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Science self-concept and valuing science: a cross-cultural analysis of their relation among students from Western and East Asian countries

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Abstract Devaluing an academic domain is a potential means of alleviating the psychological discomfort that results from the inconsistency of a low domain-specific self-concept of ability and great value attached to the domain. Such motivated devaluation of a domain is expected to be stronger in cultural contexts that promote a relatively greater focus on striving for a unique and consistent self than on the fulfillment of relevant others' expectations. Moreover, motivated devaluation is expected to be stronger the closer the value construct is tied to the self. Multiple group structural equation models tested whether students' self-concepts of their science ability differentially predicted the values students attach to science in Western and East Asian subsamples of the Programme for International Student Assessment. Science self-concept predicted value of science in all countries; however, the effects were stronger in Western than East Asian countries. Moreover, effects were stronger for the psychologically more proximal personal than for the more distal general value of science. Results are thus in line with the proposition that the value students attach to an academic domain in part results from a motivated process driven by their domain-specific self-concept of ability.

Keywords Self-concept · Devaluing · Motivation · Values · Culture · Cultural differences

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1 Introduction

School careers provide ample opportunities for frustration: Students may perceive lessons to be bookish, learning material to be too demanding, or themselves as struggling to cope. Continued frustrating experiences lead to a decline in motivation to learn. To the extent that students' domain-specific self-concepts of ability are affected, they may be motivated to devalue the respective academic domain. Students will then likely reduce their engagement with that domain, thereby corroborating their low self-concept and negative attitude toward the domain. By inducing motivated devaluation of an academic domain, a low self-concept of ability may have lasting adverse effects on students' academic progress and may ultimately impair job opportunities and life options.

1.1 Academic self-concepts

Students' academic self-concepts consist of their cognitive representations of their academic abilities. These representations are specific to domains so that, for example, a verbal self-concept can be differentiated from a mathematics self-concept (e.g., Marsh 1993). Across domains the specific self-concepts of ability are only loosely related to each other (Möller et al. 2009). Science self-concept, for example, may therefore be either high or low in students who consider themselves highly competent in English. Such cognitive representations of one's domain-specific abilities are derived from social (Festinger 1954; Huguet et al. 2009; Van Yperen and Leander 2014), temporal (Zell and Alicke 2009), and dimensional comparisons (Möller and Marsh 2013). As the research on the so-called big-fish–little-pond effect demonstrates, a reference point for social comparisons used by students cross-culturally is their schoolmates' average achievement (Seaton et al. 2009). Students have lower academic self-concepts when their reference group's mean achievement is high compared to equally competent students whose reference group's mean achievement is low.

Academic self-concepts are reciprocally related to academic achievement, that is, they are both a cause and an effect of achievement (e.g., Guay et al. 2003; Marsh and Köller 2004; Marsh et al. 2005; Trautwein et al. 2006a; see Marsh and Martin 2011, for a review). Reciprocal effects were also observed between domain-specific self-concept and interest in the domain, but interest's effect on self-concept was not as strong as the reverse effect (Marsh et al. 2005). As students mature, the association between domain-specific self-concept and interest in the domain becomes stronger (Denissen et al. 2007). The asymmetric reciprocal relation between academic self-concept and interest (Marsh et al. 2005) as well as influential motivational theories relating competency beliefs to subjective values of activities (Deci and Ryan 2000; Eccles (Parsons) et al. 1983) suggest that self-concept's effect on interest primarily drives the increasing association between both variables. Therefore, it may actually be a motivated process when students lose interest in a domain in which they do not consider themselves competent: Diminished interest in a domain might be a consequence of students actively disengaging from or

devaluing the domain (e.g., Major and Schmader 1998; Steele 1997; see also Jacobs et al. 2002).

