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The social contagion of utility value: How parents' beliefs about the usefulness of science predict their children's motivation and achievement

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Abstract

The purpose of the present study was to examine whether parents' utility value perceptions predicted their children's utility value perceptions, demonstrating social contagion effects. We also examined whether utility value would predict achievement. This is a cross-sectional study that utilized data from a subsample of adolescent students from the Program for International Student Assessment (PISA 2015), which focused on science learning and achievement from 18 regions. We performed multi-level structural equation modeling to analyze the data. Results revealed that parents' utility value perceptions predicted students' utility value perceptions, which, in turn, predicted

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science achievement. The findings of this study provide evidence of the social contagion of utility value perceptions from parents to their children and the critical role of utility value in predicting achievement across various regions/countries. Our study highlights the crucial role parents play in adolescents' motivational and learning outcomes and suggest parental involvement in programs toward enhancing adolescents' motivation and achievement.

Keywords
expectancy-value theory, utility value, social contagion, achievement

Expectancy-value theory (Eccles et al., 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) posits that a person's expectancies of success and values towards a task affect one's choices, persistence, and achievement outcomes. Expectancy for success pertains to one's perceived competencies and the probability of success in a certain task. Task values include intrinsic value (interest), attainment value (importance), utility value (usefulness), and cost (negative aspect of engaging in a task). Among these four task values, utility value has received the most interest because it is perceived as relatively more malleable and responsive to intervention efforts (Wigfield & Eccles, 1992).

Research on expectancy-value theory, however, has mostly focused on how expectancies and utility value perceptions predict learning-related outcomes as well as the factors that predict expectancies for success (Guo et al., 2017; Trautwein et al., 2012; Wigfield & Cambria, 2010). Relatively less work has been conducted on how parents shape their children's utility value perceptions from the perspective of social contagion. In this study, we examined whether parents' utility value predicted their children's utility value perceptions—a form of social contagion effect—and how the latter, in turn, predicted achievement.

Utility value and achievement

Utility value refers to the usefulness of a certain task to one's current or future goals (e.g., career goals) (Wigfield & Cambria, 2010). A task is deemed as high in utility value if it contributes toward the attainment of important goals, even if the task itself is not of interest to the person. For example, students may take classes they do not find enjoyable if they believe that it can contribute to their future careers. Although this task value component can be considered as a more extrinsic form of motivation to engage in a task, it also captures an aspect of one's internalized goals (Eccles & Wigfield, 2002).

Past studies have found that utility value predicts important learning and achievement outcomes (Hulleman et al., 2008; Nagengast et al., 2011). When students perceive a domain as useful, they work harder, become more interested, and perform better (Harackiewicz et al., 2016; Hulleman et al., 2008). The importance of utility value has been demonstrated in both laboratory and classroom settings (Hulleman, Godes, et al., 2010), as well as across different achievement domains (Han et al., 2019; Hulleman et al., 2008).

For instance, in a study by Hulleman et al. (2010), randomized experiments were conducted in laboratory and classroom settings, wherein participants were asked to write about the relevance of the materials they were learning to their lives. It was found that writing about the relevance of course materials to students' own lives increased their perceptions of utility value, as well as their performance. Positive associations between utility value perceptions and student achievement have been found in various domains, including math, psychology (Hulleman, Godes, et al., 2010), and history (Han et al., 2019).

Social contagion

Despite the vast literature on expectancy-value theory and utility value, relatively less research has been conducted on the antecedents of students' utility value perceptions. One important factor is the utility value endorsed by parents, which could be transmitted from parent to child via social contagion. Social contagion refers to "the spread of affect, attitude, or behavior from person A (the 'initiator') to person B (the 'recipient')" (Levy & Nail, 1993, p. 275). Parents' utility value perceptions shaping that of their children can be viewed from the social contagion framework. Burgess and colleagues (2018) proposed a motivational perspective of social contagion in the educational context to explain the social contagion between students and their peers or their teachers affecting their academic motivation and performance. The same process may also apply to children and their parents as parent-child interactions can facilitate the occurrence of social contagion (e.g., Chi et al., 2019; Lara et al., 2012).

Burgess et al. (2018) argued that motivation plays an important role in the convergence of behaviors in the educational context. For instance, social learning theory (Bandura, 1986) can explain how students with high self-efficacy, competence, and interest in a particular subject can spread enthusiasm to their peers through verbal persuasion (e.g., through encouragement or explanation of the subject to their classmates). Similarly, a teacher may also spread interest and enthusiasm in a subject through vicarious experience (e.g., when the students observe their teachers' interest and enjoyment in teaching a topic and vicariously enjoy it, too). Hence, peers and teachers can influence students' motivation, which can affect their performance.

