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Dimensional comparisons: How academic track students' achievements are related to their expectancy and value beliefs across multiple domains☆

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ABSTRACT

In the present study, we investigated how students' expectancies and values can be predicted by their achievements in multiple domains. Our major aim was to extend previous findings on dimensional comparison processes for expectancies to task values while systematically comparing multiple value facets defined in expectancy-value theory. We assessed the expectancies, values, and achievements of $N = 857$ students in Grades 5–12 from two German academic track schools in five academic domains. The results for students' expectancies largely supported the predictions that were derived from dimensional comparison theory: We found strong evidence for negative cross-domain paths between achievements and expectancies in "far" domains such as math and languages, indicating contrast effects. There were also some positive cross-domain paths between achievements and expectancies in "near" domains such as math and physics, indicating assimilation effects. We also found similar patterns of cross-domain paths for students' values. However, the results varied substantially across the nine value facets under investigation. We found the strongest evidence for dimensional comparison processes for the value facets most closely related to expectancy (e.g., intrinsic value and cost facets), whereas we found only a little evidence for dimensional comparison processes for the facets of utility value.

1. Introduction

Students' expectancy and value beliefs about different domains are important predictors of their effort and engagement in these domains as well as their course choices (for a review, see Wigfield, Tonks, & Klauda, 2009). In previous research, both kinds of beliefs have been found to be highly domain-specific (e.g., Bong, 2001; Eccles, Wigfield, Harold, & Blumenfeld, 1993). Students tend to favor one domain over another, and their expectancy and value beliefs about different domains such as math and English typically show only very low correlations (e.g., Trautwein et al., 2012). In addition to expectancy and value beliefs in a particular domain, the intraindividual levels of expectancies and values across domains are key determinants of students' effort and choices (Chow, Eccles, & Salmela-Aro, 2012; Eccles, 2009; Trautwein & Lüdtke, 2007). It therefore seems important to investigate these beliefs in multiple domains.

How do students develop domain-specific expectancy and value beliefs? Students' expectancies and values are influenced by their experiences with different domains in the school context and the information they receive about their performances (Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006). Students attend to both their own achievements in different areas and the achievements of others (Butler, 2005; Ruble, 1983). Marsh (1986) called such intraindividual comparisons across domains an internal frame of reference and comparisons with other students an external frame of reference. In their dimensional comparison theory (DCT), Möller and Marsh (2013) discussed the nature of dimensional comparisons and also how the perceived similarity between domains impacts how students' achievements

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and expectancies are related to each other across domains. They posited that comparisons between "far" domains (e.g., math and English) result in contrast effects, such that being good in one of the areas goes along with a lower subjective evaluation of one's competence in the other. Comparisons between "near" domains (e.g., math and science) can result in assimilation effects; being good in math also means being good at science.

In recent years, DCT has been shown to be a useful theoretical framework for stimulating a number of studies, the results of which have supported assumptions from the theory about the comparison processes that drive the formation of students' academic self-concepts (e.g., Jansen, Schroeders, Lüdtke, & Marsh, 2015; Marsh, Lüdtke, et al., 2015; Müller-Kalthoff et al., 2017). Important implications for theory, research, and practice have come from such studies. However, much less research has been conducted on how dimensional comparison processes affect constructs other than academic self-concepts. Recently, Möller, Müller-Kalthoff, Helm, Nagy, and Marsh (2016) proposed an extension of DCT, the so-called generalized IE model, in which they proposed that—besides academic self-concepts—other variables such as domain-specific motivational constructs are affected through the same social and dimensional comparison processes. Accordingly, some studies have shown cross-domain effects of achievement on intrinsic value and related constructs (Guo, Marsh, Parker, Morin, & Dicke, 2017; Marsh, Abduljabbar, et al., 2015). However, students' task values are conceptualized as multifaceted, including intrinsic value, attainment value, utility value, and cost (Eccles & et al., 2005; Wigfield & Eccles, 1992). New instruments that can be used to measure all of these value facets have only recently been developed (Gaspard et al., 2015).

In the current investigation, we integrated these two evolving areas of research to conduct a systematic investigation of dimensional comparison processes across different motivational constructs. We examined the associations between students' expectancies, values, and grades in five domains, including languages as well as math and sciences, in a sample of more than 800 German students in Grades 5 through 12. To measure students' value beliefs, we used a psychometrically sound questionnaire covering nine value facets (Gaspard, Häfner, Parrisius, Trautwein, & Nagengast, 2017).

1.1. Expectancies and values in EVT

EVT (Eccles et al., 1983) is one of the most influential theories for explaining students' learning behavior and achievement-related choices. According to this theory, students' task choice and their engagement in a task are driven by two subjective, task-specific beliefs: (a) the expectancy that one can succeed in a task and (b) the value that one attaches to a task. Eccles and her colleagues defined *expectancies for success* as individuals' beliefs about how well they will do on a task in the future (Eccles & Wigfield, 2002). This construct is conceptually related to other constructs that refer to self-evaluations of competences, such as *academic self-concept* (Marsh, 2007). Indeed, academic self-concept and expectancies for success have often been found to be highly correlated, and therefore, in research in which the EVT framework has been used, these constructs have typically been collapsed or used interchangeably (e.g., Eccles, Wigfield, et al., 1993). In this study, we do not differentiate between them and use the terms "expectancy" and "academic self-concept" synonymously.

Eccles and her colleagues distinguished four components that influence the value of a task: intrinsic value, attainment value, utility value, and cost (Eccles, 2005; Eccles & Wigfield, 2002; Eccles et al., 1983; Wigfield & Eccles, 1992). *Intrinsic value* is defined as the enjoyment a person derives from engaging in an activity. This value component is closely related to the constructs of interest and flow and is supposed to develop on the basis of positive experiences with a specific activity. *Attainment value* indicates the personal importance of doing well on a given task and has been linked to identity-related issues such as confirming important aspects of the self. *Utility value* refers to the perceived usefulness of engaging in a task for achieving short- as well as long-term future goals. Finally, *cost* describes all the perceived negative consequences of engaging in a task, including the effort and negative emotions associated with the activity itself as well as the opportunity costs of choosing one option over another.

In much of the research on task values, the four value components have not been measured separately, and cost has been the least studied value construct until recently (Wigfield & Cambria, 2010). In recent research, support has been offered for the theoretical distinction of multiple value components: Not only can four value components be separated empirically (e.g., Trautwein et al., 2012), but some of these components can be further differentiated into multiple facets. For attainment value, Gaspard et al. (2015) found that it could be separated into the importance of achievement and personal importance. They also measured utility value with items indicating usefulness for attaining short- and long-term goals in different life domains (e.g., school, daily life, social life, job) and found that these facets could be separated. Some of these goals (e.g., being accepted by one's peers) might be particularly relevant for students during adolescence (Eccles, Midgley, et al., 1993; Juvonen, Espinoza, & Knifsend, 2012). Several recent studies have also found support for the distinction between multiple facets of cost, including effort, emotional cost, and opportunity cost (Flake, Barron, Hulleman, McCoach, & Welsh, 2015; Gaspard et al., 2015; Perez, Cromley, & Kaplan, 2014).

With respect to the associations of expectancies and values, students' expectancies and values have been found to form separate factors from first grade on (Eccles, Wigfield, et al., 1993). However, students' expectancies and values in one domain are typically positively correlated, and this association was found to increase with age (Wigfield et al., 1997). Further, change over time in students' valuing of different domains can be partially explained by changes in their expectancies (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Both expectancies and values have also been found to show substantial correlations with students' achievement in the same domain from elementary school on, and this association is typically stronger for expectancies than for values (e.g., Guo et al., 2016; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Wigfield et al., 1997). With respect to the ordering of these relations, Wigfield and Eccles (1992) suggested that students come to value the tasks on which they succeed.

In studies in which the four value components were assessed separately, the components were found to be differentially related to expectancy with intrinsic value and cost showing the highest correlations (intrinsic value being positively related and cost negatively related to expectancy) and utility value showing the lowest correlation (Guo et al., 2016; Trautwein et al., 2012). Some of the correlations between expectancy and values reported in these studies were even higher than the correlations within the value components, thereby calling into question the idea that there are only two major motivational components (i.e., expectancy and value). On the basis of the definitions of these value components in EVT (Eccles, 2005; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992), it is plausible that intrinsic value and cost are especially closely linked to students' expectancies because these components have been theoretically related to constructs such as flow (for intrinsic value) and fear of failure and perceived difficulty (for cost). Both components are also assumed to develop on the basis of prior experiences with similar tasks, which can be more or less positive depending on one's performance. In this study, we therefore wanted to take a closer look at the associations between expectancy and the different types of values and the extent to which they are affected by the same comparison processes.

