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Longitudinal Relations among Self-concept, Intrinsic Value, and Attainment Value across Secondary School Years in Three Academic Domains

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Abstract

This study expanded on research on temporal relations among motivation constructs as stated by expectancy-value theory, which has so far neglected the differentiation of value facets, the examination of long time spans with multiple measurement waves, and domain-specific patterns of findings. We examined the longitudinal relations among academic self-concept, intrinsic value, and attainment value in the three domains of math, German, and English across five annual measurement waves covering grades 5 to 9 with German secondary school students ($N = 2116$). The analyses based on cross-lagged panel models. In math and English, former academic self-concept was positively related to later intrinsic value and attainment value. In German, former intrinsic value and attainment value were positively related to later academic self-concept. The cross-lagged relations among value constructs varied according to the domain, hinting at the domain specificity of findings. The relations among academic self-concept, intrinsic value, and attainment value in the three domains were of similar size and did not change across students' secondary school years. In addition, the pattern of all relations remained stable when controlling for students' domain-specific achievement measured by school grades in the respective domains.

Keywords: expectancy-value theory; intrinsic value; attainment value; academic self-concept; longitudinal relations

Educational Impact and Implications Statement

Former academic self-concept was found to be positively related to later intrinsic value and attainment value across five annual measurement waves during secondary school in the domains of math and English. This finding implies that students develop more interest and enjoyment and might perceive higher subjective relevance when they feel competent in math and English. Hence, educational practice should emphasize the enhancement of students' academic self-concept in math and English. In the domain of German, however, former intrinsic value and attainment value were found to be positively related to students' later academic self-concept. Hence, interest development and emphasizing relevance seem to be important to boost students' self-perceptions of competence in German. The temporal relations among the two value facets of intrinsic value and attainment value varied contingent upon the domain considered (i.e., math, German, and English). These findings contribute to the advancement of expectancy-value theory by pointing to the domain specificity of longitudinal relations among expectancy, intrinsic value, and attainment value facets. The findings further help to better inform empirical educational research on motivational development in secondary school.

Longitudinal Relations among Self-concept, Intrinsic Value, and Attainment Value across Secondary School Years in Three Academic Domains

According to contemporary expectancy-value theory (EVT), students' motivation comprises an expectancy component and a value component (Eccles & Wigfield, 1995). The value component has been found to encompass four different facets: Intrinsic value, attainment value, utility value, and cost (Wigfield & Eccles, 2000). Within EVT, the expectancy and the value components are assumed to be positively related (Eccles & Wigfield, 2002). Indeed, cross-sectional studies demonstrated substantial positive relations between both components (e.g., Denissen, Jaap, Zarrett, & Eccles, 2007; Durik, Vida, & Eccles, 2006; Fredricks & Eccles, 2002). However, related findings from longitudinal studies were ambiguous (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Nurmi & Aunola, 2005; Skaalvik & Valas, 1999; Spinath & Spinath, 2005; Spinath & Steinmayr, 2008). In addition, given the separation of value facets (Dever, 2016; Gaspard, Dicke, Flunger, Schreier et al., 2015; Penk & Schipolowski, 2015; Schoor, 2016), the relation between expectancy and value might differ with regard to the value facet considered. While longitudinal studies have focused on the relation between expectancy and intrinsic value (Jacobs et al., 2002; Marsh et al., 2005; Nurmi & Aunola, 2005; Skaalvik & Valas, 1999; Spinath & Spinath, 2005; Spinath & Steinmayr, 2008), there is a lack of research on the relation between expectancy and attainment value. Finally, the identification of separate value facets necessitates the examination of cross-sectional and longitudinal relations among different value facets. In cross-sectional studies, intrinsic value and attainment value have often been found to be substantially positively correlated (Trautwein et al. 2012); yet, the longitudinal relation between intrinsic and attainment values has not been assessed so far.

In this study, we therefore examined the relations among expectancy (operationalized as academic self-concept), intrinsic value, and attainment value both cross-sectionally and longitudinally. Moreover, we tested whether the longitudinal relations were stable or changed across five school years covering students' mandatory secondary education in Germany. We did this separately for the domains of math, German, and English to probe whether the patterns of findings generalize or vary across the specific domains.

Expectancy and Value Constructs

EVT is one of the most prominent theories of motivation in education (Schunk, Pintrich, & Meece, 2009). Here, Atkinson's (1966) theory marked the beginning in a history of expectancy-value models (for an overview see Eccles, Wigfield, & Schiefele, 1989). In this study, we relied on modern EVT proposed by Eccles and Wigfield (e.g., Eccles & Wigfield, 1995, 2002; Nagengast et al., 2011) assuming that students' motivation comprises two main components, an expectancy component and a value component. The expectancy and the value components have been found to predict a wide range of student outcomes including aspirations, coursework selection, engagement, and achievement both separately and interactively (Guo, Marsh, Parker, Morin, & Dicke, 2017; Guo, Nagengast et al., 2015; Nagengast et al., 2011; Trautwein et al., 2012).

The expectancy component was originally presumed to encompass ability beliefs and expectancies of success, but both constructs were found to be inseparable and to form a single factor (Eccles & Wigfield, 2002; Eccles, Wigfield, Harold, & Blumenfeld, 1993). More recently, students' academic self-concept – defined as students' self-perceptions of academic competence (Marsh & Craven, 2006) – has served to operationalize the expectancy component (Guo et al., 2017; Guo, Marsh, Morin, Parker, & Kaur, 2015; Guo, Marsh, Parker, Morin, & Yeung, 2015; Guo, Nagengast et al., 2015; Guo, Parker, Marsh, & Morin, 2015; Nagengast et al., 2011; Trautwein et al., 2012).

The value component was described as multidimensional, comprising four different facets: Intrinsic value, attainment value, utility value, and cost (Wigfield & Eccles, 2000). Intrinsic value encompasses students' enjoyment, liking, and interest. Attainment value reflects students' subjective importance of doing well and having high levels of competence.

Utility value depicts students' perceptions of the usefulness for present or future goals. Finally, cost depicts the negative consequences of choosing and engaging in a task, and opportunity cost. The differentiation between the various value components has been empirically validated (Dever, 2016; Gaspard, Dicke, Flunger, Schreier et al., 2015; Penk & Schipolowski, 2015; Schoor, 2016). Accordingly, confirmatory factor analytic (CFA) models better fitted the data when assuming separate value facets rather than a global value factor that merged various value facets. In addition, the findings from these studies showed high but not perfect correlations among the different value facets.

In this study, we focused on three constructs which fit into the EVT framework, that is, academic self-concept as one way to operationalize the expectancy component, and intrinsic value and attainment value as two value facets. We examined cross-sectional and longitudinal relations among these three constructs. Findings on longitudinal relations are of high theoretical interest as they allow insights into temporal relations and thus motivational processes.

Relations between Expectancy and Value Components

According to EVT, "(…) expectancies and values are assumed to be positively related to each other" (Eccles & Wigfield, 2002; p.118). Positive relations between expectancy and value facets have been demonstrated in many cross-sectional studies. High correlations were found between academic self-concept and intrinsic value, with the latter being operationalized as enjoyment, interest, or intrinsic motivation (Abu-Hilal, Abdelfattah, Alshumrani, Abduljabbar, & Marsh, 2013; Arens, Yeung, Craven, & Hasselhorn, 2011; Chapman & Tunmer, 1995; Denissen et al., 2007; Dinkelmann & Buff, 2016; Durik et al., 2006; Fredricks & Eccles, 2002). Moreover, academic self-concept has been found to show substantial relations to attainment value, relations being of similar size to the relations between academic self-concept and intrinsic value (Conley, 2012; Trautwein et al., 2012). Relatively lower relations were found between academic self-concept and utility value, and between academic self-concept and cost (Conley, 2012; Guo, Marsh, Parker et al., 2015; Guo, Parker, Marsh et al., 2015; Wigfield et al., 1997). Hence, the size of the relation between expectancy and value seems to vary contingent upon the value facet considered.

Cross-sectional studies, however, cannot unveil temporal relations among constructs, which can differ substantially from cross-sectional relations. That is, constructs that are highly related when measured at the same time point might be rather independent of each other regarding their temporal influence (i.e., longitudinal relations) and vice versa (e.g., Preckel, Niepel, Schneider, & Brunner, 2013). While the original EVT leaves open the question of directionality regarding the relation between expectancy and value beliefs, more recent elaborations on EVT have assumed a relation leading from former expectancy beliefs to later value beliefs: “It appears that for real-world achievement, individuals value the tasks at which they think they can succeed” (Wigfield & Eccles, 2002, p. 105; see also Eccles & Wigfield, 2002; Wigfield, Tonks, & Klauda, 2009). This assumption also fits well to Self-Determination Theory (SDT) according to which self-perceptions of competence are a prerequisite for the formation of intrinsic motivation (Deci & Ryan, 2000). Moreover, in social cognitive theory of self-efficacy, former self-efficacy beliefs are assumed to contribute to later interest: “In the temporal lag pattern, a high sense of efficacy promotes mastery experience that, over time, provide self-satisfactions conducive to growth of interest.” (Bandura, 1997, p. 220). Finally, Harter (1978) proposed a model of effectance (also labeled as competence) motivation in which perceived competence is assumed to impact intrinsic pleasure.

Empirical evidence has been rather mixed in this regard. A few studies (Jacobs et al., 2002; Lauermann, Tsai, & Eccles, 2017; Marsh et al., 2005; see also MacIver, Stipek, & Daniels, 1991) indicated the expected positive relation of former expectancy constructs to later intrinsic value constructs. For instance, Marsh et al. (2005) measured math self-concept and math interest twice within the same school year. Math self-concept showed a significant positive relation to later math interest, but former math interest was not significantly related to later math self-concept. In addition, Lauermann et al. (2017) demonstrated that math self-concept in grade 9 positively predicted math interest (i.e., intrinsic value) in grade 12, while former math interest was not significantly related to later math self-concept. Other studies, however, found no significant longitudinal relations between academic self-concept and intrinsic value (Nurmi & Aunola, 2005; Skaalvik & Valas, 1999; Spinath & Spinath, 2005; Spinath & Steinmayr, 2008).