1.2 Motivated devaluation of academic domains

Favorable attitudes toward academic domains are an educational goal as they impact academic outcomes as well as academic and professional choices. Attaching great value to an academic domain is, however, inconsistent with a low corresponding self-concept of ability. Such inconsistent cognitive elements elicit psychological discomfort (cognitive dissonance; Aronson 1968; Festinger 1957). Specifically, Aronson (1968) argued for a pivotal role of self-concept in the incurrence of cognitive dissonance. People have a need to form a stable self-concept and to predict their own behavior (Aronson 1992). Goals they pursue may be based on their values, which are part of their self-concept, next to the cognitive representations of their academic abilities, which are the academic self-concepts. A low academic self-concept is therefore more discomforting the more the respective domain is valued. The more important the inconsistent cognitions are, the higher a person's motivation is to restore consistency (Festinger 1957). Attitude change is a strategy to reduce such psychological discomfort (Elliot and Devine 1994; Festinger 1957; Harmon-Jones 2000). Low academic self-concepts may thus cause students to discount the value of a domain.

Disidentification or disengagement occurs when persons redefine their self-concepts in such a way that a particular domain is no longer used as a basis for self-esteem (Major et al. 1998; Schmader et al. 2001; Steele 1997). Devaluing an academic domain reduces its psychological importance and hence facilitates disengagement (Major and Schmader 1998). Future negative affect such as embarrassment or disappointment as a consequence of negative performance feedback or unfavorable social comparison outcomes is thus prevented. A low academic self-concept will not elicit cognitive dissonance once it is consistent with a student's expectations (Aronson 1968). As academic self-concepts are fairly stable (Marsh and Yeung 1998; Trautwein et al. 2006a) and hardly susceptible to intentional change, changing one's attitude toward the respective domain seems a corruptive strategy to evade harmful consequences for the self when a domain-specific self-concept of ability is low. Inasmuch as a low academic self-concept is acknowledged as an indicator of the unattainability of the corresponding academic goal, developmental theory suggests that disengagement is indeed an adaptive strategy (Heckhausen et al. 2010).

1.3 Culture

Culture fundamentally impacts psychological processes (Markus and Kitayama 1991; Nisbett and Masuda 2003; Triandis 1989). Culture thus also has important implications for student motivation (e.g., King and McInerney 2014). Cultural variation has been established prominently with regard to the concept of self-construal (Cross et al. 2011). Western cultural contexts more strongly promote an independent construal of the self than an interdependent construal of the self; the

reverse holds true for East Asian cultures (Markus and Kitayama 1991; Triandis 1989). For individuals who endorse a relatively greater independent self-construal, the primary reference point is their own thoughts, feelings, and actions. The primary reference point for individuals with a more interdependent self-construal is the thoughts, feelings, and actions of relevant others. For instance, when faced with the options to spend the evening studying for an upcoming exam or watching their favorite TV show, students from Western cultural contexts tend to make their decision independently based on their own preferences; students from East Asian cultural contexts are more likely to consider which behavior would be most in line with their family's preferences. Independence or interdependence, respectively, are cultural mandates which can be achieved by culturally scripted means, procedures, or routines: so-called cultural tasks (Kitayama et al. 2009). Cultural socialization thus engenders differences in psychological tendencies between individuals from different cultural contexts. Accordingly, systematic differences can be assumed between students from Western and East Asian cultural contexts in how they develop the values they attach to academic domains.

One difference in psychological tendencies between cultural contexts involves experiencing the psychological discomfort of cognitive dissonance (cf. e.g., Kitayama et al. 2004). The striving for a unique and consistent self predisposes people from Western cultural contexts to experience negative psychological consequences of inconsistent cognitions. For instance, attaching high value to an academic domain would be inconsistent with having a low self-concept of ability in that domain. In East Asian cultural contexts, inconsistency across situations is normatively expected inasmuch as behavior is expected to vary with situational demands; provided that the situational demands are being met, inconsistency is not expected to arouse cognitive dissonance. East Asians do, however, experience cognitive dissonance when interpersonal concerns are drawn (Hoshino-Browne et al. 2005). Internal attributes such as attitudes and traits are not considered primary in East Asian cultures; they may not be regarded as core aspects of a person's identity. Identity is instead mainly derived from relationships with important others, group memberships, and social roles. People in East Asian cultures accordingly focus on the fulfillment of expectations associated with a pertinent role (Markus and Kitayama 1991). The respective expectations of students are displaying a high motivation to learn, engaging in strenuous learning behavior, and attaining high levels of achievement. The greater an individual's relative endorsement of an interdependent self-construal, the more importance will be placed on relevant others' expectations; merely priming Western participants with interdependence diminished their performance in a knowledge test by assimilation to the dumb blonde stereotype (Bry et al. 2008). Having a low academic self-concept is thus assumed to arouse psychological discomfort in students from an East Asian cultural context primarily for a different reason than in a Western cultural context: To the extent that academic achievement is highly valued by self-relevant others, a low academic self-concept indicates that their expectations are not being met.