In research in which the between-domain associations of expectancies and values have been investigated, these associations have been found to vary in strength. Typically, a clear distinction between expectancies and values in verbal domains on the one hand and expectancies and values in quantitative domains on the other hand has been found in previous studies, whereas expectancies and values in domains within the verbal or quantitative areas (e.g., math and sciences) have shown much higher correlations (Bong, 2001; Jansen et al., 2015; Marsh, Lüdtke, et al., 2015; Trautwein et al., 2012). Although students already hold different beliefs about distinct domains in first grade (Eccles, Wigfield, et al., 1993), this differentiation between domains has been found to increase with age (Bong, 2001; Denissen, Zarrett, & Eccles, 2007; Marsh & Ayotte, 2003). Trautwein et al. (2012) investigated the domain-specificity of expectancy and the four value components by examining how each of these five constructs in math were correlated with the same construct in English. They found that expectancy showed the highest degree of domain-specificity ($r = -.20$), followed closely by intrinsic and attainment value (both $rs = -.18$) and then by cost ($r = -.09$). Utility value, on the other hand, showed a somewhat lower degree of domain-specificity ($r = .10$). We extended this work to examine dimensional comparison processes more directly in the present study.

1.2. Dimensional comparison processes and their consequences for students' expectancies

Given that mathematical and verbal achievements typically show strong positive correlations, it seems paradoxical that the correlations of students' expectancies in these areas are close to zero (Möller, Pohlmann, Köller, & Marsh, 2009). In his internal/external frame-of-reference (IE) model, Marsh (1986) explained why this pattern occurs. He posited that students use two different frames of reference to compare their academic abilities: (a) a social comparison in which students contrast their perceived achievement in a domain with their peers' achievement in the same domain (an external frame of reference) and (b) a dimensional comparison in which students compare their achievement in a domain with their own achievement in another domain (an internal frame of reference). When students' math and verbal academic self-concepts are regressed on their achievements in these domains, these comparison processes result in positive effects of achievement on academic self-concept in the corresponding domain and in negative effects of achievement on academic self-concept across domains. There is abundant support for the predictions of the IE model from studies involving students of different ages and from different cultures (Marsh, Abduljabbar, et al., 2015; Marsh & Hau, 2004; Möller et al., 2009).

In their DCT, Möller and Marsh (2013) provided a more general theoretical framework for the part of the IE model involving internal comparison processes and how such processes operate across multiple domains. They posited that one factor that influences dimensional comparison processes is the perceived similarity of domains (see also Möller, Streblow, & Pohlmann, 2006). Academic domains can be located on a continuum that ranges from verbal to math domains (Marsh, 1990; Marsh & Shavelson, 1985). On this continuum, both native and foreign languages are located along the verbal part of the verbal-math continuum, whereas math and physics are located along the math part of this continuum. Other domains such as biology, however, are assumed to be located close to the middle of the continuum and cannot clearly be assigned to the math or verbal part. Depending on the distance between two domains on this continuum, dimensional comparisons are expected to evoke either contrast or assimilation effects. Contrast effects between "far" domains (e.g., math and English) result in negative cross-domain paths from achievement to academic self-concept. "Near" domains (e.g., math and physics), however, might be seen as complementary, and therefore achievement in one domain can also have a positive assimilation effect on academic self-concept in the other domain. In studies in which the effects of dimensional comparisons have been examined across multiple domains, support has been provided for these propositions through significant contrast effects for far comparisons and less consistent contrast effects or even assimilation effects for near comparisons (Jansen et al., 2015; Marsh, Lüdtke, et al., 2015; Möller, Streblow, Pohlmann, & Köller, 2006).

1.3. Extending dimensional comparison processes to students' task values

Compared with the body of research in which the effects of dimensional comparisons on academic self-concepts have been examined, fewer researchers have investigated how such comparison processes affect other motivational constructs, including task values. In their generalized IE model, Möller et al. (2016) extended the social and dimensional comparisons underlying Marsh's (1986) IE model to different predictors and criteria. They proposed that people enroll in social and dimensional comparisons on the basis of their perceptions of different domains, which "may have consequences for any kind of domain-specific thought and learning behavior" (Möller et al., 2016, p. 5). They assumed that one important precondition for dimensional comparisons to affect motivational constructs is that these constructs need to be domain-specific. However, they called for empirical investigations of their assumptions, looking at a broader variety of domain-specific constructs. We additionally propose that these constructs need to be closely related to students' perceptions of their competences in these domains, at least as long as students' achievements are used as predictor variables.

As described before, task values generally fulfill these two criteria. That is, task values are conceived as domain-specific, and they have been shown to be associated with students' achievements (Eccles & Wigfield, 2002). However, different value components have also been shown to be domain-specific to different degrees with utility value showing a lower degree of domain-specificity than the other value components (Trautwein et al., 2012). Also, some value components seem to be conceptually closer to students' perceptions of their competences than others. The enjoyment of a particular domain and the perceived cost (e.g., the effort and negative emotions associated with engagement in this domain and the time lost for other activities) are closely linked to beliefs about competences in this domain (Eccles, 2005; Wigfield & Eccles, 1992). Utility value, on the other hand, has been described as a more extrinsic source of motivation (Eccles, 2005; Eccles & Wigfield, 2002). When engaging in a task for reasons of utility value, students are not engaging in said task for its own sake but to reach a desired goal. Utility value might therefore be less affected by students' competences and more affected by other factors such as parents', teachers', and peers' beliefs and expectations.

To date, researchers have found that dimensional comparisons are in play for intrinsic value and closely related constructs that describe positive affect toward a task. Nagy and colleagues investigated cross-domain relations of achievement, academic self-concept, intrinsic value, and course choices in math and biology (Nagy, Trautwein, Baumert, Köller, & Garrett, 2006) and in math and English as students' native or a foreign language (Nagy et al., 2008). They found that intrinsic value was negatively affected by dimensional comparisons, and this effect was partly mediated by academic self-concept. Marsh, Abduljabbar, et al. (2015) found negative cross-domain effects of achievement on intrinsic motivation when examining math and sciences. Schurtz, Pfost, Nagengast, and Artelt (2014) found contrasting dimensional comparison effects on the development of students' interests in math and English. Goetz, Frenzel, Hall, and Pekrun (2008) found empirical support for negative cross-domain effects of achievement on enjoyment in math and verbal language classes. Recently, Guo et al. (2017) investigated how dimensional comparison processes affect intrinsic and utility values in different science domains. Their results suggest that intrinsic value is affected by both contrasting and assimilative dimensional comparisons, whereas the findings for utility value were less consistent. In addition, previous studies have provided support for the assumption that effects of dimensional comparisons on intrinsic value are mediated by expectancy (Goetz et al., 2008; Guo et al., 2017; Nagy et al., 2006, 2008; Schurtz et al., 2014).

Whereas there is thus some initial insight into the effects of dimensional comparisons on task values, researchers did not investigate dimensional comparison processes for multiple value facets as

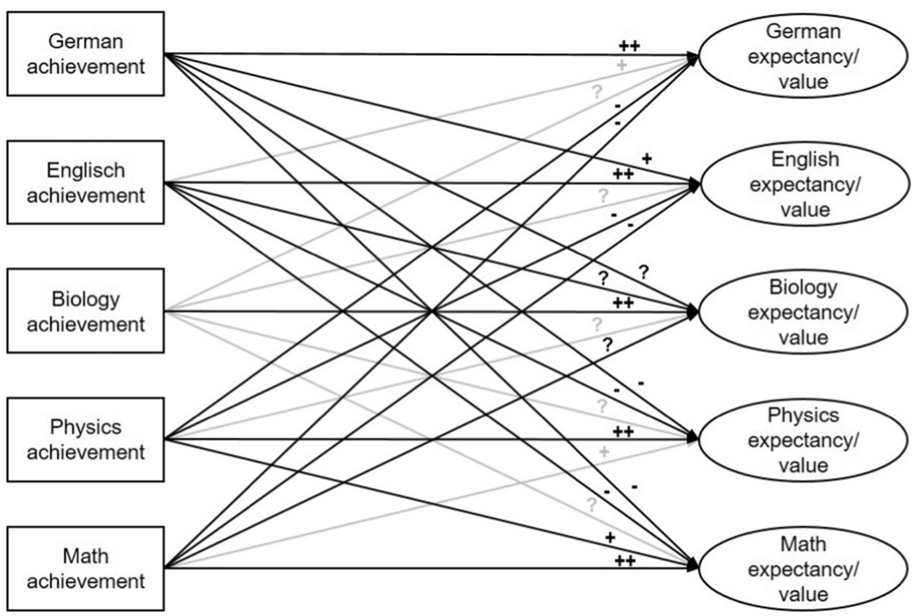

Fig. 1. Conceptual representation of structural equation models and predicted effect pattern. + + = strong positive effects expected for matching paths; + = positive effects expected for near paths; − = negative effects expected for far paths; ? = no prediction for the direction of effects for biology versus other subjects. Paths in grey were not supported by the findings of the study; paths in black were significant for at least one of the motivational constructs.

conceptualized by expectancy-value theorists so far (Eccles, 2005; Wigfield & Eccles, 1992). In addition, in previous research on dimensional comparison processes for task values, the variety of domains on the academic continuum was not covered. However, the pattern of contrast and assimilation effects found for academic self-concepts in previous studies (Jansen et al., 2015; Marsh, Lüdtke, et al., 2015; Möller, Streblow, Pohlmann, et al., 2006) suggests that exploring students' task values across a broader array of domains might be important for understanding their formation.