So far, longitudinal studies have concentrated on the temporal relations between academic self-concept as an indicator of the expectancy component and intrinsic value as one subfacet of the value component (Marsh et al., 2005; Spinath & Spinath, 2005; Spinath & Steinmayr, 2008), while neglecting relations between academic self-concept and other value components. Therefore, we did not only investigate the longitudinal relation between academic self-concept and intrinsic value, but also the longitudinal relation between academic self-concept and attainment value. In cross-sectional studies, academic self-concept showed substantial positive relations with attainment value (Conley, 2012; Guo, Nagengast et al., 2015; Trautwein et al., 2012). However, EVT does not adhere to specific assumptions about the directionality of the temporal relation between academic self-concept and attainment value. Moreover, respective empirical findings are missing. A positive relation between former academic self-concept and later attainment value can yet be assumed as individuals might attribute high levels of importance and personal relevance to those domains in which they feel competent and successful.

Relations among Value Components

Conceptually, the different value components all belong to an overarching value construct and are therefore assumed to be substantially related to each other. Indeed, cross-sectional studies demonstrated substantial correlations among value facets (Conley, 2012; Durik et al., 2006; Greene, DeBacker, Ravindran, & Krows, 1999; Guo, Marsh, Morin et al., 2015; Guo, Marsh, Parker et al., 2015; Guo, Parker, Marsh et al., 2015; Li, Lee, & Solmon, 2007). A high positive correlation has consistently been found between intrinsic value and attainment value. For instance, Trautwein et al. (2012) reported a correlation of $r = .97$ between intrinsic value and attainment value in both English and math, while the correlations among the other value facets (i.e., intrinsic value resp. attainment value, utility value, and cost), ranged between $r = .18$ and $r = .71$ in English and between $r = .36$ and $r = .77$ in math. These findings are in line with the notion of Wigfield and Eccles (2002, p. 105) that interest (intrinsic value) and importance (attainment value) share “intrinsic aspects” leading to high relations between them.

Regarding temporal relations among different value facets, EVT does not formulate any specific assumptions with respect to the direction of influence, and empirical studies are lacking. Given the substantial cross-sectional relations between intrinsic value and attainment value (Conley, 2012; Trautwein et al., 2012) and their shared intrinsic nature (Wigfield & Eccles, 2002), it is plausible to assume significantly positive temporal relations. On the one hand, students might attribute importance and relevance to domains they like so that former intrinsic value would be related to later attainment value. On the other hand, based on interest theory, environmental features of personal relevance might trigger situational interest (which in turn might invoke individual interest), leading to a relation between former attainment value and later intrinsic value (Hidi & Renninger, 2006). Hence, with respect to the temporal relation between intrinsic value and attainment value, positive reciprocal relations might exist.

Developmental Differences

When investigating longitudinal relations, one has to consider possible developmental differences such as age-dependent variations in the strength of relations among EVT facets. In the study by Wigfield et al. (1997), the relation between competence beliefs and a combined value facet encompassing usefulness and importance was non-significant in a sample of first-grade students. However, the relation was consistently positive and significant among students in grade 2 and above. The relation between competence beliefs and interest (i.e., intrinsic value) was found to be lower in first-grade and second-grade students compared to students attending grades 3 to 6. Finally, first-grade students displayed a lower correlation between the two value facets (i.e., usefulness-importance and interest) compared to students from grades 2 to 6. These age differences in the size of relations among EVT facets were found in both the domains of math and reading. Hence, the size of relations among the EVT facets seemed to be relatively low and to vary until the end of grade 2, but to increase and stabilize afterwards: "(…) it appears to be the second-grade year when competence beliefs and values become more synchronous for many children" (Wigfield et al., 1997, p. 465). The cohort-sequential design study by Fredricks and Eccles (2002) replicated the finding of lower correlations between math competence beliefs (i.e., math self-concept) and math interest, and between math competence beliefs and math importance at the beginning of elementary school (i.e., the first measurement waves when the students of the different cohorts attended grades 1, 2, or 4) compared to the end of elementary school (i.e., the third measurement waves when the students of the different cohorts attended grades 3, 4, and 6). Yet, according to this study, the size of the relation between the two math value facets (importance and interest) did not change across elementary school years.

Hence, the findings from some studies suggested that the size of relations among EVT constructs increases across elementary school years (Fredricks & Eccles, 2002; Wigfield et al., 1997). Findings from more recent studies indicated that the relation between self-concept and intrinsic value increases even beyond elementary school years (Denissen et al., 2007; see also Davis-Kean, Jager, & Collins, 2009). This finding was interpreted as a "specialization process" whereby individuals develop higher levels of value beliefs in domains of their competence and vice versa. Indeed, in the course of secondary schooling, students approach the end of mandatory schooling when they will be asked to apply for an apprenticeship or to select advanced courses which are particularly relevant for upper secondary education. Hence, students need to become aware of their own abilities and interests to select the domains they want to further pursue. This requirement might contribute to a closer relation between students' expectancies or ability beliefs on the one hand and value facets on the other hand, as one should ideally have high levels of self-perceived competence as well as high levels of subjective value beliefs in the chosen domains.

Yet, previous studies with secondary school students only included two waves of assessment (Lauermann et al., 2017; Marsh et al., 2005; Skaalvik & Valas, 1999). Therefore, it was not possible to probe for changes versus the robustness in the size of relations between self-concept and intrinsic value across secondary school years. Moreover, other value facets such as attainment value were not considered in these studies. In the present study, we therefore examined the relations among self-concept, intrinsic value, and attainment value across grades 5 to 9 with German students. Based on the specialization process assumption (Denissen et al., 2007), the size of the relations among these constructs might increase across this time period which covers the years of mandatory secondary schooling in Germany.

Generalization across Different Domains

Both expectancy and value components have been found to be domain-specific in nature. Hence, students form separate expectancy and value perceptions in different subject domains (Eccles et al., 1993; Trautwein et al., 2012). This raises the question if the pattern of relations among expectancy and value components can be generalized across domains or if the relations vary by domain. Previous studies examining the temporal relations between expectancy and intrinsic value beliefs considered the academic domain in general (Spinath & Spinath, 2005) which might mask domain-specific idiosyncrasies and differences across subjects. Other studies only focused on the math domain (Lauermann et al., 2017; Marsh et al., 2005) without investigating whether the found relations between expectancy and value components also apply to other domains.

Using a sample of German elementary school students, Spinath and Steinmayr (2008) investigated the longitudinal relations between academic self-concept (as an indicator of expectancy) and intrinsic value related to math, German (students' language of instruction), and school in general. The findings did not reveal any significant temporal relations among constructs. Yet, it has so far remained unclear whether this pattern of findings also applies to secondary school students, to further academic domains, and when adding attainment value as another value facet. Therefore, we took up a domain-specific approach and broadened it by investigating the longitudinal relations between expectancy (self-concept), intrinsic value, and attainment value with respect to math, German (students' language of instruction), and English (students' first foreign language) with a sample of secondary school students in Germany.

The three domains (math, German, and English) largely differ from each other with regard to teachers' and students' perceptions. Math and foreign language teachers were found to see their subjects as defined and homogenous subjects with clear boundaries and a well-defined body of required knowledge and skills (Grossman & Stodolsky, 1995; Stodolsky & Grossmann, 1995). In addition, math and foreign language subjects were seen as sequential school subjects in which prior learning and understanding is a prerequisite to later learning. Math and foreign language subjects were further perceived to be static as the content does not change often or rapidly. Students' language of instruction as a school subject, by contrast, appeared to be composed of a number of subdisciplines and to be thus heterogeneous in itself. Students' language of instruction was also seen as a dynamic subject as the contents of lessons change often and might be frequently replaced by more current content. Therefore, students' learning does not as strongly depend on specific prior knowledge and skills.

With regard to students' views, German secondary school students reported that the two verbal subjects of German (students' language of instruction) and English (students' first foreign language) are characterized by variety in instruction, opportunities for discussion, reference to everyday life, and inclusion of current topics (Haag & Götz, 2012). Math, by contrast, was perceived to be more difficult and anxiety-provoking than verbal subjects –

maybe because math was perceived to cover a lot of content, to require a lot of effort, to be characterized by unambiguous correct solutions and interrelations of topics, and to be particularly informative about one's own general cognitive ability (Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Haag & Götz, 2012; Hannover & Kessels, 2004; Sparfeldt, Schneider, & Rost, 2016). Similar to teachers' view, students perceived math as an unchangeable and fixed school subject in terms of its content. Learning of math was seen to primarily take place at school (Stodolsky, Salk, & Glaessner, 1991). Finally, among students as well as among teachers, there was a high level of agreement about the nature and content of math, again illustrating the homogenous nature of math (Grossman & Stodolsky, 1995; Stodolsky et al., 1991; Stodolsky & Grossmann, 1995).

Gathering up these differences between math and verbal domains, students might display differential relations among motivational facets (i.e., self-concept, intrinsic value, attainment value) in these domains. Given the high level of perceived difficulty, the self-contained, homogenous, and sequential nature as well as the clear achievement feedback associated with math, students' self-concept might play a more relevant and stable role for students' value perceptions in math than in verbal domains. Conversely, students' self-concept and value beliefs might be more widely spread across the different subskills in verbal domains. Here, a high level of self-perceived competence (i.e., academic self-concept) does not necessarily entail a high level of intrinsic value or attainment value as the respective beliefs might refer to different verbal subskills or topics. Moreover, students' self-perceptions regarding the verbal domain might be more volatile and open to influence leading to varying instead of stable relations among motivational facets.