The emphasis on the fulfillment of others' expectations in East Asian cultural contexts and the emphasis on a unique and consistent self in Western cultural contexts entail differential reactions toward negative information about the self:

Instead of displaying the self-enhancement motivation characteristic of Westerners, East Asians maintain a self-improving orientation (cf. Heine and Hamamura 2007; Heine et al. 2001; Kitayama et al. 1997). East Asians respond to negative information about the self by increasing their effort in an attempt to better fit in with others and thus secure social approval. Their implicit theory of the self as incremental rather than an entity encourages the motivational tendency to persist with a particular task after negative feedback (Heine et al. 2001). Students from East Asian cultural contexts can thus be assumed to study more and study harder instead of disengaging from domains when they perceive their achievement in the domain as comparatively low. East Asians perceive inadequacies as developmental tasks; addressing such tasks affirms belongingness to their in-group. However, negative self-relevant information still impacts East Asians' self-esteem (Kitayama et al. 1997). Devaluation of a domain in which one subjectively perceives one's own abilities as comparatively low might not be an option for East Asian students as it would negate shared values and thus belongingness to their in-group. Consequently, perceiving their own ability in a valued domain as low should motivate devaluation of that domain in Western students, but less so in East Asian students.

2 The present research

The present research tested the hypothesis that the lower students' self-concepts of their science ability are, the less utility value they attach to the science domain for themselves personally and also, but to a lesser extent, more generally for society. The general value attached to a domain is psychologically more distal and less closely tied to the self than the personal value of this domain; it is therefore assumed to elicit less discomfort when in conflict with the self-concept of ability. These relations of science self-concept with the value of science are expected to be more pronounced in students from Western countries than in students from East Asian countries. Such differential relations of students' academic self-concepts with the values they attach to the corresponding domain would corroborate the proposition that devaluation is indeed a motivated process.

3 Method

3.1 Participants

The current analyses were conducted on subsamples of the Programme for International Student Assessment (PISA) 2006 (Organisation for Economic Co-operation and Development [OECD] 2007). PISA is a cross-national survey of 15-year-old students. Sampling of students ensured representation of the full target population of 15-year-old students in all participating countries. Students from Australia, Canada, the United Kingdom, and the United States of America were selected as representatives of Western culture; students from Japan, South Korea, Chinese Taipei (also known as Taiwan), and Hong Kong-China were selected as

representatives of East Asian culture (cf. Table 1 for descriptions of these samples). Psychological research on cross-cultural differences is typically conducted with participants from these countries (although U.S. American and Japanese participants prevail).

PISA data sets include student weights which account for unequal selection probabilities of schools and of individual students within these schools as well as for non-response. These weights need to be used to obtain results representative for countries' PISA populations (OECD 2009). The student weights were scaled in each country so that the weighted number of cases corresponded to the observed number of cases (i.e., the sample size). All analyses reported below employed these student weights.

3.2 Procedure

Each PISA survey assesses students' achievement in reading, mathematics, and science. Science was the major domain in PISA 2006; hence, the extensive student questionnaire focused on science. As a result, the value students attach to an academic domain was only available with respect to science. The tests as well as the questionnaires were administered in the instructional language(s) of each country; elaborate procedures had been implemented to avoid translation errors (OECD 2009).