1.4. The present study

In this study, we investigated dimensional comparison processes by examining how students' achievements across a variety of verbal and math/science domains predict their expectancies for success as well as their task values in these domains. By investigating both expectancies and values, we aimed to replicate the pattern of effects on expectancies reported in other studies (e.g., Marsh, Lüdtke, et al., 2015) and to extend the findings to values. Based on previous studies that have shown that multiple value facets can be separated and that these facets are differentially domain-specific and differentially associated with expectancies, a major focus of our investigation was on comparing dimensional comparison effects across value facets. For this investigation, we used data from German students in Grades 5–12 (Gaspard et al., 2017) who were asked about their expectancies and task values in five domains (i.e., German, English, math, biology, and physics). With respect to task values, we applied a psychometrically sound instrument that can be used to differentiate between all four value components and additionally between facets subsumed under the attainment value, utility value, and cost components. Our aim was to compare the findings across this set of value facets. However, as these facets have been explored in only a few studies before, our expectations were largely based on research in which the major value components were examined.

Our main research hypotheses were as follows. First, in view of previous findings, we expected to find relatively high correlations between expectancy and value facets within a given domain. We also expected that these correlations would vary across the value facets with higher correlations for intrinsic value and the cost facets than for the utility value facets (Guo et al., 2016; Trautwein et al., 2012). Second, we expected expectancy and value beliefs to be highly domain-specific. In other words, we expected to find that expectancy and value facets would show small to moderate correlations between domains. The pattern of correlations between different domains was expected to follow the assumptions underlying a verbal-mathematical continuum (Marsh, 1990) with higher correlations between domains that are close to each other on this continuum. However, we also expected the degree of domain-specificity to vary between the value facets with a lower degree of domain-specificity for the utility value facets (cf. Trautwein et al., 2012).

Third, and most central to our investigation, we examined dimensional comparison effects of students' achievement in the five domains on their expectancies and values in these domains. On the basis of DCT and previous research on academic self-concept (Marsh, Lüdtke, et al., 2015), we made the following predictions for these regression analyses (see Fig. 1 for a conceptual representation of our predictions). Matching paths from achievement to expectancy/value in the same domain were expected to be positive. For cross-domain paths, we formed differential hypotheses that were based on the positions of the five domains along the verbal-math continuum. Dimensional comparisons between far domains (e.g., math and German) were expected to result in contrast effects (i.e., negative paths). Dimensional comparisons between near domains (e.g., math and physics) were expected to result in assimilation effects if they occurred (i.e., positive paths). As biology is situated in the middle of the continuum, we investigated the cross-domain paths between biology and the other domains separately and left their direction as an open research question. With respect to the constructs under investigation, we also formed hypotheses about the strength of the dimensional comparison processes. As expectancies are self-evaluations of academic achievement and have been the focus of DCT, the strongest dimensional comparison effects, in line with the pattern described above, were expected for expectancy. We expected to find similar patterns for intrinsic value, for which previous empirical evidence of dimensional comparison effects exists (Nagy et al., 2006), and for cost, as it is both conceptually and empirically closely related to expectancy (Eccles, 2005; Guo et al., 2016; Trautwein et al., 2012). Because of the lower domain-specificity of utility value and its weaker association with expectancy, we expected dimensional comparison effects to be weaker for the facets of this value component.

2. Method

2.1. Sample

A total of 857 students (51.3% female) from 51 classrooms in Grades 5–12 in two German academic track schools in Baden-

Table 1
Items used to measure expectancy and value constructs.

EVT component/subscale	Sample item	# of items	Scale reliability					
			G	E	B	P	M	Mean
Expectancy								
Academic self-concept	I am good in …	4	.87	.88	.85	.93	.88	.88
Intrinsic value								
Intrinsic value	I like doing …	4	.92	.91	.93	.95	.93	.93
Attainment value								
Personal importance	… is very important to me personally.	4	.75	.56	.71	.83	.65	.70
Importance of achievement	It is important to me to be good at …	4	.88	.87	.90	.90	.87	.88
Utility value								
Utility for daily life	Knowing the contents in … has many benefits in my daily life.	3	.84	.76	.82	.85	.84	.82
Utility for job	A good knowledge of … will help me in my future job.	4	.88	.86	.90	.92	.90	.89
Utility for school	Doing well in … brings many advantages at school.	4	.82	.71	.78	.80	.65	.75
Social utility	Being well versed in … will go down well with my classmates.	2	.71	.71	.69	.75	.74	.72
Cost								
Effort & emotional cost	… is a real burden to me.	8	.89	.91	.89	.93	.93	.91
Opportunity cost	I have to give up a lot to do well in …	3	.86	.85	.85	.87	.88	.86

Note. G = German; E = English; B = biology; P = physics; M = mathematics.

Württemberg participated in this study (see Gaspard et al., 2017). In Baden-Württemberg, as in most other German federal states, students are tracked from Grade 5 on. About 40% of all students attending elementary school go on to attend academic track schools, the highest track, in Germany (Statistisches Bundesamt [Destatis], 2016). Due to the large proportion of students attending academic track schools, this school track also has the highest heterogeneity in terms of students' socioeconomic background (Trautwein & Neumann, 2008). The two schools participated in a cooperation program of the LEAD Graduate School and Research Network at the University of Tübingen, which is aimed at improving the cooperation between educational research and practice. The schools in this cooperation program regularly participate in educational studies and receive information on the findings from these and other studies. One school agreed that all their 43 classrooms would participate, and the other school agreed that one classroom per grade level would participate (i.e., a total of eight classrooms, selected on the basis of the classrooms' availability on the day of data collection). The participating classes and students were roughly equally distributed across grade levels (with 77–117 students out of five to seven classrooms per grade level). Students' age varied from 9 to 18 years ($M = 13.9$, $SD = 2.3$). As is typical for academic track schools in Germany, students in these schools do not make any school transitions between Grades 5 and 12, and we found few differences in the relations across age. Therefore, we computed the analyses on the whole sample.

Students' participation was voluntary. Out of the 857 students with parental consent (70.7% participation rate), 27 students were absent on the day of data collection, resulting in 830 students who filled out the questionnaire. Parents also had to provide consent so that we could retrieve student record data from the school. This consent was provided for 88.9% of the participating students. Data collection took place at the beginning of the 2014–2015 school year. The questionnaires were administered by trained student assistants.

2.2. Measures

2.2.1. Expectancy and value beliefs

Expectancy and value beliefs in German, English, math, biology, and physics were assessed with a grid format that presented the item stems on the left and the domains on the right in separate columns. As physics begins in Grade 7 for students in these schools, students in Grades 5 and 6 did not answer the items for physics but had only four response columns. All item stems included "…" as a placeholder for the respective domain (e.g., "I like doing …"). Students were instructed to insert the respective domain into the blank in their minds while answering the items. This grid format offers an economical way to assess motivational constructs across many domains and has been used successfully in previous research (see Sparfeldt, Schilling, Rost, & Thiel, 2006, for a comparison of blocked vs. randomized questionnaire formats). The classes were randomly assigned to two different sets of instructions: One group was instructed to answer every item for all domains in a row before moving on to the next item, and the other group was instructed to answer all the items in a block for the first domain before moving on to the next domain. Preliminary analyses indicated that the two kinds of instructions produced similar measurement structures (see Gaspard et al., 2017) and similar dimensional comparison effects, so we analyzed these two conditions together. All items were rated on a 4-point Likert scale ranging from 1 (*completely disagree*) to 4 (*completely agree*).

We used a total of 41 items tapping expectancies and multiple value facets. As an indicator of students' expectancies, we used a measure of academic self-concept that had been used successfully in previous German large-scale studies (e.g., Gaspard et al., 2016). To measure task values, we used an adapted version of an instrument that was developed to measure multiple value facets in the context of math (Gaspard et al., 2015). This instrument includes subscales for all four value components and can additionally be used to differentiate between subscales of attainment value (importance of achievement, personal importance), utility value (utility for daily life, utility for job, utility for school, social utility), and cost (effort required, emotional cost, opportunity cost). Confirmatory factor analyses showed that these value facets were separable in the sample under investigation except for effort required and emotional cost (Gaspard et al., 2017). We therefore used a combined measure of effort and emotional cost. Table 1 presents sample items and scale reliabilities ρ (Bollen, 1989; Raykov, 2001) for the 10 scales (latent factors) that resulted from confirmatory factor analyses in each subject (see Results section). For value beliefs, the factor structure was invariant across grade levels, gender, and domains in the current study (Gaspard et al., 2017).