The Present Study

In this study, we assessed students' academic self-concept, intrinsic value, and attainment value related to the three different domains of math, German, and English at five annual measurement waves in secondary school covering grades 5 to 9. First, we tested the temporal relations between expectancy (operationalized as academic self-concept) and intrinsic value. While EVT originally leaves open the direction of influence between expectancy and value facets (Eccles & Wigfield, 2002), other theories and implicit assumptions argue for an influence of former expectancy constructs on later intrinsic value (Bandura, 1997; Deci & Ryan, 2000; Eccles & Wigfield, 2002; Harter, 1978). However, empirical evidence for this assumption has remained ambiguous (Jacobs et al., 2002; Lauermann et al., 2017; Marsh et al., 2005; Nurmi & Aunola, 2005; Skaalvik & Valas, 1999; Spinath & Spinath, 2005; Spinath & Steinmayr, 2008). Second, we tested the temporal relations between expectancy and attainment value. It is plausible to assume that students attribute higher levels of importance and personal relevance to those domains in which they feel competent and successful. Yet, EVT itself does not specify the direction of influence between expectancy and attainment value and it has not been empirically tested so far. Third, we tested the temporal relation between intrinsic value and attainment value as two distinct value facets. Again, EVT does not formulate any specific assumptions with respect to the direction of influence. Students might attribute personal relevance to domains they like, and personal relevance might trigger individual interest or intrinsic value (Hidi & Renninger, 2006). Hence, positive reciprocal relations might exist between intrinsic value and attainment value, but respective empirical evidence is missing.

The consideration of five annual measurement waves during secondary school years allows probing for potential changes in the size of the temporal relations among EVT constructs. The approaching end of mandatory schooling might prompt a specialization process which might contribute to an increasingly stronger relation among motivational constructs. Therefore, we tested if the size of temporal relations among EVT constructs increased over time.

Our research questions targeting the pattern and stability of temporal relations among self-concept, intrinsic value, and attainment value across secondary school years were all tested in the three academic domains of math, German, and English in order to probe whether the findings generalize or differ across these three different domains. Math, German, and English constitute the core school subjects for secondary school students in Germany, but differ from each other in various characteristics (Grossman & Stodolsky, 1995; Haag & Götz, 2012; Stodolsky et al., 1991; Stodolsky & Grossmann, 1995). Given the characteristics of math as a homogenous, sequential, and static school subject with clear achievement feedback, students' self-concept might play a more relevant and stable role for students' value in math than in verbal domains. Regarding the verbal domains, German is the language of instruction for German secondary school students, while English is a foreign language taught at school with a defined, static, and sequential curriculum. Hence, differences in findings regarding the pattern and stability of relations among academic self-concept, intrinsic value, and attainment value might be more pronounced between math and German than between math and English.

Finally, we tested whether the found pattern of relations remained in place when integrating students' domain-specific achievement in the models. Students' domain-specific achievement was found to demonstrate positive relations to students' self-concept and intrinsic value in the matching domains, although respective evidence is weaker for attainment value (Arens, Marsh et al., 2017; Guo et al., 2017; Marsh et al., 2005; Spinath, Spinath, Harlaar, & Plomin, 2006; Trautwein et al., 2012).

The present study thus contributes and adds to existing research and theory. We addressed research questions which have so far missed a clear theoretical framework (see the lack of specific hypotheses within EVT regarding the temporal relations among expectancy and value facets), empirical investigation (see the lacking empirical findings on temporal relations between academic self-concept and attainment value, and on the temporal relations among value facets), or which have provided inconclusive empirical findings (see the temporal relations between academic self-concept and intrinsic value). Our investigation of temporal relations between academic self-concept, intrinsic value, and attainment value in three domains thus had to remain partially exploratory or could only base on tentative assumptions.

Method

Sample

The data analyzed in this study were retrieved from the large-scale longitudinal project "Bildungsprozesse, Kompetenzentwicklung und Selektionsentscheidungen im Vorschul- und Schulalter (BiKS)" *(Educational processes, competence development and selection decisions in pre- and primary school age*; Artelt, Blossfeld, Faust, Roßbach, & Weinert, 2013) funded by the German Science Foundation (DFG). The data were made publically available by the Research Data Centre (FDZ) at the Institute for Educational Quality Improvement (IQB, Berlin). The BiKS study encompasses two studies (BiKS-3-10 and BiKS-8-14) both aiming to investigate the development of academic competences and school-related motivational constructs as well as the conditions and consequences of educational decisions. Both studies were conducted in the two German federal states of Hesse and Bavaria. BiKS-3-10 covered students' first year in kindergarten until fourth grade of elementary school (the final year of elementary school in the federal states of Hesse and Bavaria). The present study relied on BiKS-8-14, which tracked students across grades 3 to 9. BiKS-8-14 contained eight measurement waves with the first three waves taking place during grades 3 and 4 in elementary school. In this study, we focused on the final five measurement waves (i.e., waves 4 to 8) of BiKS-8-14 when the students attended grades 5 (t1), 6 (t2), 7 (t3), 8 (t4), and 9 (t5), to circumvent problems of sample attrition due to the transition from elementary to secondary school (between grades 4 and 5), and because students' self-concept, intrinsic value, and attainment value related to English were only assessed at these waves. Each of the five waves took place at the end (May to July) of the respective school years, that is, at the end of students' grades 5 to 9, starting in 2008.

The total sample of the present study consisted of 2116 students [*N* = 1021 (48.3%) male; *N* = 1095 (51.7 %) female]. A subsample of *N* = 1451 (68.6%) students came from Bavaria and a subsample of *N* = 665 (31.4%) students came from Hesse. The sample included all students who had at least one valid item on the domain-specific self-concept, intrinsic value, or attainment value measures at least at one of the five measurement waves and information on their attended school. At t1, 90.3% of the students provided at least one valid rating on the variables considered; at t2, t3, t4, and t5, the respective figures were 84.7%, 78.0%, 44.9%, and 36.6%. Students' average age at t1 was 11.45 years (*SD* = 0.46) as it is common for German students in grade 5. At t1, *N* = 1150 (54.3%) students attended the academic track ("Gymnasium"), *N* = 337 (15.9%) students attended the intermediate track ("Realschule"), *N* = 368 (17.4%) attended the vocational track ("Hauptschule"), and *N* = 229 (10.8%) students attended the comprehensive track ("Gesamtschule") of German secondary education. A small number of *N* = 32 (1.5%) students came from schools for children with special needs. To gain information about students' socioeconomic status (SES), we inspected the highest rating on the *International Socio-Economic-Index of Occupational Status (ISEI*; Ganzeboom, Graaf, & Treiman, 1992) for the household in which a student lived (HISEI). The ISEI ranges from 16 indicating low SES to 90 indicating high SES. For *N* = 1935 (84.5%) students, information on the HISEI was available. The average value of the HISEI was *M* = 53.18 (*SD* = 15.97) ranging from 16 to 90. Forty-two percent of the sample could be classified as low-SES students (HEISI in the first quartile), while 31% were high-SES students (HEISI in the fourth quartile). Regarding students' immigrant background, *N* = 1470 (69.5%) students had no immigrant background as both students and a parent had been born in Germany. Within the subsample of *N* = 325 (15.4%) students with an immigrant background, for *N* = 160 (7.6%), the student or a student's parent had been born abroad, while for *N* = 165 (7.8%), both the student and a parent had been born abroad. For *N* = 321(15.2%) students, no information on immigrant background was available. For *N* = 1702 (80.4%)

students, the mother tongue was German. Turkish came second as native language [N = 101 (4.8%)].

Instruments

Academic self-concept. Students' self-concept in math, German, and English was measured with three items each, which had parallel wordings across the three domains: "Math/German/English is easy for me"; "I learn quickly in math/German/English"; "I am good at math/German/English". The students were asked to indicate their consent to the item statements on a 5-point-Likert scale ranging from "not at all" to "very much". The items originate from the Self-Description Questionnaire II (SDQ II; Marsh, 1990) which is known as one of the most widely applied and empirically validated self-concept measures for adolescents (Byrne, 1996). The self-concept scales showed good reliability estimates in this study at each measurement wave: math self-concept: t1: α = .921; t2: α = .935; t3: α = .932; t4: α = .945; t5: α = .959; German self-concept: t1: α = .870; t2: α = .879; t3: α = .906; t4: α = .860; t5: α = .892; English self-concept: t1: α = .923; t2: α = .921; t3: α = .934; t4: α = .934; t5: α = .932.

Intrinsic value. Students' intrinsic value was measured by two parallel-worded items in each of the three subject domains (i.e., math, German, and English). The items were retrieved from the "Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood (BIJU)" study (Baumert et al., 1996). They had a strong focus on students' enjoyment and looking forward to lessons in math, German, and English, and were used to operationalize intrinsic value in a recent study (Trautwein et al., 2012): "How much do you look forward to math/German/English lessons?; How much would you like to have more math/German/English lessons?" The students responded to the items using a 5-point-Likert scale ranging from "not at all" to "very much". The coefficient alpha reliability estimates for these scales were good at the various measurement waves: math intrinsic value: t1: α = .877; t2: α = .865; t3: α = .853; t4: α = .864; t5: α = .846; German intrinsic value: t1: α = .844; t2: α = .851; t3: α = .834; t4: α = .836; t5: α = .809; English intrinsic value: t1: α = .863; t2: α = .882; t3: α = .851; t4: α = .836; t5: α = .817.

Attainment value. Attainment value related to math, German, and English was measured by two items each. The corresponding items had parallel wordings across domains and asked for students' subjective importance attributed to being good at and learning in the three subject domains: "How important is it to you to know a lot in math/German/English?; How important is it to you to memorize what you have learned in math/German/English?" The students rated their responses to these items on a 5-point-Likert scale ranging from "not at all" to "very much". The items used here to operationalize attainment value were retrieved from the BIJU study (Baumert et al., 1996) and resemble corresponding items used in other studies (Eccles, & Wigfield, 1995; Greene et al., 1999; Trautwein et al., 2012). The coefficient alpha reliability estimates of these scales were good at the five measurement waves: math attainment value: t1: α = .889; t2: α = .903; t3: α = .894; t4: α = .926; t5: α = .905; German attainment value: t1: α = .856; t2: α = .894; t3: α = .880; t4: α = .846; t5: α = .887; English attainment value: t1: α = .828; t2: α = .860; t3: α = .840; t4: α = .838; t5: α = .826.