Students' self-concepts of their science ability were measured with 6 items assessing students' agreement with statements such as "School science topics are easy for me". Reliabilities of the science self-concept scale were all excellent (Cronbach's αs = .91–.94). The two dimensions of value of science were measured by a mixed scale containing 5 items for each dimension (e.g., "I find that science helps me to understand the things around me" measuring personal value of science, and "Advances in science and technology usually help to improve the economy" measuring general value of science). Reliabilities of the two subscales were at least satisfactory in all countries (Cronbach's αs = .75–.86 and .77–.82 for personal and

Table 1 Country-specific sample characteristics

Country	$N_{students}$	$N_{schools}$	% Female	Age	
				M	*SD*
Australia	14,170	356	49.2	15.78	.29
Canada	22,646	896	51.0	15.85	.28
United Kingdom	13,152	502	50.4	15.70	.29
United States of America	5611	166	49.4	15.82	.30
Japan	5952	185	49.5	15.78	.29
Korea	5176	154	49.5	15.77	.29
Chinese Taipei	8815	236	47.6	15.79	.33
Hong Kong-China	4645	146	50.6	15.78	.29

general value of science, respectively). Although the distinction between personal and general value of a domain has not been firmly established by previous research, both scales assess the utility value component (e.g., Eccles (Parsons) et al. 1983; Wigfield and Eccles 2000): In line with the theoretical conceptualization, personal value of science has a narrow focus on the utility value of science for the self; general value of science, on the other hand, addresses the utility value of science for society. All three constructs were measured with 4-point rating scales (*strongly agree–strongly disagree*). Items were reverse coded so that higher values represent higher science self-concepts and more value attached to science; then, they were centered within-country to control for mean differences between countries. Finally, the country-residualized variables were z-standardized (i.e., $M = 0$, $SD = 1$) across countries.

Missing data were multiply imputed (cf. Rubin 1987; Schafer 1997) using M*plus* 7.11 (Muthén and Muthén 1998–2012). To account for the substantial negative impact of mean school science achievement on science self-concept (Nagengast and Marsh 2012), the two-level imputation model incorporated achievement on both the student and the school level in addition to further student characteristics. Achievement scores in PISA are obtained by scaling models based on item response theory (Adams et al. 1997). Scaling produced 5 so-called plausible values for each student within a domain; plausible values are randomly drawn values from a student's most likely achievement range (von Davier et al. 2009). Accordingly, five data sets were generated and each of these data sets was imputed $m = 10$ times, resulting in 50 data sets. Prior to their inclusion in the imputation model, individual achievement scores were linearly transformed so that, as a set, the 5 plausible values were centered at their country-mean. Subsequently, school-average achievement scores were generated by aggregating the scores of all students attending the same school (separately for the 5 plausible values).

Analyses were conducted with these 50 data sets generated using multiple imputation and combined according to the rules of Rubin (1987). Parameter estimates as reported below are averages across the 50 analyses. Standard errors represent sampling variability as well as variability of the parameter estimates between the 50 corresponding analyses (Rubin 1987; Schafer 1997).

3.3 Data analysis

The school level was not explicitly modeled; however, non-independence of student data because of students being nested in schools was taken into account by specifying school as a cluster variable. All analyses employed maximum likelihood estimation with robust standard errors. Multiple group analyses in which Western countries and East Asian countries were each considered as a group further employed country as a stratification variable to identify the subpopulations (i.e., the countries) from which the independent samples had been drawn.

Cross-country comparisons presuppose that psychological variables are measured invariantly across countries. A three-factor model was assumed to hold in all eight countries. Confirmatory factor analysis tested this assumption. A multiple group model in which both the factor loadings and the intercepts of the indicator variables

were constrained to be equal across countries (scalar invariance) provided an appropriate fit to the data, $\chi^2(990) = 19360.1$, comparative fit index (CFI) = .953, Tucker-Lewis index (TLI) = .954, root mean square error of approximation (RMSEA) = .043. The cutoff values suggested by Chen (2007; i.e., change of −.010 in CFI and .015 in RMSEA) as an alternative to difference testing using χ^2 indicate that imposing scalar invariance did not substantially reduce the fit of the model as compared with a model imposing metric invariance (i.e., constraining factor loadings to be equal across countries; ΔCFI = .000 and ΔRMSEA = −.002). At the same time, imposing metric invariance had not resulted in worse fit as compared with the baseline model in which both the factor loadings and the intercepts of the indicator variables were freely estimated for all countries (ΔCFI = −.004 and ΔRMSEA = .000). For multiple imputation χ^2 difference testing has not yet been developed.

Competing multiple group models with scalar invariance were tested to corroborate the three-factor structure. Both a one-factor model in which all items were modeled as indicators of a single latent factor and a two-factor model in which one science self-concept factor and a single value of science factor were modeled fit the data worse than the three-factor model, CFI = .674, TLI = .700, RMSEA = .110, and CFI = .918, TLI = .923, RMSEA = .056, respectively.