2.2.2. Achievement

As an indicator of students' prior achievement in the five domains, we used students' school grades from the end of the previous school year. In previous research in which the IE model was examined for grades and test scores, the associations between achievement and academic self-concept within domains were higher for grades than for test scores (Möller et al., 2009). Grades are a more salient form of feedback that students can use to develop their academic self-concept. In the current study, grades were obtained from school documents that reflected the same information found on students' report cards. If students did not have parental consent for report card data ($N = 96$) or if they had changed schools at the beginning of the school year (e.g., students in Grade 5), we used the grades as reported by the students during data collection. When we had both school data and student-reported grades, the student-reported grades were very accurate ($r = .89$–$.92$). Grades were coded such that high scores represented positive learning outcomes.

2.3. Statistical analyses

2.3.1. Structural equation modeling

We computed all analyses in Mplus 7.31 (Muthén & Muthén, 1998–2012) with the robust maximum likelihood estimator (MLR) and the design-based correction of standard errors (with type = complex) and model-fit statistics to account for the nonnormality of the indicator variables and the nonindependence of observations that resulted from the nesting of students within classes (McNeish, Stapleton, & Silverman, 2017). In all analyses, expectancies and values were represented by latent factors indicated by multiple items. Indicators were treated as continuous variables despite the fact that they had only four response categories (Rhemtulla, Brosseau-Liard, & Savalei, 2012). We chose this analytical strategy because the models under consideration were quite complex (i.e., they included multiple dimensions) and because there was a non-negligible amount of missing data that needed to be handled in a principled way (i.e., full information maximum likelihood information; FIML). In comparison with categorical estimation procedures, the use of MLR estimation has been found to have little impact on structural parameter estimates (which were the major focus of our study) when there are at least four response categories and only moderate levels of nonnormality (Beauducel & Herzberg, 2006; DiStefano, 2002; Muthén & Kaplan, 1985; Rhemtulla et al., 2012). Skewness and kurtosis in our study were not extreme (cf. Hau & Marsh, 2004; West, Finch, & Curran, 1995); across the total of 200 motivation items, the average skewness was -0.18 (with none of the skewness values exceeding 2), and the average kurtosis was -0.30 (with only seven items having a kurtosis between 2 and 4; see the Online Supplemental Materials for more information). Nevertheless, we acknowledge that treating the motivational indicators as continuous variables is a potential limitation of our study.[1]

We first conducted confirmatory factor analyses (CFAs) to estimate correlations of expectancies and values within and between domains. We applied CFAs in each of the five domains to investigate the distinctiveness of the expectancy and value constructs and their interrelations. To avoid an overly complex model (i.e., 10 constructs in five domains, resulting in 50 factors), we then conducted separate CFAs for each construct under investigation to examine between-domain correlations. To test the effects predicted by DCT on students' expectancies and values in the five domains, we used structural equation modeling and followed the analytical approach that Marsh, Lüdtke, et al. (2015) had used for academic self-concept. In these analyses, we modeled the expectancy and value constructs in the five domains as separate latent factors and regressed them on students' grades in all domains. We included method factors to account for parallel items across domains (Marsh & Hau, 1996). We specified one method factor per item and restricted the method factors to be uncorrelated with each other as well as with all other variables in the model (see the Online Supplemental Materials for exemplary Mplus input). We computed separate analyses for all 10 constructs under consideration.

To deal with multiple testing, we applied the procedure recommended by Benjamini and Hochberg (1995) in all our analyses to control the false discovery rate at .05. To this end, we built one set of observed p-values to underlie the correlation or regression coefficients examined in each of the CFAs or structural equation models. More specifically, the CFAs were used to examine within- and between-domain correlations and the structural equation models were used to examine regression coefficients when grades were used to predict students' expectancy and value beliefs.

In all analyses, we assessed the model fit with the Comparative Fit Index (CFI), the Tucker Lewis Index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). CFI and TLI values greater than .90 and .95 are typically considered to reflect acceptable and excellent fits to the data, respectively (Hu & Bentler, 1999; Marsh, Hau, & Wen, 2004). RMSEA values of less than .06 are typically considered to reflect a reasonable fit (Hu & Bentler, 1999). For the SRMR, values of less than .08 are considered to indicate a good fit (Hu & Bentler, 1999).

2.3.2. Missing data

There was a non-negligible amount of missing data (ranging from 3.5% to 37.2% for the indicators of the motivational constructs and from 6.5% to 47.1% for grades, see the Online Supplemental Materials for more detailed information) that occurred for different reasons. Questionnaire data were missing because students were absent on the day of data collection or because they skipped individual items. In addition, students in Grades 5 and 6 ($N = 222$) were not administered the physics items because physics classes are not yet offered in these grades. These items were missing by design in Grades 5 and 6, resulting in a relatively high rate of missing data for physics (up to 32.0% to 37.2% for the expectancy and value items compared with up to 3.5% to 13.5% for the other subjects). Information on grades was also missing because the five domains were not taught in each grade level in these schools (i.e., physics was taught only from Grade 7 on, biology was not taught in Grade 8, and students could drop English, biology, and/or physics in Grades 11 and 12). To deal with these missing data, we used the FIML approach implemented in Mplus, in which all available information is taken into account when the model parameters are estimated (Schafer & Graham, 2002). Given the high rates of missing data in Grades 5 and 6, we additionally ran two sets of robustness checks (see the Online Supplemental Materials for detailed results). First, we included students' grade level and gender as covariates in our structural equation models. Second, we ran the same set of analyses (without any covariates) using only the students from Grade 7 to Grade 12 ($N = 635$). Both sets of analyses yielded very similar results to those with the total sample without covariates. We therefore decided to use all available information and not to include any covariates because this approach corresponds to the typical analytical approach of the IE model in the literature (for a comparison of the effects with/without covariates, see Marsh, Lüdtke, et al., 2015).

3. Results

3.1. Within-domain associations

Our first research question addressed within-domain associations of

[1] To test whether treating indicator variables as continuous instead of categorical had an effect on our findings, we also tried using a categorical approach with a robust weighted least squares estimator (WLSMV). Because this approach cannot be used with FIML, we used multiple imputation as an alternative way to account for missing data. To this end, we built separate two-level imputation models for each of the expectancy and value constructs, always including students' grades in the five subjects as continuous variables, students' responses on the respective two to eight items in the five domains as categorical variables, and students' grade level and gender as covariates. For each motivational construct, we imputed 20 data sets and then used these imputed data sets to run our structural equation models with the WLSMV estimator. The results (averaged over the 20 imputed data sets) were almost identical to those in which we used the maximum likelihood approach with FIML ($r = .99$ between the two sets of regression coefficients). However, for the effort and emotional cost scale, which was measured with eight items in each of the five domains, the imputation model included a larger number of categorical variables and did not converge. Therefore, we decided to keep using the maximum likelihood estimation approach with the MLR estimator.

Table 2
Within-domain correlations of grades, academic self-concept, and value facets.

Variable	1	2	3	4	5	6	7	8	9	10	11
German (above the diagonal)/English (below the diagonal)											
(1) Grade	–	.43	.24	.20	.25	.14	.12	.18	*.03*	−.28	−.35
(2) Self-concept	.60	–	.81	.62	.54	.49	.47	.39	.26	−.76	−.69
(3) Intrinsic value	.43	.86	–	.80	.63	.62	.55	.48	.42	−.74	−.51
(4) Personal importance	.30	.70	.81	–	.91	.85	.79	.80	.51	−.61	−.36
(5) Importance of achievement	.25	.53	.62	.91	–	.66	.67	.79	.45	−.44	−.26
(6) Utility for daily life	.10	.36	.45	.66	.55	–	.80	.76	.49	−.44	−.26
(7) Utility for job	.10	.32	.37	.64	.57	.67	–	.74	.46	−.39	−.23
(8) Utility for school	.13	.33	.40	.71	.76	.68	.66	–	.52	−.36	−.18
(9) Social utility	*.03*	.18	.24	.26	.30	.18	.23	.27	–	−.13	*.00*
(10) Effort & emotional cost	−.48	−.87	−.81	−.65	−.46	−.34	−.27	−.31	*−.08*	–	.73
(11) Opportunity cost	−.46	−.73	−.64	−.51	−.36	−.31	−.24	−.25	*.03*	.81	–
Biology (above the diagonal)/physics (below the diagonal)											
(1) Grade	–	.47	.30	.31	.30	.20	.19	.12	*.07*	−.33	−.31
(2) Self-concept	.51	–	.88	.78	.67	.58	.54	.51	.33	−.83	−.66
(3) Intrinsic value	.40	.91	–	.91	.75	.71	.66	.60	.41	−.76	−.56
(4) Personal importance	.39	.85	.93	–	.88	.78	.80	.75	.50	−.56	−.45
(5) Importance of achievement	.40	.74	.77	.88	–	.67	.64	.78	.45	−.67	−.39
(6) Utility for daily life	.33	.69	.74	.75	.62	–	.75	.70	.47	−.46	−.32
(7) Utility for job	.40	.76	.79	.86	.74	.76	–	.67	.41	−.42	−.29
(8) Utility for school	.27	.64	.70	.80	.80	.70	.75	–	.45	−.45	−.32
(9) Social utility	.17	.39	.42	.40	.37	.46	.39	.44	–	−.16	−.10
(10) Effort & emotional cost	−.41	−.88	−.83	−.76	−.65	−.58	−.64	−.57	−.27	–	.76
(11) Opportunity cost	−.40	−.70	−.61	−.55	−.55	−.47	−.49	−.46	−.21	.79	–
Math											
(1) Grade	–										
(2) Self-concept	.64	–									
(3) Intrinsic value	.49	.87	–								
(4) Personal importance	.47	.74	.82	–							
(5) Importance of achievement	.43	.62	.64	.90	–						
(6) Utility for daily life	.29	.48	.58	.70	.56	–					
(7) Utility for job	.36	.60	.60	.77	.64	.72	–				
(8) Utility for school	.30	.41	.44	.76	.81	.61	.62	–			
(9) Social utility	.16	.26	.33	.39	.38	.34	.32	.41	–		
(10) Effort & emotional cost	−.53	−.89	−.86	−.71	−.54	−.49	−.55	−.37	−.21	–	
(11) Opportunity cost	−.52	−.76	−.67	−.56	−.45	−.41	−.43	−.34	−.10	.83	–