Aside from social contagion from teachers and peers (Burgess et al., 2018; King, 2020; King & Datu, 2017; King & Mendoza, 2020), Wigfield and Eccles (1992) suggested that parents, too, play a critical role in socializing their children into the development of their motivation. Parents' perceptions regarding a certain domain

can influence the way they behave, which in turn, may also influence their children's beliefs and behaviors (Eccles, 1993; Simpkins et al., 2012). For instance, parents who believe in the value of science may talk about science more, visit science museums more often, and buy more science books, thereby demonstrating to their children the value of science and encouraging them to value it as well. This can influence their children's motivational beliefs about science, as well as their performance and achievement (Eccles, 1993; Simpkins et al., 2012).

Parental influence on utility value

Previous studies on the expectancy-value theory employing longitudinal methods and nationally representative samples have demonstrated the parent to child transmission of expectancy, which in turn, predicted various aspects of student motivation and achievement (Froiland et al., 2013; Froiland & Davison, 2016). Whereas the literature on parent-child transmission of expectancy is better developed, it is possible that a similar mechanism applies to utility value perceptions.

Past studies have also found some evidence of the parent-child transmission of utility value. For instance, field experiments showed that adolescents whose parents have undergone an intervention to increase their utility value beliefs in mathematics and science have taken more science, technology, engineering, and mathematics (STEM)-related courses in high school (Harackiewicz et al., 2012; Rozek et al., 2015). Harackiewicz et al. (2012) found that mothers who underwent the intervention had increased utility value of STEM courses for their children, which in turn, influenced their children's STEM utility value (Harackiewicz et al., 2012). Furthermore, Rozek et al. (2015) found that the intervention was effective for low-achieving boys and high-achieving girls but did not help low-achieving girls, suggesting gender differences in parental transmission of utility value. However, a limitation of these two studies is that they relied exclusively on experimental approaches, which, while having a high degree of internal validity, might have more limited ecological or external validity.

Another study conducted by Simpkins and colleagues (2012) found that parents' beliefs predicted their children's motivational beliefs. In this longitudinal study, mothers' beliefs in sports, music, math, and reading positively predicted their behaviors in these domains. Mothers' behaviors, in turn, predicted their children's self-concepts of ability and values, which predicted how much time the children spent in activities in these domains. Except in reading, mothers' behaviors mediated the associations between theirs and their children's beliefs, and the children's beliefs mediated the associations between their mothers' and their behaviors. In most cases, the associations among the indicators held across child gender. Nevertheless, this study focused on a wide range of motivational beliefs and not just on utility value, and was also confined to the US context and White middle-class families.

Other studies yielded similar findings. Šimunović and colleagues (2018) found that parents' utility value of STEM predicted that of their children through their

children's perception of parents' encouragement of STEM interest. Acosta and Hsu (2014) found that parents' general valuing of science predicted their children's valuing of science and stimulated their children's motivation to learn science, which in turn, increased their children's science performance. Likewise, Lee and colleagues (2020) found that parents' utility value beliefs in science predicted their children's motivation and achievement, but only among boys. However, these studies involved relatively small samples from a single country/region, which may limit the generalizability of its findings.

The current study

In this study, we examined a model of parents' utility value perceptions of science (i.e., that science is useful to them personally and to the society) predicting students' utility value perceptions of science (i.e., that studying science is useful for the attainment of their future goals), which in turn, predict students' science achievement. Doing so allowed us to test for the social contagion of utility value from parents to their children as well as the association between utility value and achievement.

To address the methodological limitations of the previous research (i.e., limited ecological validity, relatively small sample size, focusing only on a single country/region), we used data from the Organisation for Economic Co-operation and Development—Programme for International Student Assessment (OECD-PISA; OECD, 2015) derived from nationally-representative samples of adolescent students from 18 countries/regions. This could complement the findings of previous studies by providing stronger evidence and entailing greater generalization of parental contagion of utility value perceptions and its relationship with achievement. Due to the increasing need for students to learn STEM, which is considered a critical determinant of a country's economic competitiveness, whereas student motivation in this area continues to decline (Shin et al., 2019), we focused on utility value and achievement in the science context.