4 Results

Table 2 displays the descriptive statistics for the latent factors within countries. Australia was specified as the reference group in the multiple group analysis; all Australian factor means are therefore fixed at zero.

4.1 Prediction of personal value of science

To test the effects of science self-concept on the personal and general value that students in Western and East Asian countries attach to science, a two-group structural equation model was fit. The model fit the data well, $\chi^2(228) = 14354.2$,

Table 2 Latent means and standard deviations by country

Country	Science self-concept		Personal value of science		General value of science	
	M	*SD*	*M*	*SD*	*M*	*SD*
Australia	0	.884	0	.896	0	.764
Canada	.009	.947	−.002	.859	−.002	.727
United Kingdom	.048	.791	0	.812	.001	.720
United States of America	.054	.913	0	.811	.001	.794
Japan	.053	.872	.001	.736	.002	.825
Korea	.054	.844	.002	.683	.002	.675
Chinese Taipei	.055	.865	.002	.672	.003	.704
Hong Kong-China	.011	.851	.003	.640	.004	.658

Table 3 Standardized path coefficients for science self-concept predicting personal and general value of science from the multiple group structural equation model

Country	Personal value of science		General value of science	
	β	*SE*	β	*SE*
Australia	.626	.008	.498	.010
Canada	.593	.010	.421	.013
United Kingdom	.610	.011	.478	.014
United States of America	.550	.015	.417	.015
Japan	.461	.015	.280	.017
Korea	.556	.015	.232	.018
Chinese Taipei	.378	.013	.183	.015
Hong Kong-China	.435	.017	.262	.020

All coefficients are statistically significant at $p < .001$

Table 4 Wald χ^2 test statistics for bilateral country comparisons of science self-concept's effects on value of science

Country	Personal value of science				General value of science			
	JPN	KOR	TAP	HKG	JPN	KOR	TAP	HKG
AUS	183.179	117.001	464.134	297.178	62.377	171.081	282.187	137.637
CAN	63.006	24.906	221.717	122.711	7.228**	50.510	99.846	36.465
GBR	139.721	83.956	338.876	212.318	53.929	131.952	208.351	104.558
USA	26.921	3.937*	104.935	57.348	19.522	74.442	126.856	53.685

AUS Australia, *CAN* Canada, *GBR* United Kingdom, *HKG* Hong Kong-China, *JPN* Japan, *KOR* Korea, *TAP* Chinese Taipei, *USA* United States of America

* $p < .05$; ** $p < .01$. All other test statistics are significant at $p < .001$

CFI = .960, TLI = .958, RMSEA = .039. Science self-concept predicted personal value of science in Western (β = .602, $p < .001$) as well as in East Asian countries (β = .453, $p < .001$). The lower students' science self-concept was, the less value they attached to science for themselves personally. A Wald χ^2 (*W*) test of parameter equalities determined that, as expected, the effect was stronger in Western than in East Asian countries, $W(1) = 495.17$, $p < .001$.

Results for the multiple group structural equation model in which all countries were considered separately are displayed in Table 3 (see the three-factor model with scalar invariance for the fit statistics). The effect of science self-concept on personal value of science was statistically significant in all countries.

Comparisons between Western and East Asian countries that were carried out separately for all countries revealed that all Western countries' path coefficients for the prediction of personal value of science by science self-concept were significantly different from all East Asian countries' path coefficients (cf. Table 4). In all but one between-country comparisons, science self-concept more strongly predicted personal value of science in the Western than the East Asian country.

Contrary to the expectations the effect was stronger in Korea than in the United States of America.

4.2 Prediction of general value of science

The pattern of results was expected to be similar for general value of science as for personal value of science. The two-group structural equation model indeed demonstrated that science self-concept significantly predicted general value of science in Western ($\beta = .452$, $p < .001$) as well as in East Asian countries ($\beta = .234$, $p < .001$). The lower students' science self-concept was, the less general value they attached to science. Again, the Wald χ^2 test determined, as expected, that the effect of science self-concept on general value of science was significantly larger in Western than in East Asian countries, $W(1) = 298.443$, $p < .001$.