Note. Correlations were corrected for measurement error except for grades. Italicized correlations were not significant; all other correlations were significant at $p < .05$, corrected for a false discovery rate of .05.

expectancies and values. Our expectations were that we would find high positive associations between expectancies and values in a given domain and that the associations between expectancies and values would vary in accordance with the value facet under consideration. To test these hypotheses, we computed CFAs within the five domains, separating between the expectancy and value constructs that had been defined a priori (i.e., academic self-concept and nine value facets) as well as achievement (see Table 2). Model fit was acceptable in all five domains (CFI ≥ .951, TLI ≥ .944, RMSEA ≤ .039, SRMR ≤ .041, see the Online Supplemental Materials for the exact fit indices). Students' grades were highly correlated with their academic self-concept in the same domain (r = .43–.64). Intrinsic value and the facets of attainment and utility value were also positively correlated with students' grades in these domains, and cost facets were negatively related to grades. However, these associations were generally lower than for students' academic self-concept, especially for the utility value facets, and even nonsignificant for social utility in three of the five domains.

We were particularly interested in the correlations between academic self-concept on the one hand and the different value facets on the other hand. These were moderate to high in each of the five domains. The rank order of these correlation coefficients for the different value facets was similar within the five domains. Academic self-concept showed the highest correlations with intrinsic value (r = .81–.91) and effort and emotional cost (r = −.76 to −.89). The correlations with personal importance (r = .62–.85), importance of achievement (r = .53–.74), and opportunity cost (r = −.66 to −.76) were somewhat lower but still relatively high. The utility value facets generally had somewhat lower correlations with academic self-concept, with the lowest correlations for social utility (r = .18–.39). The correlations between academic self-concept and utility for daily life (r = .36–.69), utility for job (r = .32–.76), and utility for school (r = .33–.64) varied more according to the domain under consideration, with higher correlations in biology and physics.

3.2. Between-domain associations

Our second research question addressed the domain-specificity of expectancy and value beliefs. We expected to find small to moderate correlations between domains. In accordance with a verbal-mathematical continuum, we expected to find higher correlations between domains that are close to each other on this continuum. We also expected that the degree of domain-specificity would vary between the value facets with a lower degree of domain-specificity for the utility value facets. To address these hypotheses, we computed CFAs to examine the associations between the five domains for all the constructs under investigation (see Table 3). Model fit was good for all motivational constructs (CFI ≥ .967, TLI ≥ .961, RMSEA ≤ .039, SRMR ≤ .045, see the Online Supplemental Materials for the exact fit indices). Students' grades showed moderate to high correlations across all of the five domains under consideration. The correlations for students' academic self-

Table 3
Between-domain correlations of students' grades, academic self-concepts, and value facets.

	Grades						Personal importance						Utility for job						Effort & emotional cost				
	G	E	B	P	M		G	E	B	P	M		G	E	B	P	M		G	E	B	P	M
G						G						G						G					
E	.58					E	.32					E	.37					E	.43				
B	.55	.53				B	.22	*.10*				B	.16	*−.08*				B	.37	.24			
P	.42	.42	.54			P	*−.08*	*.03*	*.06*			P	*−.09*	*−.07*	.20			P	.13	*.09*	.32		
M	.53	.51	.60	.68		M	*.10*	.18	*.08*	.51		M	.16	.15	.15	.64		M	*.10*	.11	.23	.59	
	Academic self-concept						Importance of achievement						Utility for school						Opportunity cost				
	G	E	B	P	M		G	E	B	P	M		G	E	B	P	M		G	E	B	P	M
G						G						G						G					
E	.30					E	.55					E	.57					E	.56				
B	.18	*.05*				B	.53	.36				B	.53	.47				B	.41	.38			
P	−.12	*−.07*	.17			P	.21	.26	.32			P	.23	.21	.38			P	.24	.24	.50		
M	−.17	*−.06*	*.05*	.52		M	.34	.45	.32	.55		M	.56	.62	.44	.40		M	.29	.32	.39	.61	
	Intrinsic value						Utility for daily life						Social utility										
	G	E	B	P	M		G	E	B	P	M		G	E	B	P	M						
G						G						G											
E	.30					E	.24					E	.76										
B	.23	.12				B	.24	.14				B	.75	.76									
P	*−.07*	*−.06*	.13			P	*.11*	*.08*	.38			P	.64	.69	.73								
M	*−.02*	*.04*	*.08*	.50		M	.36	.11	.18	.53		M	.69	.84	.73	.83							

Note. G = German; E = English; B = biology; P = physics; M = mathematics. Correlations were corrected for measurement error except for grades. Italicized correlations were not significant; all other correlations were significant at $p < .05$, corrected for a false discovery rate of .05.

concept, however, showed a relatively high degree of domain-specificity. The pattern of correlations was in line with a verbal-mathematical continuum. Students' academic self-concepts in German and English ($r = .30$) and math and physics ($r = .52$) were relatively strongly correlated. Students' academic self-concept in biology was also positively correlated with their academic self-concepts in both German ($r = .18$) and physics ($r = .17$). Students' academic self-concept in German, on the other hand, was negatively correlated with their academic self-concepts in math ($r = -.17$) and physics ($r = -.12$). All other correlations were nonsignificant.

When comparing the pattern of correlations for the nine value facets, it became evident that the correlations for some of these value facets showed a pattern that was quite similar to that of academic self-concept, whereas others showed a much lower degree of domain-specificity. Intrinsic value ($r = -.07$ to .50), personal importance ($r = -.08$ to .51), utility for job ($r = -.09$ to .64), and effort and emotional cost ($r = .09$–.59) all seemed to be highly domain-specific. Many of the correlations between domains were nonsignificant, and only the correlations between near domains were relatively high. Other facets such as utility for school ($r = .21$–.57), social utility ($r = .64$–.84), and opportunity cost ($r = .24$–.61), however, showed higher between-domain correlations overall. This was especially striking for social utility.

3.3. Tests of predictions relating achievements to expectancy and value constructs

Our third and major research question addressed dimensional comparison effects of students' grades on the expectancy and value constructs. We used SEM to test how grades predicted students' expectancies and values in the five domains. We ran these analyses separately for the 10 motivational constructs, always including the motivational construct in all five domains and regression paths from all grades to all outcomes (i.e., $5 \times 5 = 25$ paths). Table 4 presents the standardized regression coefficients as well as the mean coefficients across different sets of paths for each motivational construct. The 25 regression coefficients were grouped into different categories according to our a priori predictions (see Fig. 1 for a conceptual representation of these models and our predictions). Paths leading from grades in one domain to academic self-concept and values in the same domain were classified as "matching" (5 paths); these paths were expected to be positive. Paths from achievement in one domain to academic self-concept and values in a different domain were classified as "nonmatching" (20 paths). The nonmatching paths were further classified into three categories. Paths between one of the two verbal domains (German and English) and one of the two math-related domains (math and physics) were classified as "far" (8 paths); these paths were expected to be negative. Paths from achievement to motivation within the two verbal or the two math-related domains were classified as "near" (4 paths) and were expected to be positive if they were significant. Paths between biology and the other domains were classified as "biology versus others" (8 paths). No a priori prediction was made for these paths. To compute the mean of the regression coefficients across these categories, we used the model constraint option implemented in Mplus, which also provides standard errors and significance levels for the newly computed coefficients. To reduce problems arising from multiple testing, we used a more conservative alpha level of $.05/25 = .002$ for these summary statistics.

We first considered the effects on students' academic self-concepts, for which dimensional comparison effects have been thoroughly investigated in previous research, and we used these effects as a comparison standard for the value facets. The mean coefficients across the different sets of paths showed substantial positive regression coefficients for students' grades in predicting their academic self-concepts in the matching domain ($M = .71$, $SE = .02$). The mean of all 20 nonmatching paths was significant and negative ($M = -.09$, $SE = .01$). However, when we considered different categories of these nonmatching paths, a more differentiated picture emerged: The mean of the eight far paths was significant and negative ($M = -.19$, $SE = .02$), whereas the mean of the four near paths was significant and positive ($M = .07$, $SE = .03$). For the individual paths, all eight far paths were significant, but only one of the four near paths was significant (i.e.,

Table 4
Standardized regression coefficients of students' academic self-concepts and value beliefs on their achievements in the five domains.

