels of math self-concept and values, girls tended to have higher mathematics achievement and educational aspirations; (c) family socioeconomic status is more strongly linked to educational aspirations for boys.

Expectancy-value theory (EVT), beginning with the seminal work of Atkinson (1957), continues to be one of the most dominant theories of achievement motivation (Eccles, 1994, 2009). EVT proposes that expectancy of success in a given task and the degree to which this task is valued are determinants of achievement-related performance and choices (Eccles, 1994, 2009). Although Eccles and her colleagues (Eccles, 1994, 2009; Eccles & Wigfield, 2002; Eccles (Parsons) et al., 1983) elaborated multiple components of subjective task values and linked motivational beliefs to other psychological, social, and cultural factors, the multiplicative relation between expectancy and value, which was the cornerstone of classic EVT (Atkinson, 1957), has been less researched. This gap could be due to the lack of advanced statistical techniques suited to measuring expectancy by value interactions. With recent developments of latent variable approaches to interaction effects, researchers are now able to more accurately analyze the latent interactions inherent in classic EVT (Marsh, Wen, & Hau, 2004; Nagengast et al., 2011; Trautwein et al., 2012). However, these empirical studies only considered one component of task values with expectancy when testing the interactive relation, which is inconsistent with the assumption of EVT that multiple task values simultaneously influence achievement-related outcomes.

In addition, in the EVT model, the association of children's backgrounds, including gender role socialization and family socioeconomic status (SES), with educational outcomes is believed to be mediated through expectancy and task values. Even though recent studies have demonstrated that motivational beliefs play a significant role in mediating the relation of gender and SES with educational outcomes (e.g., De la Fuente, Sander, & Putwain, 2013; Nagy, Trautwein, Baumert, Köller, & Garrett, 2006; Nagy et al., 2008; Parker et al., 2012), few studies have considered both expectancy and multiple task values together and compared direct and indirect effects when investigating the mediating role of motivational beliefs.

Therefore, our aim is to provide a comprehensive test of EVT, including the multiplicative relation and mediating role of math expectancy and task values on math academic achievement and educational aspirations. Given that social and cultural processes are achievement-related behaviors (Eccles, 2009), we also explore gender differences in the relations of SES and motivational beliefs with educational outcomes, particularly in the multiplicative relation between expectancy and task values. For robustness of the analysis, we include data from multiple cohorts (1999, 2003, 2007) of Hong Kong students who participated in the Trends in International Mathematics and Science Study (TIMSS). The substantial changes in the Hong Kong education system resulting from major educational reforms from the year 2000

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(Education Commission, 2000) together with the handover of sovereignty from the UK to China in 1997 (Dimmock & Walker, 1997) provide us with an interesting context for testing the salience of EVT predictions. Specifically, consistency of results across this historically important period would provide a strong test of the robustness of predictions based on EVT.

1. Expectancy-value theory

The modern EVT model posits that achievement-related performance is most directly influenced by the individual's expectancies of academic success and a subjective assessment of the inherent value of the academic task. However, socialization processes linked to various cultural and social settings (e.g., school and family) introduce individual differences in motivational beliefs, leading to differential performance. Modern EVT (Eccles (Parsons) et al., 1983) defines expectancy of success as a task-specific belief about the possibility of experiencing future success in that task that is directly related to one's evaluation of one's competency within a specific academic domain (e.g., academic self-concept, Marsh, 1986). Following Eccles and colleagues (Eccles, 2009; Eccles & Wigfield, 2002; also see Nagengast et al., 2011; Nagy et al., 2008), here we use academic self-concept as a measure of expectancy of success.

Modern EVT distinguishes between multiple components of value (Eccles & Wigfield, 2002). In the current study, we focus on two value components: intrinsic value that refers to the enjoyment a person gains from performing an activity; and utility value, relating to how a specific task fits within individual future plans and objectives. Expectancy and value are both known to be domain specific (Eccles & Wigfield, 2002; Wigfield & Eccles, 2002). Research has shown that competence beliefs are related positively to several different dimensions of value within a specific domain, but that the relations involving intrinsic value seem to be the strongest (Wigfield & Eccles, 2002). In cross-sectional and longitudinal studies, there is growing evidence of expectancy beliefs having a strong influence on achievement, while value beliefs have stronger influence on choice, effort, and persistence in achievement-related activities (Gasco & Villarroel, 2014; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Nagengast et al., 2011; Trautwein et al., 2012).