Achievement. The school grades the students had obtained in their last (i.e., mid-term) school report in grade 5 (t1) in math, German, and English served as achievement indicators, which was considered as a control variable. In Germany, school grades range from 1 to 6, with 1 representing the best, and 6 the poorest grade. To facilitate interpretation of the results, the grades were reversely coded before all analyses, thus, higher values indicated higher levels of achievement.

Statistical Analyses

All models were conducted within the approach of structural equation modeling (Kline, 2005) and estimated by Mplus 8.0 (Muthén & Muthén, 1998-2017). The models were estimated using the robust maximum likelihood estimator (MLR) which is robust against nonnormality of the observed variables and further considers the treatment of items responded on a Likert-type scale as continuous variables (Beauducel & Herzberg, 2006; Hox, Maas, & Brinkhuis, 2010; Muthén & Muthén, 1998-2017). The data had a hierarchical (i.e., multilevel) structure as students were nested in 97 schools. Therefore, all analyses were conducted using the Mplus option “type = complex” treating schools as clustering variables. This option corrects for possible bias in standard errors resulting from the hierarchical nature of the data. Multiple imputation was applied to handle missing data. Missing data on the self-concept, intrinsic value, attainment value, and achievement measures were imputed based on the students' self-concept, intrinsic value, and attainment value ratings and achievement on previous or subsequent measurement waves, as well as on student background variables (e.g., gender, HEISI, and migration status; see Online Supplements for a full description of the imputation model). Twenty sets of imputed data were created as recommended by Enders (2010). The analyses were conducted with all twenty data sets and then combined using the formulas provided by Little and Rubin (2002). All models included correlated uniquenesses between the same items over the five measurement waves. This approach accounts for the shared method variance due to the repeated use of items (Marsh & Hau, 1996).

The analyses consisted of a series of models which were subsequently conducted with regard to math, German, and English. The series started with CFA models to examine the underlying measurement model. At each measurement wave, separate but correlated factors for self-concept, intrinsic value, and attainment value were assumed which were defined by the respective domain-specific items. These 3-factor models are configural models as the latent factors were freely derived from the manifest item indicators at each wave with no further restrictions. In a further step, longitudinal factor loading (i.e., metric) invariance was examined. For this purpose, each item indicator was assumed to have equal-sized loadings on the corresponding factor across measurement waves (Millsap, 2011; Widaman, Ferrer, & Conger, 2010). Longitudinal factor loading invariance is a prerequisite for testing longitudinal relations among factors, ensuring that the factors have the same underlying meanings across time.

Based on the models of longitudinal factor loading invariance, the analyses turned to cross-lagged panel models (Curran & Bollen, 2001; Kenny, 1975). In cross-lagged panel models, the relations among constructs are estimated across time in addition to the correlations among the disturbances of the constructs within each wave. The temporal relations among constructs tested in cross-lagged panel models include the stability of the constructs (i.e., the relation of a construct measured at an earlier point in time to the same construct measured at a later point in time) as well as the temporal relations among constructs (i.e., cross-lagged paths as the relations of one construct measured at an earlier point in time to another construct measured at a later point in time). We started with full-forward models (Marsh, Byrne, & Yeung, 1999). Full-forward models include first-order and higher-order stability and cross-lagged paths. First-order paths refer to paths between two constructs measured at two directly adjacent measurement waves (e.g., math self-concept t1 → math self-concept t2 as an example for a first-order stability path; math self-concept t t2 → math intrinsic value t3 as an example for a first-order cross-lagged path). Higher-order paths address paths between two constructs measured at two more distal waves with at least one wave in between. Hence, the paths leading from math self-concept measured at t1 to math self-concept measured at t3, t4, and t5 are examples for second-order, third-order and fourth-order stability paths, respectively. The paths leading from math self-concept measured at t1 to math intrinsic value measured at t3, t4, and t5 are examples for second-order, third-order, and fourth-order cross-lagged paths. When considering higher-order paths, it makes sense to separate between direct and total effects. Direct effects are the higher-order effects of relations between the directly considered constructs (e.g., math self-concept t1 → math self-concept t3). Total effects also encompass indirect effects as effects mediated through other variables at the intervening measurement waves (e.g., math self-concept t1 → math self-concept t2, math intrinsic value t2, math attainment value t2 → math self-concept t3).

Based on the full-forward models, we tested alternative models to increase model parsimony and to probe for the adequacy to include first-order and higher-order stability and cross-lagged paths. Therefore, we estimated models that included first-order and higher-order stability but first-order cross-lagged paths only, models that included first-order and higher-order cross-lagged paths but first-order stability only, and models that included only first-order stability and cross-lagged paths.

We compared the fits of the full-forward models with the fits of the alternative and more parsimonious models to select the final model. In the final model, we set the cross-lagged paths for the relations among constructs to invariance. As such, for instance, the relation between math self-concept at t1 and math intrinsic value at t2 was assumed to be of the same size as the relation between math self-concept at t2 (t3, t4) and math intrinsic value at t3 (t4, t5). In addition, we restricted the stability estimates to invariance across waves. For example, the relation between math self-concept at t1 and math self-concept at t2 was assumed to have the same size as the relation between math self-concept at t2 and math self-concept at t3. These invariance models allowed us to examine the robustness versus change of relations among EVT constructs across time. In addition, the invariance constraints added parsimony to the models leading to more robust and precise estimates and thereby facilitating the interpretation of results.

In a last step, we included achievement measured at t1 as a covariate. We thus estimated the relations among self-concept, intrinsic value, and attainment value in the three domains while controlling for domain-specific achievement at t1. The achievement factors were single-item factors defined by students’ school grades in the three domains, the measurement error of school grades fixed to zero.

To evaluate model fit, we followed the advice to consider a wide range of descriptive goodness-of-fit indices (e.g., Marsh, Hau, & Wen, 2004). Accordingly, we report 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). For the CFI and TLI, values above .90 and .95 represent an adequate respectively good model fit (Hu & Bentler, 1999). For the RMSEA, values should be below .05 for a close fit, or between .05 and .08 for a reasonable fit (Browne & Cudeck, 1993). Regarding the SRMR, Hu and Bentler (1999) propose values below .08 as indicative of a good model fit.

In order to compare models and to evaluate invariance, we examined the changes in the descriptive goodness-of-fit indices. According to the guidelines proposed by Cheung and Rensvold (2002; see also Chen, 2007), two models can be seen as equivalent and invariance can be assumed as long as the CFI does not drop by more than $\Delta CFI \leq -.01$. Given the various goodness-of-fit indices and their controversial cut-off criteria for model fit evaluation, researchers are recommended to simultaneously take different goodness-of-fit indices into account and to treat the respective cut-off criteria as guidelines instead of "golden rules". In addition to the inspection of a range of resulting fit indices, the final model evaluation should be based on different pieces of information including the resulting parameter estimates, statistical conformity, and theoretical adequacy of the models (Marsh, Hau, & Wen, 2004).

Results

Math

A CFA model assuming separate factors for math self-concept, math intrinsic value, and math attainment value factors at each measurement wave fitted the data well (Model 1 in Table 1).[1] Therefore, math self-concept, math intrinsic value, and math attainment value were found to constitute separate factors at each measurement wave. According to the factor correlations, math self-concept, math intrinsic value, and math attainment value were substantially positively correlated within each wave (e.g., t1: math self-concept and math intrinsic value: $r = .644$; math self-concept and math attainment value: $r = .502$; math intrinsic value and math attainment value: $r = .623$; for all $p < .05$; Table 2).

The model fit remained excellent and only displayed a negligible drop (ΔCFI = -.001) when assuming longitudinal factor loading invariance (Model 2 in Table 1), making it possible to inspect temporal relations among constructs. Based on this, we stated a full-forward cross-lagged panel model estimating the path coefficients for all relations among constructs (Table S1 of the Online Supplements). We compared the fit of the full-forward model[2] with the fits of a model including first-order and higher-order stability paths, but only first-order cross-lagged paths (Model 3; Table S1 of the Online Supplements), a model including first-order stability paths only but first-order and higher-order cross-lagged paths (Model 4), and a model including first-order stability and cross-lagged paths only (Model 5). The fit indices of Models 4 and 5 were below the fit of the full-forward model, but the fit of Model 3 was similar to the fit of the full-forward model (ΔCFI = -.002). In addition, in the full-forward model, many higher-order stability paths were statistically significant, while only two higher-order cross-lagged paths were statistically significant (Table S1 of the Online Supplements). Hence, it seemed to be warranted to keep higher-order stability paths but to drop higher-order cross-lagged paths from the model. Yet, this model (Model 3) might suffer from multicollinearity since, for instance, the relation between former intrinsic value and later attainment value was significantly negative across t2 and t3, but significantly positive across t3 and t4 (Table S1 of the Online Supplements). We tried to remedy for multicollinearity problems originating from the two value facets by constraining the paths from intrinsic value respectively attainment value to self-concept to the same value (Model 6; see Marsh, Dowson, Pietsch, & Walker, 2004). Since the CFI value of this Model 6 only declined by Δ = -.001 compared to Model 3, this model modification seemed to be permitted. Afterwards, we compared this model (Model 6) to a model (Model 7) in which the cross-lagged relations among, and the stabilities of, the constructs were set to be invariant across waves to test whether the relations among constructs changed or remained stable across time. Hence, in this Model 7, all first-order cross-lagged paths between the same constructs were set to the same value [e.g., math self-concept t1 → math intrinsic value t2 = math self-concept t2 (t3, t4) → math self-concept t3 (t4, t5)] as well as the first-order stability paths [e.g., math self-concept t1 → math self-concept t2 = math self-concept t2 (t3, t4) → math self-concept t3 (t4, t5)] and the higher-order stability paths [e.g., math self-concept t1 → math self-concept t3 = math self-concept t2 (t3) → math self-concept t4 (t5)]. Since the CFI value only declined by $\Delta = -.002$, time-invariant cross-lagged paths among, and stabilities of, the constructs could be assumed.