Predictor	Self-concept	Intrinsic value	Personal importance	Importance of ach.	Utility for daily life	Utility for job	Utility for school	Social utility	Low effort & em. cost	Low opp. cost	Predictions	# sign. paths
German outcomes												
German ach.	.65 (.05)*	.48 (.06)*	.35 (.07)*	.34 (.07)*	.24 (.06)*	.22 (.05)*	.26 (.07)*	.10 (.06)	.49 (.06)*	.46 (.06)*	Match (+ +)	9
English ach.	.02 (.05)	−.03 (.05)	−.02 (.06)	.03 (.06)	.00 (.06)	−.07 (.05)	−.01 (.06)	−.10 (.06)	−.03 (.06)	.03 (.06)	Near (+)	0
Biology ach.	.00 (.05)	−.04 (.05)	.02 (.06)	.05 (.06)	−.01 (.05)	.03 (.05)	−.03 (.07)	.04 (.07)	−.02 (.06)	−.08 (.06)	Biology (?)	0
Physics ach.	−.17 (.06)*	−.14 (.07)	−.18 (.06)*	−.10 (.07)	−.03 (.07)	−.03 (.07)	−.06 (.08)	−.09 (.09)	−.08 (.08)	−.03 (.10)	Far (−)	2
Math ach.	−.29 (.05)*	−.27 (.06)*	−.13 (.07)	−.16 (.06)*	−.15 (.06)	−.12 (.06)	−.04 (.07)	−.03 (.08)	−.27 (.07)*	−.14 (.07)	Far (−)	4
English outcomes												
German ach.	.05 (.05)	.07 (.05)	.15 (.06)*	.07 (.05)	.17 (.06)*	.04 (.05)	.24 (.05)*	.03 (.04)	.07 (.05)	.10 (.06)	Near (+)	3
English ach.	.76 (.06)*	.57 (.05)*	.37 (.07)*	.29 (.05)*	.10 (.07)	.13 (.06)	.10 (.06)	.01 (.05)	.61 (.05)*	.53 (.06)*	Match (+ +)	6
Biology ach.	−.04 (.04)	−.04 (.05)	−.11 (.08)	−.03 (.06)	.01 (.07)	.00 (.06)	−.14 (.07)	.03 (.08)	−.06 (.04)	−.09 (.04)	Biology (?)	0
Physics ach.	−.15 (.06)*	−.08 (.07)	−.03 (.08)	−.02 (.06)	−.02 (.07)	.00 (.08)	.04 (.07)	−.07 (.09)	−.08 (.06)	.01 (.08)	Far (−)	1
Math ach.	−.21 (.05)*	−.26 (.05)*	−.15 (.07)	−.08 (.07)	−.16 (.08)	−.09 (.07)	−.08 (.08)	−.04 (.08)	−.21 (.06)*	−.19 (.06)*	Far (−)	4
Biology outcomes												
German ach.	.09 (.04)*	.06 (.04)	.10 (.04)*	.11 (.06)	.09 (.05)	.04 (.05)	.14 (.07)	.01 (.06)	.12 (.04)*	.12 (.04)*	Biology (?)	4
English ach.	−.26 (.05)*	−.18 (.05)*	−.17 (.06)*	−.12 (.06)*	−.05 (.06)	−.11 (.06)	−.01 (.06)	−.16 (.06)	−.21 (.05)*	−.13 (.04)*	Biology (?)	6
Biology ach.	.74 (.05)*	.55 (.06)*	.53 (.06)*	.44 (.07)*	.30 (.07)*	.28 (.06)*	.17 (.07)	.24 (.06)*	.50 (.06)*	.35 (.06)*	Match (+ +)	9
Physics ach.	−.02 (.06)	.03 (.06)	−.02 (.06)	.04 (.07)	.04 (.08)	.03 (.08)	−.02 (.09)	−.01 (.09)	.02 (.07)	.05 (.08)	Biology (?)	0
Math ach.	−.29 (.04)*	−.30 (.05)*	−.24 (.06)*	−.23 (.06)*	−.19 (.07)*	−.09 (.06)	−.08 (.07)	−.06 (.09)	−.19 (.06)*	−.09 (.07)	Biology (?)	6
Physics outcomes												
German ach.	−.15 (.04)*	−.17 (.05)*	−.17 (.06)*	−12 (.06)	−.10 (.06)	−.24 (.06)*	−.15 (.07)	−.06 (.06)	−.13 (.06)*	.02 (.06)	Far (−)	5
English ach.	−.19 (.05)*	−.17 (.05)*	−.13 (.06)*	−.06 (.06)	−.10 (.06)	−.05 (.06)	−.03 (.06)	−.15 (.08)	−.17 (.05)*	−.15 (.05)*	Far (−)	5
Biology ach.	.03 (.05)	.01 (.05)	.01 (.06)	.04 (.06)	−.02 (.06)	.00 (.05)	.02 (.06)	.06 (.06)	.00 (.06)	.05 (.07)	Biology (?)	0
Physics ach.	.64 (.06)*	.54 (.05)*	.41 (.07)*	.39 (.07)*	.40 (.06)*	.45 (.06)*	.24 (.08)*	.11 (.12)	.55 (.05)*	.38 (.07)*	Match (+ +)	9
Math ach.	.01 (.04)	.02 (.05)	.12 (.06)	.10 (.06)	.02 (.06)	.12 (.06)	.13 (.09)	.14 (.09)	.02 (.05)	.08 (.05)	Near (+)	0
Math outcomes												
German ach.	−.16 (.03)*	−.16 (.04)*	−.04 (.05)	−.05 (.05)	−.02 (.06)	−.16 (.05)*	.14 (.06)	−.01 (.05)	−.15 (.05)*	−.05 (.05)	Far (−)	4
English ach.	−.21 (.04)*	−.18 (.03)*	−.20 (.05)*	−.09 (.05)	−.10 (.06)	−.12 (.05)	−.10 (.06)	−.15 (.05)*	−.18 (.04)*	−.17 (.06)*	Far (−)	6
Biology ach.	−.06 (.05)	−.06 (.05)	−.04 (.05)	.01 (.05)	.09 (.07)	.04 (.04)	−.02 (.05)	.06 (.06)	−.02 (.05)	.06 (.05)	Biology (?)	0
Physics ach.	.22 (.07)*	.20 (.07)*	.07 (.06)	.09 (.05)	.07 (.08)	.20 (.07)*	.04 (.07)	.00 (.08)	.23 (.06)*	.15 (.09)	Near (+)	4
Math ach.	.75 (.06)*	.57 (.06)*	.59 (.07)*	.45 (.06)*	.24 (.08)*	.34 (.07)*	.24 (.11)	.19 (.08)	.56 (.06)*	.49 (.07)*	Match (+ +)	8
Summary (Across the different set of paths)												
M	.71 (.02)**	.54 (.03)**	.45 (.03)**	.38 (.03)**	.26 (.03)**	.29 (.03)**	.20 (.03)**	.13 (.03)**	.54 (.02)**	.44 (.02)**		
# sign. paths	5	5	5	5	4	4	2	1	5	5		
20 nonmatching paths												
M	−.09 (0.01)**	−.08 (.01)**	−.06 (.01)**	−.03 (.01)	−.02 (.01)	−.03 (.01)**	.00 (.01)	−.03 (.01)**	−.07 (.01)**	−.02 (.01)		
# sign. paths	12	9	8	3	2	3	1	1	10	5		
8 far paths												
M	−.19 (.02)**	−.18 (.02)**	−.13 (.02)**	−.09 (.02)**	−.08 (.02)**	−.10 (.02)**	−.04 (.02)	−.08 (.02)**	−.16 (.02)**	−.09 (.02)**		
# sign. paths	8	6	4	1	0	2	0	1	6	3		
4 near paths												
M	.07 (.03)	.07 (.03)	.08 (.03)**	.07 (.02)	.06 (.03)	.07 (.03)	.10 (.03)**	.02 (.03)	.07 (.03)	.09 (.03)**		
# sign. paths	1	1	1	0	1	1	1	0	1	0		
8 biology paths												
M	−.07 (.02)**	−.07 (.02)**	−.06 (.02)	−.01 (.02)	.00 (.03)	−.01 (.02)	−.02 (.02)	.00 (.03)	−.05 (.02)	−.01 (.02)		
# sign. paths	3	2	3	2	1	0	0	0	3	2		
PSI	–	.99	.96	.97	.87	.87	.73	.74	.99	.96		

Note. Ach. = achievement; em. = emotional; opp. = opportunity; sign. = significant; PSI = profile similarity index. The PSI is an estimate of the correlation between the regression coefficients for self-concept and the value facets. Standard errors are in parentheses.

* $p < .05$, corrected for a false discovery rate of .05.