The multiple group analysis in which all countries were considered separately revealed that the effects of science self-concept on general value of science were statistically significant in all countries (cf. Table 3). In subsequent two-group models which considered Western and East Asian countries separately, all Western countries' path coefficients for the prediction of general value of science by science self-concept were significantly larger than all East Asian countries' path coefficients (cf. Table 4).

4.3 Relations of personal and general value of science in comparison

As personal value of science is more proximal to the self than general value of science, the motivated effects of science self-concept were expected to be stronger on the former than the latter. Indeed, the two-group structural equation model revealed that science self-concept was a stronger predictor of personal than of general value of science both in Western and East Asian countries, $W(1) = 971.012$, $p < .001$, and $W(1) = 554.364$, $p < .001$, respectively (see also Fig. 1). At the same

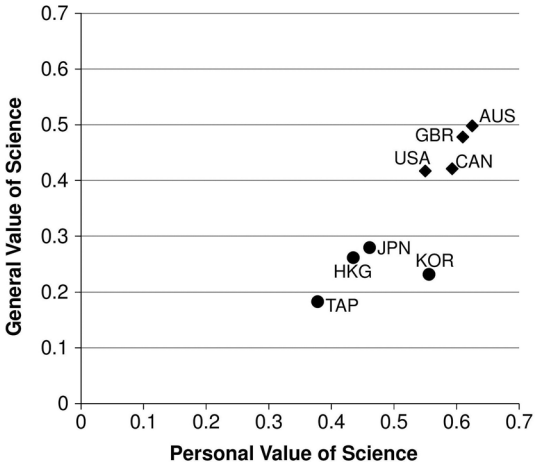

Fig. 1 Path coefficients for the prediction of personal and general value of science in Western and East Asian countries from the multiple group structural equation model. *AUS* Australia, *CAN* Canada, *GBR* United Kingdom, *HKG* Hong Kong-China, *JPN* Japan, *KOR* Korea, *TAP* Chinese Taipei, *USA* United States of America

time, the difference between science self-concept's effect on personal and its effect on general value of science was larger in Western than in East Asian countries, $W(1) = 13.340$, $p < .001$. The association of personal and general value of science was equally strong in Western ($\beta = .713$, $p < .001$) and East Asian ($\beta = .721$, $p < .001$) countries, $W(1) = 1.873$, $p = .17$.

5 Discussion

The objective of the current study was to demonstrate that students attach less value to an academic domain, namely science, the lower their domain-specific self-concept of ability is. The inconsistency of a low domain-specific self-concept of ability and great value attached to that domain was argued to arouse discomfort both in Western and East Asian students. Yet, devaluing an academic domain would come at a higher cost for East Asian students than for Western students as it would mean negating shared values. Motivated devaluation of science was therefore assumed to be stronger for students from Western than East Asian cultural contexts. In countries with both cultural backgrounds, the motivation to devalue science was argued to be weaker on the more distal general level than on the more proximal personal level. The data were representative for the 15-year-old student population in each of the eight countries considered and bilateral country comparisons were conducted to investigate whether the hypothesized differential relations replicated across pairings.

As expected, the effects of science self-concept on the personal and general value that students attach to science were stronger in Western than in East Asian countries. However, both effects were statistically significant in all countries. Motivated devaluation of an academic domain thus seems to occur in the general student population from both cultural backgrounds. Results thus corroborate previous research suggesting that East Asian students also suffer negative psychological consequences from negative information about the self (cf. Heine and Lehman 1999; Heine et al. 1999). Based on the literature that demonstrates robust differences between Westerners and East Asians one might speculate, however, that the effects of science self-concept on value of science rely on different psychological processes in these two cultural contexts: Whereas Western students strive to maintain consistency and (high) positive self-regard, East Asians may be affected to such an extent that they appraise their science achievement as failing to satisfy expectations of relevant others.

The smaller coefficients for the predictor science self-concept in East Asian countries as compared with the corresponding coefficients for Western countries supposedly reflect the stronger emphasis on a common value base in East Asia—values are not as much predicated on the individual's traits and preferences (Markus and Kitayama 1991). In East Asia, there is generally a great emphasis on school achievement (ultimately on knowledge; e.g., Li 2003). On the individual level, valuing academic domains is less normative in Western countries and is thus more a matter of individual discretion. This is reflected in the somewhat higher variability of value attached to science in Western countries compared to East Asian countries.