Considering that some of the past studies on parental contagion of utility value perceptions suggested gender differences (e.g., Lee et al., 2020; Rozek et al., 2015), and that socioeconomic status (SES) is one of the most consistent predictors of academic achievement (see meta-analytic review by Sirin, 2005), we included student gender and SES as covariates to control for the variance accounted for by these variables.

Method

Data and measures

We used the OECD-PISA 2015 data (OECD, 2015) of 83,131 adolescent students from 18 countries/regions: Belgium, Chile, Croatia, Dominican Republic, France, Georgia, Germany, Hong Kong SAR, Ireland, Italy, Korea, Luxemburg, Macao SAR, Malta, Mexico, Portugal, Spain, and United Kingdom. In PISA 2015, only

these 18 countries/regions had data on parents' utility value which explains why only these 18 societies were included in the study. Among the students, 42,555 were girls and 40,576 were boys. The mean age was 15.79 ($SD = .29$) years.

Utility value perceptions were operationalized as parents' (e.g., "<Broad science> is helpful to help us to understand the natural world.") and students' (e.g., "What I learn in my <school science> subject(s) is important for me because I need this for what I want to do later on.") utility value for science. Variables were measured using 5-item and 4-item scales, respectively, with responses ranging from 1 (*strongly agree*) to 4 (*strongly disagree*) (see Table 1). Reverse scoring was employed so higher scores would mean stronger endorsement of utility value.

Achievement was operationalized as science achievement, or the students' performance in PISA's standardized ability test that measures their ability to use science knowledge and skills to meet real-life challenges, which was scaled to have a mean of 500 ($SD = 100$) (OECD, 2017). SES was measured using PISA 2015's measure of economic, social, and cultural status (ESCS; OECD, 2015),

Table 1. Descriptive statistics and reliability for the study variables.

		Items	Mean	SD
Parents' Utility Value	PA033Q02	<Broad science> is important to help us to understand the natural world.	3.48	.57
	PA033Q06	<Broad science> is valuable to society.	3.45	.58
	PA033Q07	<Broad science> is very relevant to me.	3.11	.71
	PA033Q08	I find that <broad science> helps me to understand tde tdings around me.	3.25	.64
	PA033Q09	Advances in <broad science> usually bring social benefits.	3.37	.63
		Total	3.33	.50
		Cronbach's alpha	.86	
Students' Utility Value	ST113Q01	Making an effort in my <school science> subject(s) is worth it because this will help me in tde work I want to do later on.	2.90	.90
	ST113Q02	What I learn in my <school science> subject(s) is important for me because I need this for what I want to do later on.	2.80	.91
	ST113Q03	Studying my <school science> subject(s) is worthwhile for me because what I learn will improve my career prospects.	2.88	.87
	ST113Q04	Many things I learn in my <school science> subject(s) will help me to get a job.	2.77	.89
		Total	2.85	.81
		Cronbach's alpha	.93	
Science Achievement		489.20	98.85	

which was based on the International Socio-Economic Index of Occupational Status (ISEI); the highest level of education of students' parents; and PISA index of family wealth, home educational resources, and family possessions.

Data analysis

Multiple imputation method was used to replace missing values (Rubin, 1987; Schafer, 1997). As we intended to produce findings generalizable across all countries, we used international data instead of choosing one country in the analysis. Our critical interest was in investigating relationships among parental utility value, student's utility value, and achievement at the student-level. Hence, we used multilevel structural equation modeling and controlled for all effects above the school-level (Level 2 and above). Doing so also allowed us to control for country-level effects.

We followed the recommended two-step approach to structural equation modeling (SEM) wherein we first conducted a CFA before testing the theoretical linkages among the variables using a full SEM (Anderson & Gerbing, 1988). In Stage 1, we assessed the measurement validity of each latent variable, i.e., parent utility value and student utility value, and the full measurement model that combined both latent variables, science achievement, as well as the covariates, SES and gender.

In Stage 2, a two-level SEM was conducted. At the individual level, science achievement was regressed on student utility value, parent utility value, and covariates; and, student utility value on parent utility value and covariates. As our research interest was on student-level effects, we controlled for all effects above the school level. Hence, our results can be interpreted as pure student-level (Level 1) effects after controlling for school-and country-level effects. Mplus Version 8.3 (Muthén & Muthén, 2019) was used, with maximum likelihood robust (MLR) as the estimator.