The resulting path coefficients of Model 7 showed substantial stability coefficients for all constructs (Table S1 of the Online Supplements). With respect to the temporal relations among self-concept and value constructs, former math self-concept was found to be positively related to later math intrinsic value across the four time lags. The reverse relation between former math intrinsic value and later math self-concept was not statistically significant. Former math self-concept also demonstrated significantly positive relations to later math attainment value, but the reverse relation between former math attainment value and later math self-concept was not significant at any time lag. With respect to the temporal relations among value constructs, former math intrinsic value showed positive relations to later math attainment value across the four time lags, but former math attainment value was not significantly related to later math intrinsic value.

This found pattern of relations remained in place when including math achievement as a covariate (Model 8 in Table 1; Figure 1). Hence, math self-concept, math intrinsic value, and math attainment value displayed high stability across time. Beyond first-order stability between consecutive time waves, the constructs showed higher-order stabilities which were partly mediated through constructs at the intervening measurement waves (see the direct and total effects for the higher-order stability estimates; Table 3). Former math self-concept was related to later math intrinsic value (t1-t2: $\beta = .121$; t2-t3: $\beta = .127$; t3-t4: $\beta = .118$; t4-t5: $\beta =$

.127; for all $p < .05$) and to later math attainment value (t1-t2: $\beta = .096$: t2-t3: $\beta = .099$; t3-t4: $\beta = .095$; t4-t5: $\beta = .099$; for all $p < .05$). In addition, former math intrinsic value was related to later math attainment value (t1-t2: $\beta = .079$: t2-t3: $\beta = .072$; t3-t4: $\beta = .067$; t4-t5: $\beta = .074$; for all $p < .05$). Math achievement at t1 was positively related to math self-concept, math intrinsic value, and math attainment value at the same wave. Math achievement at t1 was also found to be related to math self-concept, math intrinsic value, and math attainment value at later time waves. In this case, the relations between math achievement and math self-concept, math intrinsic value, and math attainment value were at least partially mediated through variables at the intervening measurement waves (see the total effects; Table 3).

German

The longitudinal CFA model including separate factors for German self-concept, German intrinsic value, and German attainment value at each measurement wave fitted the data well (Model 9 in Table 1)[3]. This finding corroborated the separation between German self-concept, German intrinsic value, and German attainment value. The factor correlations documented substantial cross-sectional correlations among constructs within waves (Table 2).

When including invariant factor loadings (Model 10 in Table 1), the CFI value only declined by $\Delta = -.001$ indicating longitudinal metric measurement invariance. Therefore, the inspection of temporal relations among constructs was feasible. A model including first-order and higher-order stability paths and first-order cross-lagged paths (Model 11) seemed to represent the data best when comparing the full-forward model[4] (see Table S2 of the Online Supplements) to alternative and more parsimonious models [i.e., a model with first-order and higher-order stability paths and first-order cross-lagged paths only (Model 11); a model with first-order stability paths only and first-order and higher-order cross-lagged paths (Model 12), and a model with first-order stability and cross-lagged paths only (Model 13)]. In fact, the fit of this model (Model 11) did not drop substantially compared to the fit of the full-forward model. In addition, the findings of the full-forward model showed that most of the higher-order stability paths, but only a few of the higher-order cross-lagged paths were statistically significant (Table S2 of the Online Supplements). To control for potential multicollinearity originating from intrinsic value and attainment value (see some theoretically implausible negative relations among constructs such as the negative relation between attainment value at t3 and self-concept at t4), the paths leading from intrinsic value to self-concept and the paths leading from attainment value to self-concept were set to invariance (Model 14). The descriptive goodness-of-fit indices of this model fit did not change compared to Model 11. In a further step, time-invariant (first-order and higher-order) stability and cross-lagged paths were included into Model 14 leading to Model 15. The model fit remained adequate as the CFI value only declined by $\Delta = -.001$ between Models 14 and 15 supporting the robustness of the relations among constructs across time. Former German intrinsic value was found to be positively related to later German self-concept, but the reverse relation was not significant. Former attainment value in German was positively related to later German self-concept and German intrinsic value, but the reverse relations were not significant (Table S2 of the Online Supplements).

The pattern of relations among EVT constructs related to the domain of German remained in place when including German achievement at t1 as a covariate (Model 16 in Table 1; Figure 1). That is, German self-concept, German intrinsic value, and German attainment value were stable across time and they showed significant first-order and higher-order stability estimates, the latter mediated through constructs at the intervening measurement waves (Table 4). Former intrinsic value was related to later self-concept (t1-t2: $\beta = .027$, t2-t3: $\beta = .024$; t3-t4: $\beta = .026$; t4-t5: $\beta = .028$; for all $p < .05$), and former attainment value was related to both later self-concept (t1-t2: $\beta = .022$; t2-t3: $\beta = .023$; t3-t4: $\beta = .024$; t4-t5: $\beta = .026$; for all $p < .05$) and later intrinsic value (t1-t2: $\beta = .089$; t2-t3: $\beta = .097$; t3-t4: $\beta = .088$; t4-t5: $\beta = .099$; for all $p < .05$). German achievement at t1 was directly and indirectly (i.e. mediated through other variables, see total effects) related to German self-concept, intrinsic value, and attainment value at the same and later measurement waves (Table 4).

English

The longitudinal CFA model including separate factors for English self-concept, English intrinsic value, and English attainment value at each measurement wave fitted the data well (Model 17 in Table 1).[5] The resulting factor correlations were substantial among English self-concept, English intrinsic value, and English attainment value within each wave (Table 2).

The inclusion of invariant factor loadings (Model 18 in Table 1) only led to a decrease of ΔCFI = -.001 attesting longitudinal measurement invariance and allowing the examination of temporal relations among constructs. To this aim, we first stated a full-forward cross-lagged panel model (Table S3 of the Online Supplements). The fit of the full-forward model[6] was similar to the fit of a model (Model 19) including first-order and higher-order stability paths but only first-order cross-lagged paths. Since many of the higher-order stability paths were statistically significant but none of the higher-order cross-lagged paths in the full-forward model, we kept Model 19 for further analyses (see also Table S3 of the Online Supplements). As done with the models for math and German, we constrained the paths leading from intrinsic value to self-concept and from attainment value to self-concept to invariance in order to control for potential multicollinearity originating from the two value facets. The descriptive goodness-of-fit indices of this Model 22 remained stable relative to the fit indices of Model 19, except for a decline of Δ = -.001 in the TLI value. The model also did not change substantially when including time-invariant (first-order and higher-order) stability paths and time-invariant cross-lagged paths (Model 23). In this model (Model 23), former English self-concept was found to be positively related to later intrinsic value and attainment value in English. Negative relations appeared between former intrinsic value and later attainment value (Table S3 of the Online Supplements).

This pattern of relations remained unchanged when including English achievement measured at t1 as a covariate (Model 24 in Table 1; Figure 1). In fact, beyond the substantial first-order and higher-order stabilities of English self-concept, English intrinsic value, and English attainment value, former English self-concept was positively related to later English intrinsic value (t1-t2: $\beta = .145$, t2-t3: $\beta = .154$; t3-t4: $\beta = .162$; t4-t5: $\beta =.108$; for all $p < .05$) and English attainment value (t1-t2: $\beta = .108$, t2-t3: $\beta = .111$; t3-t4: $\beta = .125$; t4-t5: $\beta =.118$; for all $p < .05$). Former intrinsic value had negative relations to later attainment value (t1-t2: $\beta = -.070$, t2-t3: $\beta = -.069$; t3-t4: $\beta = -.072$; t4-t5: $\beta = -.068$; for all $p < .05$). English achievement at t1 showed positive relations to self-concept, intrinsic value, and attainment value at the same and later waves, the latter relations mainly being mediated through other constructs at the intervening waves (Table 5).

Discussion

This study focused on the longitudinal relations among academic self-concept and two value facets, that is, intrinsic value and attainment value, in three domains (math, German, and English) with secondary school students in Germany. Thereby, the study adds considerably to existing research on the longitudinal relations among EVT components. So far, respective studies remained restricted to intrinsic value as one subcomponent of value beliefs (Marsh et al., 2005; Lauermann et al., 2017; Nurmi & Aunola, 2005; Skaalvik & Valas, 1999; Spinath & Spinath, 2005; Spinath & Steinmayr, 2008), considered only one domain masking domain-specific findings (Marsh et al., 2005; Spinath & Spinath, 2005), or included only two measurement waves concealing long-term effects (Marsh et al., 2005; Skaalvik & Valas, 1999).

Relations between Academic Self-concept and Value Facets

In summary, substantial cross-sectional relations between academic self-concept and value were demonstrated when considering both intrinsic value and attainment value, irrespective of the domain considered. Findings from previous studies on the interrelations among EVT constructs were therefore replicated (Conley, 2012; Denissen et al., 2007; Durik et al., 2006; Fredricks & Eccles, 2002; Guo, Marsh, Parker et al., 2015; Guo, Parker, Marsh et al., 2015; Trautwein et al., 2012).

Regarding the temporal relations, former academic self-concept was found to be positively related to later intrinsic value in math and English. That is, higher levels of academic self-concept contributed to higher levels of intrinsic value in these domains. This finding is well aligned with the hypothesis that students tend to like only those domains in which they feel competent (Bandura, 1997; Deci & Ryan, 2000; Harter, 1987; Wigfield & Eccles, 2002). In addition, our study thus replicated empirical findings showing positive longitudinal relations between former self-concept and later interest (Jacobs et al., 2002; Lauermann et al., 2017; Marsh et al., 2005). Yet, for the German domain, there was no significant relation between former self-concept and later intrinsic value, but the findings revealed the reverse relation between former intrinsic value and later self-concept. This finding points to the domain specificity of relations among EVT-related constructs and might originate from the specific characteristics of math, German, and English. The relation between former intrinsic value and later self-concept in German might be mediated by further factors. For example, higher levels of intrinsic value might enhance students' engagement, effort, and time invested which might then bolster students' achievement and self-perceived competence (Vallerand & Bissonnette, 1992; Walker, Greene, & Mansell, 2006). The explanation of the found relation between former intrinsic value and later self-concept in German but not in math and English is a direction for future research.