** $p < .002$.

from physics grade to math academic self-concept). The mean of the eight paths between biology and the other domains was significant and negative ($M = -.07$, $SE = .02$). However, in addition to significant, negative paths from both English and math grades to biology academic self-concept, there was also a significant, positive path from German grade to biology academic self-concept.

We then compared the findings for the nine value facets with those for academic self-concept. We had expected to find similar patterns for the value facets with high degrees of domain-specificity and strong associations with expectancy. In line with our expectations, we found that both intrinsic value and effort and emotional cost showed such a correlational pattern and were thus ideal candidates for results that would show regression coefficients that were in accordance with our predictions for dimensional comparison processes. Because of the lower domain-specificity of utility value and its weaker association with expectancy, we predicted that these regression coefficients would be weaker for the facets of this value component.

To be able to more easily compare the results with academic self-concept and the positive value facets, we recoded the indicators of cost for these analyses so that high scores indicated lower perceived cost. As a measure of similarity between the regression coefficients, we computed a profile similarity index (PSI). The PSI is an estimate of the correlation between the regression coefficients for academic self-concept and each of the nine value facets. The PSI ranged from .73 for utility for school to .99 for both intrinsic value and effort and emotional cost (see Table 4). Overall, there was thus a high degree of similarity in the regression coefficients for the different expectancy and value constructs.

However, the PSI reflects similarity in the direction of regression coefficients but does not reflect differences in the overall magnitudes of these regression coefficients. Such differences can be seen in the summary statistics (see Table 4), which show that matching and nonmatching paths were most substantial for academic self-concept and that there was substantial variation in the strength of regression coefficients across the nine value facets. The means of the matching paths were significant and positive for all nine value facets ($M = .13$–$.54$). However, the means of the matching paths were larger for academic self-concept compared with all value facets and generally smaller for the utility value facets ($M = .13$–$.29$). The means of the far paths were significant and negative for all value facets except for utility for school, for which it was not significant ($M = -.08$ to $-.18$). The most pronounced cross-domain paths between far domains were found for intrinsic value ($M = -.18$) and effort and emotional cost ($M = -.16$), for both of which six out of the eight far paths were significant and negative. For utility for school, on the other hand, none of the eight paths were significant. The means of the near paths were significant and positive for personal importance, utility for school, and opportunity cost ($M = .07$–$.10$). There were some significant positive cross-domain paths from physics achievement to math value and from German achievement to English value. The mean of the eight paths between biology and the other domains was significant and negative only for intrinsic value ($M = -.07$). As for academic self-concept, we found significant, negative paths from English and math achievement to biology value and significant, positive paths from German achievement to biology value, although these regression coefficients were not statistically significant for all value facets.[2]

3.4. Mediating role of expectancies

As dimensional comparison effects on task values were found to be mediated by expectancies in previous studies, we further tested whether the paths from students' achievements in different domains to their task values could be explained by their expectancies. To this end, we evaluated a mediation model in which students' grades in the five domains predicted their expectancies, which in turn predicted their task values. Again, we ran these models for all value facets separately. For all mediation models, the magnitudes of all of the 25 direct paths from achievements to task values were relatively small and most were nonsignificant. We therefore compared the fit of these mediation models with models in which these 25 direct paths were constrained to be zero. For all nine value facets, this led to a negligible decrease in model fit compared with the unconstrained model (ΔCFI = .000–.002, ΔTLI = $-.002$ to .002, ΔRMSEA = $-.001$ to .001, ΔSRMR = $-.001$ to .002, see the Online Supplemental Materials for further details). Thus, these results indicate that expectancies fully explained the paths from achievements to task values.

4. Discussion

In the present study, we investigated how students' expectancies and values in five domains (German, English, biology, physics, and math) could be predicted by their achievements within and between domains. With respect to expectancies, our findings largely replicated previous research on dimensional comparisons (Jansen et al., 2015; Marsh, Lüdtke, et al., 2015) with strong support for negative cross-domain paths between far domains—indicating contrast effects—and some support for positive cross-domain paths between near domains—indicating assimilation effects. The major contribution of our study is that we extended the literature on dimensional comparisons between near and far domains to students' task values. To do so, we compared nine value facets. Some of these value facets (e.g., intrinsic value) were highly correlated with expectancy in the same domain, and these same value facets also showed a between-domain correlation pattern similar to that of expectancy. In line with these associations, regression analyses to examine how students' achievements predicted their values also showed a pattern of cross-domain paths similar to that of expectancy—indicating both contrasting and assimilating dimensional comparisons. Other value facets (e.g., social utility) showed weaker associations with expectancy and a lower degree of domain-specificity. These value facets also showed much weaker associations with students' achievements in the same and in other domains. Our findings are therefore evidence that DCT can be extended to task values but also indicate that it is necessary to differentiate between value facets.

4.1. Expectancy and value constructs in EVT

The associations of expectancy and value beliefs we found within domains have important implications for conceptualizations of expectancy and value beliefs in EVT. In line with previous studies in which the four value components were separated (Guo et al., 2016; Trautwein et al., 2012), we found that some value dimensions showed stronger associations with academic self-concept than others. Similar to these other studies, the highest correlations with academic self-concept were found for intrinsic value and effort and emotional cost. Students with a high self-concept in one domain experienced these domains as more interesting and less threatening and exhausting. The utility value facets, on the other hand, showed lower correlations with academic self-concept, suggesting that utility value is related to students' perceived competence in a domain to a smaller extent. Instead, students' evaluations of how useful a domain is for achieving their goals might be more strongly driven by other factors; possibilities include other student characteristics such as their goals for the future or the extent to

[2] Given the large range of grade levels in our sample, we also tested whether our results varied by grade level. To this end, we included students' grade level and the interactions between students' achievements and grade level as additional predictors in the regression analyses (see the Online Supplemental Materials for detailed results). We found that there were only a few interactions with students' grade level. Of the total of 25 interaction terms included in each model, zero to six interactions were significant for each of the outcomes. These significant interaction terms were roughly equally dispersed across the matching and nonmatching paths. Most but not all interaction terms indicated that the associations became more pronounced in higher grade levels. Given the large number of interaction terms tested and the small number of significant interactions, however, detailed interpretations do not seem to be warranted.

which teachers can capture the relevance of what students are learning. Relations were the weakest for social utility; this finding is not surprising given that this is the least academic aspect of utility. Our results indicate that researchers should not only distinguish between expectancy and value as the two key motivational constructs in EVT but rather highlight the importance of considering the differences between the value facets (cf. Trautwein et al., 2013).

4.2. Domain-specificity of expectancy and value

The patterns of between-domain associations we found for expectancy and value beliefs were mostly in line with our expectations. For academic self-concept, the pattern of associations strongly supports the idea that academic domains can be ordered on a verbal-math continuum. In line with the findings of previous studies (Jansen et al., 2015; Marsh, Lüdtke, et al., 2015), we found moderate positive correlations between domains that are close to each other on this continuum (i.e., German and English; math and physics) and zero or small negative correlations between domains that are on opposite ends of the continuum (i.e., verbal and quantitative domains).

In our study, we went beyond previous research on the domain-specificity of value beliefs as we investigated nine value-related beliefs in five domains. One of the most interesting findings in this study is the large degree of variation in domain-specificity across the nine value facets. For intrinsic value, personal importance, utility for job, and effort and emotional cost, there was a distinction between different domains that was almost as strong as for academic self-concept, and the pattern of correlations was also in line with a verbal-math continuum. However, some facets of utility value (i.e., utility for school, social utility) showed much higher correlations between domains overall, and the correlations did not show a distinction between the quantitative and verbal domains. It may be the case that when thinking of school utility, students focus on school overall rather than on specific domains. Similarly, social utility has to do with students' peer relations, which they likely think about more generally, rather than how they vary in different classes.

Beginning with Eccles et al. (1983), expectancy-value theorists have characterized both expectancies and values as task specific. On the basis of the high between-domain correlations we found for some value facets, we suggest that these facets are more domain-general. Researchers might therefore consider measuring these value facets for school in general in future studies, as well (see Steinmayr & Spinath, 2010). The high between-domain correlations could result in multicollinearity problems when such value beliefs measured across domains are used as predictors of students' academic outcomes. For other value facets, however, it seems very important to measure them separately for different domains instead of using domain-general measures. To further explore the structure of value beliefs in terms of their domain-general and domain-specific aspects and their associations with academic outcomes, it might be worthwhile to measure value beliefs at both levels and to explicitly model this hierarchical structure (see Gogol, Brunner, Martin, Preckel, & Goetz, 2017).

4.3. Dimensional comparison processes

Following the assumptions in DCT (Möller & Marsh, 2013) and the generalized IE model (Möller et al., 2016), we examined how students' expectancy and value beliefs depend on their achievements in multiple domains. As posited in DCT, dimensional comparisons can affect students' academic self-concepts in two ways: Contrast effects will result for domains that are considered dissimilar, and assimilation effects will result for domains that are considered similar or complementary. Our results on students' academic self-concepts support these propositions. Comparisons between far domains consistently resulted in negative cross-domain paths. Möller and Marsh (2013) discussed these effects with respect to the importance of individuals having accurate understandings of their strengths and weaknesses. They further noted that when engaged in contrasting comparisons, individuals often point to their stronger areas as a way to maintain positive views about themselves.