We used the following fit indices and cutoff values: root mean square error of approximation (RMSEA): < 0.08 and < 0.05, acceptable and good fit (Browne & Cudeck, 1992); standard root mean square residual (SRMR): < 0.09, reasonable fit (Hu & Bentler, 1999); comparative fit index (CFI) and Tucker-Lewis index (TLI): >0.90 and >0.95, acceptable and good fit (Byrne, 2010).

Results

Preliminary analyses

Table 1 shows the descriptive statistics, while Table 2 presents the bivariate correlations of the study variables of the aggregated sample. To check whether the relationships among the variables held within each of the 18 regions sampled, we also included the bivariate correlations among parental utility value, student utility value, and achievement within each region (see Table 3). Positive

Table 2. Bivariate correlations of the study variables for the total sample.

	1	2	3	4
1. Science Achievement	—			
2. Parents' Utility Value	.111**	—		
3. Students' Utility Value	.038**	.155**	—	
4. Socioeconomic status	.376**	.164*	.009**	—
5. Gender	.041**	.024**	.038**	.020**

Note. *$p < .05$; **$p < .01$.

associations between parents' and students' utility value perceptions and science achievement were found both for the aggregated data and within each of the 18 regions.

Primary analyses

Next, we checked the results of the two-stage multilevel analysis (see Table 4). The first stage involved a CFA for utility value perceptions of parents (Model 1a), students (Model 1 b), and the full measurement model (Model 1c: combing both utility variables, achievement, sex, and SES). All models fit the data well. In the second stage, we checked the theoretical linkages among the variables using multilevel SEM (Model 2) that control for between school effects. Results also fit the data well.

Parents' utility value perceptions directly predicted science achievement ($\beta = .12$, $p < .001$). Moreover, parents' utility value perceptions predicted that of their children's ($\beta = .17$, $p < .001$), which in turn, predicted science achievement ($\beta = .09$, $p < .001$) (see Figure 1). The effect of parents' utility value perceptions on achievement was partially mediated through students' utility value perceptions ($\beta = .02$, $p < .001$), with an effect size of 14% of the total effect.

We also comment on the covariates, we found that boys had higher beliefs in the utility value of science ($\beta = .08$, $p < .001$) and higher levels of science achievement ($\beta = .03$, $p < .001$). In terms of SES, students from more advantaged families had higher science achievement ($\beta = .15$, $p < .001$). Surprisingly, we found that SES was associated with slightly lower students' utility value ($\beta = -.01$, $p < .001$) though this relationship was extremely weak.

Discussion

The aim of this study was to examine the social contagion of utility value from parents to their children, and whether utility value would predict achievement. Findings provided evidence of parental contagion as parents' utility value perceptions significantly predicted their children's utility value. An examination of the relationship between parents' utility value perceptions and that of their children showed that the positive relationship between the two is consistent among all

Table 3. Bivariate correlations among the variables within the 18 regions.

Region/Countries	Bivariate Correlations		
	Achievement with students' utility value	Achievement with parents' utility value	Parent and student utility value
Belgium	.065**	.250**	.129**
Chile	.011	.141**	.109**
Croatia	−.030*	.200**	.098**
Dominican Republic	−0.033	.062**	.021
France	.210**	.260**	.186**
Georgia	−.074**	.187**	.058**
Germany	.086**	.220**	.141**
Hong Kong SAR	.126**	.162**	.122**
Ireland	.204**	.274**	.178**
Italy	.094**	.175**	.153**
Korea	.201**	.227**	.162**
Luxembourg	.134**	.202**	.099**
Macao SAR	.099**	.111**	.099**
Malta	.224**	.261**	.190**
Mexico	.002	.118**	.096**
Portugal	.173**	.225**	.158**
Spain	.176**	.207**	.170**
United Kingdom	.298**	.330**	.165**

Note: SAR = Special Autonomous Region (of P. R. China); **$p < .01$; *$p < .05$.

Table 4. Model fit statistics.

	χ^2	*df*	χ^2/df	*p-value*	RMSEA (95% C.I.)	SRMR	CFI	TLI
CFA for Parents' Utility Value (Model 1a)	1060.649	3	353.55	.000	.065 (.062, .068)	.009	.995	.982
CFA for Students' Utility Value (Model 1 b)	147.067	1	147.067	.000	.042 (.036, .048)	.002	.999	.997
Full Measurement Model (Model 1c)	4376.074	47	93.11	.000	.033(.032, .034)	.031	.991	.997
Multilevel Model (Model 2)	10100.043	91	110.99	.000	.036	.043 (within)	.973	.967

*Note.*The following covariances were freed: PA033Q07 and PA033Q08, and PA033Q02 and PA033Q06 for parents; and ST113Q01 and ST113Q02 for students.