When examining the relations between self-concept and attainment value, former self-concept was found to be positively related to later attainment value in math and English. Hence, in math and English, students seem to attach high levels of subjective relevance when they already have high levels of self-perceived competence. In other words, if individuals perceive themselves as being competent in a specific domain, this perception strengthens the subjective belief that it is important to be competent in this domain. However, former self-concept was not significantly related to later attainment value in German, but here, former attainment value was related to later self-concept, again illustrating the domain specificity of the findings. The positive relation between former attainment value and later self-concept in German is hard to explain in the first place but might be again due to the operation of mediating variables. For instance, high levels of perceived relevance (i.e., attainment value) of a specific domain might boost students' engagement and effort in this domain which enhances students' achievement and in turn students' self-perceived competence, that is, self-concept.

Relations among Value Facets

Since the present longitudinal study included two value facets (i.e., intrinsic value and attainment value), it offered insight into the longitudinal relations among them. It thus expands on previous research which has so far predominantly investigated cross-sectional relations among value facets (Conley, 2012; Gaspard, Dicke, Flunger, Schreier et al., 2015; Trautwein et al., 2012). Since theoretical models are insufficient and given the lack of empirical evidence, we treated this research question mainly as exploratory although positive reciprocal relations seem to be conceivable. Yet, reciprocal relations were not found in any domain considered here. The results rather differed between the math, German, and English domains. In math, former intrinsic value was positively related to later attainment value. Hence, in math, students' felt interest and enjoyment boosted students' perceived relevance. In German, however, the reverse relation was found since former attainment value was positively related to later intrinsic value. Hence, higher levels of relevance contributed to higher levels of interest and enjoyment. In English, former intrinsic value was negatively related to later attainment value. Given the positive cross-sectional relations between intrinsic value and attainment value and their common underlying core as subfacets of the overarching EVT value component, this negative relation is surprising and hard to explain. It could result from a multicollinearity problem. Hence, we propose to treat this finding with caution and outline the need for future studies. In general, given the domain-specific findings for the longitudinal relations among value facets, we would like to note the need for more advanced theoretical considerations to understand the development of values in academic settings which take the specificity and idiosyncrasies of different academic domains into account.

Developmental Differences

The findings argue for the adequacy of highly restrictive models in which the longitudinal relations among self-concept, intrinsic value, and attainment value are invariant across grades 5 to 9. This finding applied to all three domains considered (math, German, and English). The findings thus indicated robustness of the relations among motivational constructs across a long time span covering the years of mandatory secondary education in Germany. This conclusion brings other studies to mind which indicated developmental equilibrium, that is, the absence of time-varying differences in the relation between academic self-concept and achievement (Arens, Marsh et al., 2017; Marsh et al. 2017), or in the relation between self-efficacy beliefs and behaviors (Davis-Kean et al., 2008; see also Marshall, Parker, Ciarrochi, & Heaven, 2014). The findings yet do not support the assumption of a specialization process, according to which the cross-sectional and longitudinal linkages among motivational facets would become stronger across secondary school years.

Domain Specificity

In general, our findings underscore the relevance of domain-specific approaches rather than studying the academic domain in general (Spinath & Spinath, 2005) or one domain only (Marsh et al., 2005) since the longitudinal relations among self-concept, intrinsic value, and attainment value varied across the three domains studied (i.e., math, German, and English). Some similarities could be found for math and English. In both domains, former self-concept was positively related to later intrinsic value and attainment value. In the German domain, in contrast, these two directions of influence (i.e., former self-concept led to later intrinsic value and attainment value) were not significant, but the reverse relations were found to be significant – that is, former intrinsic value and former attainment value led to later self-concept – , which were yet not significant in math. Hence, while in math and English, former students' self-perceptions of competence (i.e., self-concept) seem to impact upon their value perceptions in terms of intrinsic and attainment values, in German, students' later self-perception of competence (i.e., self-concept) was impacted by their former value perceptions (intrinsic value and attainment value). Math and first foreign languages (i.e., English in the present study) are perceived as defined, homogenous, sequential, and static school subjects (Stodolsky & Grossmann, 1995). Hence, students might deem the feedback they receive to be highly informative about their own domain-specific abilities in these school subjects. This in turn might facilitate the formation of academic self-concepts then impacting upon students' intrinsic value and attainment value in the math and English domains. This underscores the importance of students' self-perceptions of competence for the development of value perceptions. One might also surmise a self-protection strategy. Students consider their math achievement as a valid indicator of their own cognitive ability (Hannover & Kessels, 2004). In consequence, students are only inclined to assign value to the math domain when feeling competent in this domain. Yet, this line of thought is speculative and needs further elaboration and investigation.

In the German domain, students might be confronted with feedback from different sources inside and outside the school context and related to different language skills (e.g., listening, reading, speaking, writing), making the academic self-concept formation more difficult in this domain (see also Arens & Jansen, 2016; Schmidt et al., 2017). Hence, German self-concept might be less influential on intrinsic value and attainment value in German, but might instead rely itself on value perceptions. In other words, intrinsic value and attainment value might themselves be a source of German self-concept. Previous studies demonstrated a stronger use of social comparisons (i.e., comparing one's achievement with the achievement of others) and dimensional comparisons (i.e., comparing one's achievement across domains) for self-concept formation in math than in the verbal domain of students' language of instruction (Arens, Becker, & Möller, 2017; Möller, Pohlmann, Köller, & Marsh, 2009; Schurtz, Pfost, Nagengast, & Artelt, 2014). Hence, the formation of German self-concept seems to be more volatile and to include a broader variety of determinants, including value perceptions as found in the present study. From the perspective of value development, academic self-concept takes on a less influential role in the formation of intrinsic value and attainment value granting the value facets more impact on academic self-concept themselves.

In sum, more research seems to be necessary to explain the domain specificity of findings regarding the relations among EVT constructs. In this context, it might be worthwhile to pursue qualitative studies including students' reports on their perceived (dis)similarities of subjects (e.g., Helm, Müller-Kalthoff, Nagy, & Möller, 2016) and students' disclosure of relations between motivational constructs within and across domains.

Achievement as a Covariate

The relations among self-concept, intrinsic value, and attainment value remained in place when controlling for students' achievement. Students' achievement demonstrated substantial relations to academic self-concept, intrinsic value, and attainment value measured at the same wave (i.e., t1) in all three domains (math, German, English). In addition, in all three domains, achievement assessed at the first measurement wave demonstrated a direct long-term effect on academic self-concept measured at the later waves, but achievement had no long-term effects on intrinsic value and attainment value. Yet, the significant total effects indicate that there seem to be long-term achievement effects mediated through other variables on all three motivational constructs (i.e., self-concept, intrinsic value, and attainment value) in all three domains.

Practical Implications

Our findings on the temporal relations among academic self-concept, intrinsic value, and attainment value entail practical implications. Given the domain-specific nature of findings, interventions targeting the enhancement of students' academic self-concept (Brisson et al., 2017; O'Mara, Marsh, Craven, & Debus, 2006) or value beliefs (Gaspard, Dicke, Flunger, Brisson et al., 2015; Hulleman & Harackiewicz, 2009; Hulleman, Kosovich, Barron, & Daniel, 2017) should be domain-specific in nature. An intervention approach addressing students' motivation in math might not have the same effects on students' motivation in other domains (see for example Gaspard et al., 2016).

Since academic self-concept was found to be related to later intrinsic value and to later attainment value in math and English, a specific focus should lie on effective self-concept enhancement programs (O'Mara et al., 2006; O'Mara, Green, & Marsh, 2006). A combination of internally focused performance feedback and attributional feedback has been found to be effective in enhancing students' academic self-concept (Craven, Marsh, & Debus, 1991). For German, the findings documented a positive relation between former intrinsic value and later self-concept, so teachers and educators should aim to foster students' intrinsic value through interest promotion in instruction (see for example, Renninger, 2009; Rotgans & Schmidt, 2011), which in turn should boost students' academic self-concept. In addition, given the positive relation between former attainment value and later self-concept in German, facilitating students' subjective importance of being good at German might help enhance students' German self-concept.

Limitations and Directions for Future Research

Despite its strengths, our study faces some shortcomings which should be addressed by future studies. This longitudinal study is characterized by a relatively long time span covering five consecutive school years and students' mandatory secondary education in Germany (grades 5 to 9). It is necessary to test the findings with respect to the generalizability to other age groups like elementary school students who might differ in their cognitive abilities for self-perceptions (Harter, 1999). Another interesting line of research would be to investigate the longitudinal relations among motivation constructs across the transition from elementary to secondary school. Previous studies documented a decline in the mean levels of students' motivation (Eccles et al., 1993; Wigfield, Eccles, MacIver, Reuman, & Midgley, 1991). Hence, examining the longitudinal relations among motivational constructs during the transition period might deliver insights into whether the relations vary according to specific incidents in students' school careers. Beyond studying the robustness of findings across students' ages and school years, it might be generally worthwhile to study the generalizability of our findings across a range of student characteristics such as gender[7], SES, or cultures.

The relevant constructs were assessed annually in our study. A challenging question refers to the optimal time lag between consecutive measurement waves. Too short time lags might inflate the stability of the considered constructs concealing relations among constructs, but too long time lags might undermine both the stability and cross-lagged relations among constructs (Marsh et al., 1999). Hence, the design of the present study might be adequate to unveil temporal relations among constructs. Yet, researchers should examine whether the patterns of findings on the relations among EVT constructs vary contingent upon the time lag considered. In this context, rather than only focusing on long-term relations, it might be also interesting to link the framework of the present study to studies on the short-term development of EVT components (Kosovich, Flake, & Hulleman, 2017) and to research on students' motivation in specific actual situations such as test taking (Knekta, & Eklöf, 2015).

We realized a variable-centered approach in our study. Alternatively, future research might benefit from person-centered approaches (Laursen & Hoff, 2006; Rosenzweig & Wigfield, 2017). It would thus be possible to detect whether students can be clustered within groups which differ from each other in the pattern, size, and stability of temporal relations among expectancy and value facets. In addition, we considered only student reports which might be affected by response biases such as acquiescence or social desirability.