Consequently, Western students are at greater liberty to devalue an academic domain in order to protect their self-esteem.

The fact that also East Asian students' science self-concept was significantly related to the value they attached to science is particularly interesting, because they are known to endorse an incremental theory of the self which encourages the motivational tendency to persist with a particular task after negative feedback (Heine et al. 2001) and indeed to respond to negative information about the self by increasing their effort (cf. Heine and Hamamura 2007; Heine et al. 2001; Kitayama et al. 1997). These previous findings thus seem somewhat in conflict with the present results. However, effort and persistence are more easily recognized by relevant others than students' attitudes. Striving to conform with relevant others' values and to fulfill corresponding expectations might therefore be more important and more consistently pursued on the behavioral than the attitudinal level.

On the other hand, to the extent that schoolmates are construed as part of the self, an individual's low academic self-concept may be somewhat less bothersome. When prompted to predict another person's performance on a particular task, individuals with a more interdependent as opposed to a more independent construal of the self project higher performance of close others than of a stranger in self-relevant tasks; apparently, the success of a person close to the self on a self-relevant task is perceived as less threatening when he or she is construed as part of the self. Individuals with a more independent self-construal suffer negative psychological consequences when close others perform well in a self-relevant domain and therefore project comparatively low performance for them (Gardner et al. 2002). In a related vein, belonging to a group with high average achievement is associated with positive effects on the group-members' self-concepts (Cialdini et al. 1976); the pan-cultural big-fish–little-pond effect (i.e., the negative effect of school-average achievement on academic self-concept controlling for individual achievement) is a net effect of assimilation and contrast effects (Marsh et al. 2000). Three studies employing data representative for the respective 15-year-old student population and relating to three different academic domains demonstrated, however, that the big-fish–little-pond effect was not statistically significant in Korea (Marsh and Hau 2003; Nagengast and Marsh 2012; Seaton et al. 2009). As an explanation for the absence of this universal effect in Korea, Seaton et al. (2009) proposed that the assimilation effect associated with attending a Korean school where school-average achievement is high (i.e., a prestigious school) may compensate for the opposed contrast effect. This proposition is in line with the finding that the intraclass correlation for students' science self-concept was descriptively higher in Korea than in most other countries participating in the PISA 2006 survey and was twice the size of the average intraclass coefficient (Nagengast and Marsh 2012). The only deviation from the theoretically expected pattern of results in the current study was also associated with Korea. The flipside of strong assimilation effects is competent students who attend schools with low average achievement having comparatively low academic self-concepts. To the extent that attendance at prestigious schools is unattainable for 15-year-old Korean students, they might be more inclined than other East Asian students to discount the value of science for themselves personally. The comparatively low percentage of Korean students achieving at or below

proficiency level I (cf. OECD 2007) suggests, however, that achievement-related behavior might be less affected: Even if they attach less value to science for themselves personally than their schoolmates do, Korean students may still strive to achieve and fulfill others' expectations. More generally, these results underscore the importance of considering potential differences in psychological processes between cultural contexts. Results obtained in a particular country may not unqualifiedly generalize to other countries, even if they are of a similar cultural background (Kitayama et al. 2009).

5.1 Implications

Discarding the negative psychological consequences associated with a comparatively low level of achievement while maintaining a high value of the domain is not easily accomplished. First of all, social comparison information is highly salient (Van Yperen and Leander 2014) and academic self-concepts are fairly stable (rank-order stability; e.g., Marsh and Yeung 1998; Trautwein et al. 2006a). Secondly, a self-perpetuating or even deteriorating process is conceivable: As the stereotype threat literature demonstrates, beliefs one holds about one's abilities impact actual achievement (e.g., Steele and Aronson 1995; see also Guay et al. 2003; Marsh and Köller 2004; Marsh and Martin 2011; Marsh et al. 2005; Trautwein et al. 2006a; Valentine et al. 2004). Not only are students with low academic self-concepts thus prone to corroborate their relatively low standing in the reference group, they are also likely to devalue the respective domain and thus rationalize low effort and persistence. As a consequence, they fail to realize their full potential.