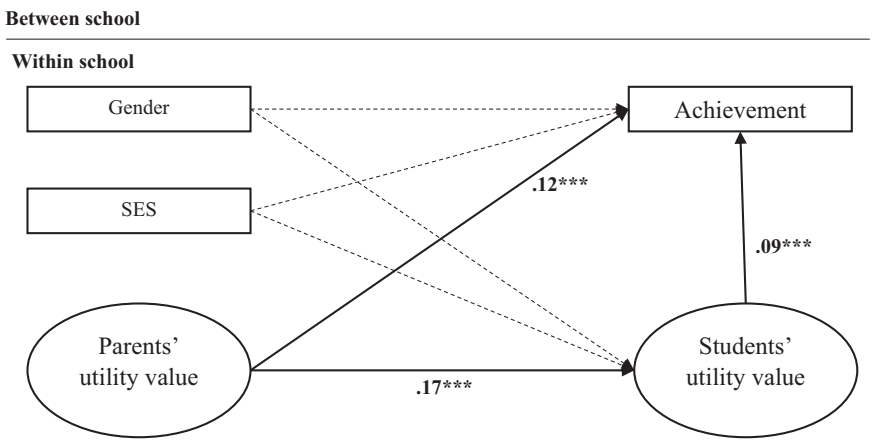

Figure 1. Model of parents' utility value perceptions of science predicting that of their children's (i.e., parental contagion of utility value perceptions) and subsequent science achievement, controlling for gender and SES, and school level effects. *Note.* ***$p < .001$, **$p < .001$. Model fit statistics: $\chi^2 = 10100.043$, $df = 91$, $p = .000$; $\chi^2/df = 110.99$; RMSEA = .036; SRMR (within) = .043; CFI = .973; TLI = .967. For clarity, the indicators for latent variables were no longer included in the figure.

participating countries (except in the Dominican Republic), further providing evidence supporting the generalizability of the parent-child contagion of utility value beliefs across countries and cultures. Moreover, parents' utility value perceptions predicted achievement directly, and indirectly through students' utility value perceptions. Further examination of the correlations per country also showed that parents' utility value perceptions are associated with student achievement in all countries. These findings provide support for the important role parents play on adolescent students' motivation and achievement across different cultures.

Parental contagion of utility value perceptions and its influence on achievement can be explained by the parents' role in the expectancy-value model as critical socializers to adolescents' development of identity and motivation (Wigfield & Eccles, 1992). Parents' perceptions, including those pertaining to the importance of a certain domain, their feelings of self-efficacy, and their children's ability tend to affect the way parents behave, which in turn, influence their children's motivational beliefs and subsequent behaviors (Eccles, 1993; Simpkins et al., 2012). Parents may transmit their beliefs to adolescents through mechanisms such as role modeling; encouragement and reinforcement; provision of related experiences or materials; and co-participation in related activities. These may then influence adolescents' motivational beliefs (e.g., their utility value perceptions), which in turn, may contribute to their performance and achievement (Eccles, 1993; Simpkins et al., 2012).

The findings of the present study are consistent with past research on parent-adolescent contagion of utility value perceptions. Similar to the studies of Acosta and Hsu (2014) and Lee et al. (2020), evidence of transmission of parental utility

value perceptions to their children were found. However, these studies focused on a single country with relatively small sample size. Likewise, the findings are consistent with that of Harackiewicz et al. (2012), Piesch et al. (2019), and Rozek et al. (2015) who conducted experimental studies on the transmission of parental utility value to their children. Simpkins et al. (2012) also found similar findings, but they focused on a wide range of motivational beliefs and not just utility value, and confined their investigation to the White middle-class families in the US. Our study extended the findings of these past studies and provided greater generalizability by including a larger sample size from more countries/regions.

By extending the findings on parental contagion of utility value perceptions to a wider scope of parents and adolescents from more countries/regions, this study also presents the possibility that such interventions may apply to samples from other countries. Furthermore, it emphasizes the importance of parental involvement in the development of adolescents' motivation and learning, especially in the science context, which is increasingly viewed as important for a wide range of careers and with STEM being considered as a critical determinant of a country's economic competitiveness (Shin et al., 2019).