In our study, the expectancy component of EVT was operationalized as students' academic self-concept. This approach has been pursued in other recent studies (e.g., Guo et al., 2017; Guo, Marsh, Morin et al., 2015; Guo, Marsh, Parker et al., 2015; Nagengast et al., 2011; Trautwein et al., 2012). Originally, the expectancy component was assumed to encompass students' expectancies for success as well as ability beliefs (Eccles & Wigfield, 1995). However, since ability beliefs and expectancies for success were found to be empirically inseparable and to form a single factor (Eccles et al., 1993; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000), researchers have restricted the operationalization of the expectancy component to academic self-concept. Yet, ability beliefs and expectancies for success might still present distinct constructs. While ability beliefs address individuals' general self-evaluations of their competences in a specific domain (i.e., academic self-concept; Marsh & Craven, 2006), expectancies for success are future-oriented and ask for individuals' expectancies to successfully complete specific upcoming tasks. Hence, beyond academic self-concept, the expectancy component might also encompass academic self-efficacy defined as students' self-perceived confidence to successfully perform future tasks (Bandura, 1997; Zimmerman, 2000). Self-concept and self-efficacy have been found to be theoretically and empirically distinguishable (Bong & Skaalvik, 2003; Jansen, Scherer, & Schoeders, 2015; Lee, 2009; Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014). Hence, the expectancy component of EVT might be operationalized by combining self-concept and self-efficacy scales or items [see for example Rosenzweig and Wigfield (2017) who used self-efficacy items to operationalize the expectancy component of EVT]. Nonetheless, even a combination of self-concept and self-efficacy scales or items might not be adequate as the self-concept and self-efficacy constructs might not be identical with the actual EVT expectancy component. It might be more appropriate to adhere to the original construct of the expectancy component as formulated in EVT, to retain the theoretical differentiation between ability beliefs and expectancies for success, and to use separate measures for both constructs which are particularly designed within the EVT framework (Dietrich, Viljaranta, Moeller, & Kracke, 2017).

The present study integrated intrinsic value and attainment value as two value facets. We thus considered the recently found separation of value components (Dever, 2016; Gaspard, Dicke, Flunger, Schreier et al., 2015; Penk & Schipolowski, 2015; Schoor, 2016). Our study therefore differs from earlier studies that solely focused on single value facets (e.g., Eccles et al., 1989; Pinxten, Marsh, De Fraine, Van Den Noortgate, & Van Damme, 2014), used combined subscales (e.g. "usefulness-importance" merging attainment value and utility value; Durik et al., 2006; Watt et al., 2012; Wigfield et al., 1997), or applied a global value factor (Jacobs et al., 2002; Simzar, Martinez, Rutherford, Domina, & Conley, 2015). However, given the nature of the BiKS data used for secondary analyses, we could only use two value facets, that is, intrinsic value and attainment value. Although the inspection of relations between intrinsic value and attainment value might be particularly interesting owing to their shared "intrinsic" aspects (Wigfield & Eccles, 2002), future studies should include all four value facets proposed by EVT (i.e., intrinsic value, attainment value, utility value, and cost) (see for example Conley, 2012; Dever, 2016; Trautwein et al., 2012; Wigfield & Eccles, 2000), or an even more fine-grained differentiation of value facets (Gaspard, Dicke, Flunger, Schreier et al., 2015). Respective studies would offer a more complete picture of cross-sectional and temporal relations among different value facets as well as of their possibly differential relations to academic self-concept.

Finally, the analyses relied on separate models for the math, German, and English domains. In future studies, more complex models could be stated which simultaneously include the motivational constructs related to all three domains to study temporal cross-domain relations among the motivational constructs.[8] As a theoretical framework for respective cross-domain analyses, EVT and dimensional comparison theory (DCT; Möller & Marsh, 2013) could be combined. DCT addresses the phenomenon of dimensional comparisons where students compare their own characteristics across domains, this comparison bearing influence on outcomes related to these domains. In the context of examining the relations among EVT constructs across domains, self-concept and value facets related to one domain may impact on self-concept and value facets related to another domain. Yet, it has been so far unclear whether and how domain-specific competence and value self-perceptions influence each other across domains since most of the research on dimensional comparisons targets the comparison of domain-specific achievements (Möller et al., 2009). Hence, theoretical approaches are needed to formulate assumptions regarding relations among EVT constructs across domains.

Future studies would also benefit from including outcome variables such as achievement, course choices, or aspirations. The expectancy and value components as stated in EVT have been found to be separately and jointly (i.e., interactively) related to these important educational outcomes (Chow, Eccles, & Salmela-Aro, 2012; Durik et al., 2006; Guo, Marsh, Morin et al. 2015; Simpkins, Davis-Kean, & Eccles, 2006; Watt et al., 2012). Research on EVT might benefit from examining temporal relations between the expectancy and value components and a variety of outcome variables within and across different domains.

Conclusion

In line with EVT, we found positive cross-sectional relations between expectancy (operationalized as academic self-concept), intrinsic value, and attainment value in the domains of math, German, and English. The longitudinal relations among the EVT constructs varied by domain revealing some similarities for math and English, and different findings for German. The pattern of domain-specific longitudinal relations among self-concept, intrinsic value, and attainment value was found to be robust across five measurement waves and when controlling for students' domain-specific achievements. Yet, EVT in its current state offers no fully developed theoretical statements for longitudinal relations among the various motivational constructs and cannot account for our findings. Therefore, research on motivation in education would need to further develop EVT to better inform longitudinal empirical research on motivational development.

Footnotes

[1] In order to examine the differentiation between intrinsic value and attainment value, we compared the 3-factor model (i.e., separate factors for self-concept, intrinsic value, and attainment value in math at each measurement wave) with a 2-factor model. The 2-factor model assumed one math self-concept factor and one global math value factor at each wave, the latter defined by the items referring to intrinsic value and attainment value. The fit of the 2-factor model was inferior to that of the 3-factor model: $\chi^2(445) = 8684.393$; CFI = .875; TLI = .833; RMSEA = .094.

[2] The fit of the full-forward cross-lagged panel model was equivalent to the fit of Model 2 (i.e., the 3-factor CFA model with invariant factor loadings across time) because both models were statistically equivalent. In the full-forward model, the factor correlations were only replaced by regression paths for all relations among constructs.

[3] This 3-factor model (i.e., separate factors for self-concept, intrinsic value, and attainment value in German at each measurement wave) was compared to a 2-factor model. The 2-factor model assumed one German self-concept factor and one global German value factor at each wave, the latter defined by the items referring to intrinsic value and attainment value. The fit of the 2-factor model was inferior to the fit of the 3-factor model: $\chi^2(445) = 6042.478$; CFI = .885; TLI = .846; RMSEA = .077.

[4] The fit of the full-forward cross-lagged panel model was the same as the fit for the CFA model including invariant factor loadings (Model 10 in Table 1) as the factor correlations were only replaced by regression coefficients for all relations among constructs.

[5] We compared the 3-factor CFA model with a 2-factor CFA model in order to test the separation between intrinsic value and attainment value. In the 2-factor CFA model, we assumed a factor for English self-concept and a factor for English value at each wave, the

latter defined by the items referring to both intrinsic value and attainment value. The fit of the 2-factor model [$\chi^2(445) = 5663.906$; CFI = .908; TLI = .877; RMSEA = .074)] was inferior to the fit of the 3-factor model.

[6] The fit of the full-forward model was equivalent to the fit of the 3-factor CFA model with invariant factor loadings across time (Model 18 in Table 1) as the factor correlations were only replaced by path coefficients for all relations among constructs.

[7] Supplementary analyses documented gender invariance of our findings (see Table S4 of the Online Supplements). The results from the invariance tests revealed that the temporal relations among self-concept, intrinsic value, and attainment value related to math, German, and English did not differ between boys and girls. In addition, supplementary analyses showed the invariance of our findings across secondary school tracks (see Table S5 of the Online Supplements).

[8] See Table S6 of the Online Supplements for the factor correlations among self-concept, intrinsic value, and attainment value in each of the three domains (math, German, and English) at each of the five waves.

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Table 1

Goodness-of-fit Indices

Model		χ^2	df	CFI	TLI	RMSEA
	Math					
1	Separate factors for self-concept, intrinsic value, and attainment value at each measurement point; free factor loadings across time	2246.855	385	.972	.956	.048
2	Separate factors for self-concept, intrinsic value, and attainment value at each measurement point; invariant factor loadings across time	2288.078	401	.971	.957	.047
3	Cross-lagged panel model, first-order and higher-order stability paths and first-order cross-lagged paths	2504.785	437	.969	.957	.047
4	Cross-lagged panel model, first-order and higher-order cross-lagged paths and first-order stability paths	2948.814	419	.962	.945	.053
5	Cross-lagged panel model, first order stability and cross-lagged paths	3202.680	455	.958	.945	.053
6	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity	2523.682	441	.968	.957	.047
7	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time	2733.020	474	.966	.957	.047
8	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate	2842.375	494	.965	.955	.047
	German					
9	Separate factors for self-concept, intrinsic value, and attainment value at each measurement point; free factor loadings across time	2343.212	385	.960	.938	.049
10	Separate factors for self-concept, intrinsic value, and attainment value at each measurement point; invariant factor loadings across time	2404.441	401	.959	.939	.049
11	Cross-lagged panel model, first-order and higher-order stability paths and first-order cross-lagged paths	2651.355	437	.954	.938	.049
12	Cross-lagged panel model, first-order and higher-order cross-lagged paths and first-order stability paths	2980.316	419	.947	.925	.054
13	Cross-lagged panel model, first order stability and cross-lagged paths	3321.402	455	.941	.923	.055
14	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity	2669.444	441	.954	.938	.049

continued

Table 1 (continued)

		χ^2	df	CFI	TLI	RMSEA
15	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time	2865.857	474	.951	.938	.049
16	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate	3014.756	494	.949	.935	.049
	English					
17	Separate factors for self-concept, intrinsic value, and attainment value at each measurement point; free factor loadings across time	2596.113	385	.961	.940	.052
18	Separate factors for self-concept, intrinsic value, and attainment value at each measurement point; invariant factor loadings across time	2671.230	401	.960	.940	.052
19	Cross-lagged panel model, first-order and higher-order stability paths and first-order cross-lagged paths	2860.114	437	.957	.942	.051
20	Cross-lagged panel model, first-order and higher-order cross-lagged paths and first-order stability paths	3123.073	419	.952	.932	.055
21	Cross-lagged panel model, first order stability and cross-lagged paths	3373.711	455	.948	.933	.055
22	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity	2894.694	441	.957	.941	.051
23	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time	3057.442	474	.954	.943	.051
24	Cross-lagged panel model, higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate	3178.446	494	.953	.940	.051

Note. All models are estimated with the Robust Maximum Likelihood (MLR) estimator; all χ^2 are significant ($p < .05$). The models with separate factors for self-concept, intrinsic value, and attainment value at each measurement point and invariant factor loadings across time (Models 2, 10, and 18) are statistically equivalent to full-forward cross-lagged panel models and thus have the same fit indices.