2. Multiplicative effect of expectancy and task value

The classic EVT conceptualization emphasizes the presence of the multiplicative combination of expectancy and value (Atkinson, 1957). More precisely, both high expectancy beliefs and task values were seen as essential for attaining high academic achievement and guiding educational aspirations. That is, expectations and subjective values were proposed to combine multiplicatively to determine the outcomes (Feather, 1982). Nevertheless, tests of EVT models are primarily additive in nature (where two or more predictors uniquely and independently predict the outcome variable) rather than multiplicative. Over time, this has led to the disappearance of possible multiplicative interaction effects from EVT research (see Nagengast et al., 2011). A possible reason for the omission of the interaction term was the lack of appropriate methods for testing multiplicative relations (see Appendix A in Supplemental material for more discussion). However, applied researchers now have access to new methods for testing latent interactions. Nagengast et al. (2011) found significant multiplicative relations between self-concept and intrinsic value on extracurricular activities and aspirations across 57 countries based on the Programme for International Student Assessment (PISA) 2006 data. In a study with a German sample, Trautwein et al. (2012) also found evidence of the significant multiplicative effects of expectancy and four subcomponents of value (attainment, intrinsic value, utility value, and cost), each considered separately, on English and math achievements. These findings have yet to be replicated with a stronger analytic approach to examine multiple predictions of multiple outcomes across multiple data points within the same study.

3. Family background and gender

According to the EVT framework (Eccles, 2007, 2009), parents provide social–emotional influences on children's motivation beliefs which in turn influence children's educational performance and aspirations (Eccles, 2007, 2009). Because parents' beliefs and behaviors are associated with their socio-economic status (SES), families with higher SES are likely to produce more positive outcomes for children (Eccles, 2009). However, the majority of the literature on family SES has focused on direct, positive effects of SES on children's academic achievement (see Sirin, 2005 for a review), perceived competence and task beliefs (Eccles, 2007) and children's expectations of how far they will go in school (Halle, Kurtz-Costes, & Mahoney, 1997). More recent research has started to investigate the mediation effects of motivational beliefs, suggesting that the relations of SES to academic achievement and educational aspirations are partially mediated by motivation variables (Grolnick, Friendly, & Bellas, 2009).

Likewise, based on EVT (Eccles, 2009), gender exerts influences on achievement-related behaviors through its associations with motivational beliefs. In other words, gender differences in achievement-related behaviors are mediated by gender differences in motivational beliefs (Eccles, Barber, & Jozefowicz, 1999; Nagy et al., 2006, 2008; Simpkins, Davis-Kean, & Eccles, 2006). Multiple studies have reported more positive math self-concepts, attitudes and affect for males (Eccles & Wigfield, 2002; Marsh & Yeung, 1998; Marsh et al., 2013). However, in recent decades, growing evidence in cross-national meta-analyses (Else-Quest, Hyde, & Linn, 2010; Lindberg, Hyde, Petersen, & Linn, 2010) shows gender similarities in math achievement. Furthermore, there has been a dramatic increase in females' educational aspirations, and particularly in secondary school, females tend to report higher educational aspirations than their male counterparts (Schoon & Polek, 2011). Although the mediating role of motivation factors has been widely addressed in the literature (e.g., Parker et al., 2012), apparently no previous studies have considered both self-concept and multiple task values and their multiplicative effects simultaneously and examined the direct, indirect and total effects of gender and SES to educational outcomes.

In addition to mediation effects, gender also exerts moderation effects (Eccles, 2009; Nagy et al., 2006; Simpkins et al., 2006; Watt et al., 2012). However, research so far has yielded mixed evidence regarding gender differences when examining the relations among SES, motivational beliefs, and academic outcomes across different cultures. For example, math utility value was found to play a more important role for educational aspirations in Australian high school female samples, whereas the relation between math motivation beliefs and educational aspirations did not vary by gender in samples from the USA and Canada (Watt et al., 2012). In addition, the relation between SES and educational aspirations did not vary by gender in the UK sample (Schoon & Polek, 2011), whereas the relation was stronger for African-American males (Trusty, 2002). However, very little research has examined whether the relationships among SES, motivational beliefs, and educational outcomes, vary as a function of gender in an Asian context.

4. The Hong Kong context

In 1997, Hong Kong experienced its largest social change—the handover of sovereignty from the UK to China. Among the many effects of this change of government, there have been profound changes in the Hong Kong educational system. Since the changeover, a number of new initiatives have been implemented with the attempt to enhance the quality of school education. They include a Medium of Instruction Guidance for Secondary Schools to reinforce the 'biliterate and