In Western countries, the cross-sectional observation at age 15 is possibly an underestimation of students devaluing an academic domain. A low academic self-concept may have impaired the development of academic achievement in students who initially achieved comparatively little. Low domain-specific self-concepts may then have entailed reduced effort and persistence in learning that has been rationalized by the discounted value of the domain (see Rydell et al. 2010; Taylor and Walton 2011, for evidence that stereotype threat undermines not only performance but learning). Teachers may even reinforce this vicious circle by adapting their own behavior toward students according to the perceived ability, effort, and persistence (e.g., Skinner and Belmont 1993). Devaluation of an academic domain is thus a potential mechanism by which domain-specific self-concepts impact subsequent achievement within the corresponding domains (Marsh and Martin 2011).

Inasmuch as devaluing a domain entails reduced effort and persistence and thus fosters deterioration of academic achievement, East Asian students' restricted options to devalue a domain help to maintain their learning motivation and ultimately promote their development of academic achievement (cf. the mean science achievement scores as assessed by PISA 2006 which were above the OECD average in the four East Asian countries considered here; OECD 2007). Where Western students may give up on a domain, East Asian students keep going and thus improve their life and career options. The presumed absence of deteriorating

academic progress in East Asian countries, however, comes at the cost of continued negative psychological consequences for students with low academic self-concepts.

5.2 Limitations

Given the cross-sectional nature of the data, the study design is not fit to determine a causal ordering of the domain-specific self-concept of ability and the value attached to that domain. Theoretically, reciprocal relations could be assumed. The higher a domain is valued, the more time and effort will be expended on learning, the better students' achievement and, as a consequence, their domain-specific self-concepts of ability will be—at least in Western countries. This natural experiment conducted with a strong data base nevertheless established associations in the populations that are consistent with the differential predictions for students from different cultural backgrounds: The value attached to science is more strongly associated with students' science self-concept in Western than in East Asian countries. The robust finding that students' science self-concept is more strongly associated with the personal than the general value of science further corroborates the proposition of the motivated nature of devaluation of an academic domain. Still, convergent evidence from research rigorously testing the assumed psychological processes is needed.

Such rigorous tests would also need to include explicit measures of the psychological constructs presumably involved in Western and East Asian students dealing with low self-concepts of ability. Students from the countries considered in the present study probably differ with regard to a range of characteristics; other explanations than the motivated devaluation of science as proposed here may also account for the observed pattern of results. In this regard, using the PISA data sets entailed the limitation of being confined to the constructs which had been included in the survey.

6 Conclusion

Students' academic self-concepts are important not only for their own sake but also because they are associated with other variables like interest in the domain (e.g., Trautwein et al. 2006b), school grades, standardized test scores (e.g., Marsh et al. 2005), course selection (Nagy et al. 2006), and career aspirations (Nagengast and Marsh 2012). The current study demonstrates that the self-concept of ability is also robustly associated with the utility value that students attach to the respective domain. Data from surveys such as PISA do not lend themselves to a firm investigation of psychological processes; however, the cross-cultural comparison as well as the comparison of the two value constructs differing in psychological proximity within countries is in line with the assumption that the value students attach to an academic domain in part results from a motivated process driven by their domain-specific self-concept of ability.

Students in the current samples were approaching the end of compulsory schooling. Once they have graduated from school, they will not need to address science topics unless they choose to. People with low science self-concepts are quite

unlikely to create opportunities in which they will be able to perceive their own science achievement as high. They will instead strive to avoid exposure to science. This way, they forfeit experiences that may break the vicious circle and change their attitude toward science for the better.

Still, each individual has to make many decisions during their lifetime that should be based on scientific evidence (e.g., whether or not to have one's children receive the measles vaccination, whether to buy an electrically powered instead of a gas-operated car). Even avoiding conscious decision-making is no remedy: Disregarding the information available and ignoring the options that have to be actively pursued and thereby making the decision to not act might entail harmful consequences. A certain degree of science achievement is necessary to make informed decisions for ourselves and those who are under our care. There is not much to be gained by basing one's self-esteem on domains which are not a personal strength, but devaluation has a negative side to it in that it implies a refusal to engage with the domain.

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