The significant relationships of the covariates gender and SES with student utility value perceptions and achievement are also worth considering given that past studies have suggested their role in shaping motivation and achievement. Consistent with the findings of past studies (e.g., Lee et al., 2020; Rozek et al., 2015), boys were found to have higher utility value perceptions of science and science achievement. This could mean that more attention has to be given towards promoting girls' perceptions of the usefulness of and achievement in science. In terms of SES, students with higher SES were found to have higher levels of science achievement. This is consistent with the findings of past studies showing how students from more advantaged families do better in school (e.g., Sirin, 2005). Despite accounting for the statistical effects of gender and SES as covariates, our substantive results held suggesting the robustness of our results.

Parental utility value had a stronger relationship with students' achievement compared to students' own utility value perceptions. Past studies on utility value have seldom included data on both parents and children, so this finding provides novel information on the relative effects of parent and student beliefs on achievement. Nevertheless, these findings are consistent with past studies that examined parental expectancy (Froiland & Davison, 2014, 2016), wherein parent expectations had a robust effect above and beyond student expectations. Parents with higher expectations read more to their children and provided more academic resources. Parents with higher expectations also tend to have stronger parent-school relationships, which could contribute to positive school outcomes (Froiland & Davison, 2014, 2016). These behavioral mechanisms can also be explored in future studies on utility value contagion.

Part of the reason for the finding on the relationship between parents' utility value perceptions and students' achievement could be that the participants in our study were adolescent students, most of whom lived with their parents.

During adolescence, parental effects on student outcomes is critical (Gniewosz & Watt, 2017; Hombrados-Mendieta et al., 2012; King, 2015). Perhaps, when students enter university as young adults and when they live independently from their families, the effects of parental beliefs on student outcomes will be attenuated. As students get older and become more independent from their parents, their own utility value perceptions might play an increasingly more important role in learning and achievement. Indeed, studies among university students have found students' utility value perceptions to be robust predictors of achievement and other learning-related outcomes (Hulleman, Godes, et al., 2010; Hulleman et al., 2017).

It should also be noted that the effects we found, despite being statistically significant, are quite small (<.30) as the correlations between utility value perceptions (parents and students) and achievement ranged from $r = .04$ *to* $.11$, $p < .001$. The size of these relationships, however, are similar in magnitude to what past meta-analytic investigations have found for motivational variables (Hulleman, Schrager, et al., 2010; Richardson et al., 2012; Robbins et al., 2004). Moreover, the effects are comparable with past studies of parent and child utility value perceptions (e.g., Harackiewicz et al., 2016). Our effect sizes were also in line with past utility value studies. For example, Trautwein and colleagues (2012) found that the standardized effects of students' utility value beliefs on achievement ranged from .02 to .07 which puts it in a similar range to what we found. Despite having small effects on achievement, the practical significance of these effects should not be ignored when interpreting the study findings because when repeated across time, small effect sizes can have big implications (Martell et al., 2005). This is especially true for motivation, which operates whenever students face an achievement task (Collins et al., 2004).

Limitations and directions for future research

This study has some limitations. First, the cross-sectional design prevents us from making inferences regarding causal or temporal relationships among the variables. Second, we focused only on utility value perceptions and achievement in the science contexts, which may not be generalizable to other domains. Third, we did not consider parent behaviors (e.g., taking children to science museums and planetariums, talking about science, buying science books, etc.), which the expectancy-value theory suggests mediates the relationship between parents' beliefs and that of their children (Eccles, 1993; Simpkins et al., 2012). This was because we were confined to the data that was in PISA 2015. However, future researchers can include key parental behaviors as mediators of the social contagion effect. Doing so will allow a more nuanced understanding of the mechanisms by which parental beliefs are transmitted to their children. Fourth, we measured parents' utility value in terms of parents' personal utility value (i.e., the perception that science is useful to them) but not students' perception of their parents' utility value of science, defined as how much

children perceived their parents to value science (e.g., Šimunović et al., 2018). These different utility value beliefs might have important implications for student learning, which future researchers can examine.

Conclusion

By using data from a large-scale survey that involves parents and adolescents from various societies, this study provided empirical support for the parental contagion of utility value and its role in achievement. Parents who believe that science is relevant are likely to transmit these beliefs to their children. Both parental utility value and students' own utility value perceptions are crucial predictors of achievement. These findings highlight the important role parents play in adolescents' motivational and learning outcomes. It also suggests that parents be involved and be considered as important resources when designing programs toward enhancing adolescents' motivation and achievement.

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