There was also some evidence of assimilation effects with a significant path from physics grade to math self-concept. Given the same grade in math, students thus reported a higher math self-concept when their grade in physics was higher. However, as reported in previous studies (Jansen et al., 2015; Marsh, Lüdtke, et al., 2015), the findings for dimensional comparisons between near domains were less consistent. It therefore seems important to further explore the circumstances under which assimilation effects occur. These kinds of effects have not received as much attention as contrast effects have (Möller & Marsh, 2013). Perhaps individuals engage in assimilating dimensional comparisons less frequently overall as they form their competence beliefs for the different activities that they do.

In line with biology's middle position on the verbal-math continuum, our results are evidence that this domain has a somewhat different role in comparison with the other domains in our study. Whereas students' grade in biology did not predict any of their academic self-concepts in other domains, their biology self-concept was positively predicted by their grade in German and negatively predicted by their grades in English and math (for similar results, see Marsh, Lüdtke, et al., 2015). Whereas students seem to perceive biology as dissimilar from both English and math, they might view good skills in German as complementary to biology because this is the language used in class.

The results of our study are evidence that students' value beliefs also depend on their achievements across multiple domains. Similar to academic self-concepts, we also found evidence for both positive and negative cross-domain paths. Negative cross-domain paths were found between far domains as well as between biology and both math and English. Positive cross-domain paths were found from physics to math and from German to both English and biology, although these paths were somewhat less consistent, as was the case for academic self-concept. By investigating a broader range of domains than have been explored in previous research, we showed that the patterns of cross-domain paths to value beliefs also reflect the similarities of different domains along the verbal-math continuum, with at least some evidence for assimilating dimensional comparisons as well.

However, in line with our predictions, dimensional comparisons were more pronounced for the value facets that are closely related to expectancy than for facets showing lower correlations with expectancy. In line with previous studies (Goetz et al., 2008; Guo et al., 2017; Nagy et al., 2006, 2008; Schurtz et al., 2014), we also found that the paths from students' achievements to their task values could be explained by those from achievements to academic self-concepts. However, we note that academic self-concepts and task values are likely to be reciprocally related (Marsh et al., 2005) and that it would be inappropriate to imply a causal ordering of these associations when our data are cross-sectional. The pattern of results was most similar to academic self-concepts for intrinsic value, personal importance, and effort and emotional cost. These findings are in line with previous studies that found contrast effects for intrinsic value, interest, and related constructs (Goetz et al., 2008; Guo et al., 2017; Marsh, Abduljabbar, et al., 2015; Nagy et al., 2006, 2008; Schurtz et al., 2014).

An important extension of earlier work is our finding that dimensional comparison effects extend to perceived cost as a negative value component. As noted earlier, cost has only recently been studied as one additional factor that is related to students' learning behavior and academic choices beyond expectancy and positive value components (Perez et al., 2014). Given the high correlations between some aspects of cost and achievement, it is clear that perceived cost deserves continued attention in work that is based on EVT.

Facets of utility value—especially utility for school and social utility—showed notably fewer significant associations with achievements within and across domains. In addition to lower correlations with expectancy, these value facets also showed a smaller degree of domain-specificity. It is not completely clear why this is the case; as noted earlier, perhaps students consider at least some aspects of the utility of what they are learning to be domain-general rather than domain-specific. More work is thus needed on what impacts students' utility value.

Although the contributions of our study are mainly theoretical in nature with implications for both DCT and EVT, it is also possible to derive implications for interventions that target students' expectancies and values on the basis of our findings. When developing such interventions, it seems important to keep their domain-specific nature in mind, at least for many of the value facets. It is likely that these interventions will need to be implemented in a specific domain to be effective (see O'Mara, Marsh, Craven, & Debus, 2006). However, expectancy and value beliefs in one domain are also embedded in a more complex belief system, and it therefore seems unlikely that motivational interventions in one domain will work independently from those in other domains. Recently, Gaspard et al. (2016) showed that an intervention for fostering students' value beliefs in math had a negative effect on their value beliefs in language arts. As this was the first study to examine such side effects of domain-specific interventions on non-targeted domains, more research is needed to examine the conditions under which these occur. In line with our findings, one could also expect value interventions to affect value beliefs in similar domains positively if students perceive them as complementary.

4.4. Limitations and suggestions for future research

Although we have provided an extension to previous research by investigating dimensional comparisons across multiple value facets and a broad range of domains, some limitations of the current study should also be mentioned. As in most research on dimensional comparisons, we used cross-sectional correlational data, and causal interpretations should therefore be made only with extreme caution. In our study, we regressed students' expectancy and value beliefs on students' grades in five subjects, which were correlated moderately to highly. Whereas this is a typical approach used in the literature on dimensional comparison effects on academic self-concepts (e.g., Jansen et al., 2015; Marsh, Lüdtke, et al., 2015), some of these regression coefficients would not have been significant when testing bivariate associations. However, it is important to note that the original IE model (Marsh, 1986) was developed to explain why academic self-concepts in different domains are typically uncorrelated, whereas achievements in these domains are correlated positively. It is therefore an important part of the theoretical assumptions underlying this model to control for achievements in the matching domain when testing dimensional comparison effects despite (or because of) their high correlation. Dimensional comparison processes have also been supported by the results of experimental and introspective studies (Möller & Marsh, 2013), and therefore, the cross-domain effects found in path-analytic studies seem to represent meaningful psychological processes. Future research is needed to examine whether this holds for value beliefs as well.

Although we found support for the proposition that dimensional comparison processes for task values are associated with those for academic self-concept, longitudinal studies would be required for stronger tests of these processes. One of the core assumptions made in DCT is that students engage in dimensional comparisons on the basis of the perceived similarity of academic domains (Möller & Marsh, 2013). Although the pattern of cross-domain paths we found in our study was in line with a verbal-mathematical continuum, our study did not include measures of such beliefs about similarity and dissimilarity (for students' belief in the negative interdependence of verbal and math abilities, see Möller, Streblow, & Pohlmann, 2006). More research is needed to directly investigate the mechanisms underlying dimensional comparisons.

In our study, we aimed to integrate DCT and EVT in investigating how students' expectancy and value beliefs are related to their achievements across multiple domains. In EVT, comparisons between domains also play a crucial role in the assumption that students' course and career choices are based on intraindividual hierarchies in expectancies and values across domains (Eccles, 2009). Although our study highlights one of the potential mechanisms driving the development of these intraindividual hierarchies, investigating how expectancies and values in multiple domains combine to predict students' educational choices would be an important next step in bringing together these two motivational theories. Some first studies have already yielded promising results in this direction, indicating that educational choices are indeed affected by expectancies and values across multiple domains (Chow et al., 2012; Guo et al., 2017; Nagy et al., 2006) and that dimensional comparisons can explain important practical problems such as the lower proportion of girls and women in math-related courses and careers (Chow et al., 2012; Nagy et al., 2006). However, according to our study's results, it seems important to investigate these patterns for multiple value facets and across a broad range of domains.

When interpreting the results of our study, it is also important to keep in mind that the sample consisted of German students from two academic track schools. Although these are regular schools, the sample was not representative of German students but was positively selected in terms of student achievement. It is therefore possible that some of the findings in our study were affected by the characteristics of these particular schools and their student composition. However, the predictions that can be derived from the IE model for math and verbal self-concepts have been validated in different cultures (Marsh & Hau, 2004; Möller et al., 2009). Still, the perceived similarities of different domains along the verbal-mathematical continuum could vary by school context and the ways in which the domains are taught. For instance, biology and physics are taught as separate domains in Germany, and this might increase the perceived distance between them. Researchers might therefore want to explore how the school structure impacts dimensional comparisons, particularly regarding the conditions under which comparisons between domains closer on the verbal-math continuum result in assimilation or contrast effects. The generalizability of our findings to students in lower tracks also requires future investigation. Because researchers who have explored the development of expectancy and value beliefs have found that school transitions during early adolescence can have a negative impact on these beliefs (Eccles, Wigfield, et al., 1993; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991), researchers might also wish to explore whether and how such transitions affect dimensional comparison processes in the future.

4.5. Conclusions

In this study, we aimed to integrate EVT and DCT to investigate how students' expectancies and task values are affected by their achievements across multiple domains. Whereas we were able to replicate the findings of previous studies in which students' expectancies were shown to be affected through contrasting and assimilating dimensional comparisons, we also extended this body of research to students' task values. When comparing the results for the nine value facets that we investigated in our study, it seems that some of these value facets (i.e., intrinsic value and cost) are highly domain-specific and also depend to a large extent on students' achievements within and between domains, whereas other value facets (i.e., utility value) are less domain-specific and show only weak associations with students' achievements. In future research, it will be important to investigate the generalizability of these findings to different groups of students and school contexts, the psychological processes underlying dimensional comparisons, and the consequences of dimensional comparisons on students' academic choices.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.cedpsych.2017.10.003.

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