CFA = confirmatory factor analyses; CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

Table 2

Standardized Factor Correlations

	ASC t1	INT t1	ATT t1	ASC t2	INT t2	ATT t2	ASC t3	INT t3	ATT t3	ASC t4	INT t4	ATT t4	ASC t5	INT t5
INT t1	.644/ .596/ .654													
ATT t1	.502/ .530/ .628	.623/ .733/ .743												
ASC t2	.646/ .530/ .561	.443/ .327/ .392	.319/ .311/ .370											
INT t2	.438/ .285/ .378	.541/ .428/ .483	.330/ .319/ .348	.669/ .507/ .674										
ATT t2	.364/ .228/ .368	.412/ .348/ .363	.442/ .405/ .453	.531/ .460/ .626	.699/ .742/ .745									
ASC t3	.518/ .391/ .469	.352/ .249 .321	.294/ .218/ .300	.628/ .554/ .612	.432/ .334/ .399	.339/ .277/ .381								
INT t3	.339/ .159/ .279	.380/ .250/ .296	.271/ .181/ .222	.419/ .271/ .430	.538/ .418/ .498	.404/ .353/ .407	.624/ .506/ .610							
ATT t3	.299/ .157/ .229	.271/ .239/ .210	.370/ .317/ .316	.341/ .303/ .343	.352/ .391/ .319	.528/ .529/ .513	.491/ .443/ .515	.610/ .669/ .680						
ASC t4	.442/ .385/ .413	.304/ .191/ .245	.276/ .173/ .306	.520/ .433/ .535	.359/ .200/ .314	.287/ .180/ .338	.671/ .599/ .712	.444/ .330/ .444	.335/ .231/ .437					
INT t4	.289/ .146/ .220	.380/ .273/ .313	.277/ .238/ .255	.361/ .156/ .373	.459/ .370/ .404	.396/ .365/ .326	.413/ .213/ .469	.516/ .449/ .601	.371/ .312/ .421	.642/ .414/ .580				
ATT t4	.197/ .179/ .215	.266/ .234/ .234	.346/ .368/ .328	.327/ .223/ .340	.400/ .219/ .237	.485/ .438/ .404	.324/ .227/ .448	.407/ .365/ .418	.495/ .509/ .607	.519/ .396/ .567	.663/ .651/ .625			
ASC t5	.401/ .347 .396	.281/ .196/ .270	.215/ .214/ .276	.500/ .393/ .532	.321/ .239/ .293	.250/ .207/ .303	.595/ .537/ .664	.365/ .269/ .388	.234/ .233/ .349	.672/ .671/ .770	.454/ .319/ .418	.337/ .337/ .480		
INT t5	.317/ .145/ .220	.323/ .208/ .294	.269/ .200/ .227	.347/ .182/ .298	.412/ .289/ .325	.292/ .237/ .294	.425/ .263/ .415	.524/ .490/ .512	.275/ .375/ .381	.519/ .260/ .453	.640/ .493/ .507	.437/ .466/ .403	.716/ .498/ .614	
ATT t5	.266/ .109/ .207	.280/ .205/ .238	.319/ .238/ .262	.325/ .178/ .267	.355/ .287/ .192	.377/ .390/ .357	.345/ .271/ .337	.407/ .395/ .340	.406/ .488/ .491	.440/ .229/ .384	.509/ .307/ .318	.566/ .555/ .580	.577/ .416/ .537	.649/ .664/ .690

Note. ASC = academic self-concept, INT = intrinsic value, ATT = attainment value. The first coefficient refers to the model for math (Model 1 in Table 1), the second coefficient refer to the model for German (Model 9 in Table 1), and the third coefficient refers to the model for English (Model 17 in Table 1). All factor correlations are statistically significant with $p < .05$.

Table 3

Standardized Parameters Estimates for Math (Model 8 in Table 1)

Stability		Self-concept	Intrinsic value	Attainment value
t1-t2		.529*	.402*	.322*
t2-t3		.535*	.374*	.336*
t1-t3				
	Direct	.121*	.171*	.179*
	Total	.406*	.325*	.291*
t3-t4		.520*	.337*	.317*
t2-t4				
	Direct	.119*	.143*	.176*
	Total	.400*	.272*	.285*
t1-t4				
	Direct	.113*	.111*	.082*
	Total	.389*	.281*	.232*
t4-t5		.514*	.380*	.338*
t3-t5				
	Direct	.114*	.146*	.177*
	Total	.384*	.277*	.287*
t2-t5				
	Direct	.110*	.104*	.085*
	Total	.378*	.265*	.243*
t1-t5				
	Direct	.021	.025	.041
	Total	.327*	.224*	.200*

Cross-lagged paths	Self-concept → intrinsic value	Intrinsic value → self-concept	Self-concept → attainment value	Attainment value → self-concept	Intrinsic value → attainment value	Attainment value → intrinsic value
t1-t2	.121*	.010	.096*	.010	.079*	.023
t2-t3	.127*	.009	.099*	.011	.072*	.025
t3-t4	.118*	.009	.095*	.010	.067*	.022
t4-t5	.127*	.009	.099*	.010	.074*	.025

Correlations	Self-concept ↔ intrinsic value	Self-concept ↔ attainment value	Intrinsic Value ↔ attainment value
t1	.624*	.482*	.604*
t2	.593*	.448*	.643*
t3	.548*	.395*	.550*
t4	.577*	.477*	.573*
t5	.663*	.495*	.521*

Covariates	Outcome: Self-concept	Outcome: Intrinsic value	Outcome: Attainment value
Achievement t1 → outcome t1/t2/t3/t4/t5	.446*/.150*/.081*/.042*/.015	.214*/.032/-.047/-.011/.029	.177*/.030/.019/-.097*/-.013
Total effects: Achievement t1 → outcome t2/t3/t4/t5	.390*/.347*/.322*/.274*	.176*/.108*/.119*/.155*	.147*/.151*/.032/.085*

Note. * $p < .05$.

Table 4

Standardized Parameters Estimates for German (Model 16 in Table 1)

Stability		Self-concept	Intrinsic value	Attainment value
t1-t2		.458*	.309*	.399*
t2-t3		.432*	.294*	.449*
t1-t3				
	Direct	.118*	.203*	.160*
	Total	.315*	.293*	.339 *
t3-t4		.485*	.276*	.422*
t2-t4				
	Direct	.125*	.182*	.169*
	Total	.335*	.262*	.358*
t1-t4				
	Direct	.068*	.090*	.150*
	Total	.279*	.227*	.360*
t4-t5		.473*	.320*	.420*
t3-t5				
	Direct	.137*	.198*	.159*
	Total	.367*	.286*	.336*
t2-t5				
	Direct	.071*	.093*	.157*
	Total	.288*	.234*	.379 *
t1-t5				
	Direct	.076	.004	-.039
	Total	.284*	.163*	.228*

Cross-lagged paths	Self-concept → intrinsic value	Intrinsic value → self-concept	Self-concept → attainment value	Attainment value → self-concept	Intrinsic value → attainment value	Attainment value → intrinsic value
t1-t2	-.004	.027*	.006	.022*	-.008	.089*
t2-t3	-.004	.024*	.006	.023*	-.008	.097*
t3-t4	-.004	.026*	.006	.024*	-.008	.088*
t4-t5	-.004	.028*	.006	.026*	-.008	.099*

Correlations	Self-concept ↔ intrinsic value	Self-concept ↔ attainment value	Intrinsic Value ↔ attainment value
t1	.583*	.523*	.725*
t2	.458*	.429*	.721*
t3	.460*	.390*	.637*
t4	.430*	.419*	.625*
t5	.473*	.361*	.588*

Covariates	Outcome: Self-concept	Outcome: Intrinsic value	Outcome: Attainment value
Achievement t1 → outcome t1/t2/t3/t4/t5	.347*/.132*/.117*/.118*/.009	.155*/0.056/.003/-.046/.043	.128*/.005/.022/-.043/.069
Total effects: Achievement t1 → outcome t2/t3/t4/t5	.298*/.290*/.323*/.250*	.114*/.072*/.014/.073	.057*/.069*/.016/.092*

Note. * $p < .05$.

Table 5

Standardized Parameters Estimates for English (Model 24 in Table 1)

Stability		Self-concept		Intrinsic value		Attainment value	
t1-t2		.531*		.376*		.425*	
t2-t3		.524*		.381 *		.455*	
t1-t3							
	Direct	.147*		.138*		.107*	
	Total	.428*		.284*		.302*	
t3-t4		.548*		.375*		.488*	
t2-t4							
	Direct	.152*		.138*		.123*	
	Total	.441*		.283*		.347*	
t1-t4							
	Direct	.114*		.103*		.097*	
	Total	.431*		.263*		.298*	
t4-t5		.548*		.357*		.432*	
t3-t5							
	Direct	.159*		.129*		.117*	
	Total	.462*		.265*		.330*	
t2-t5							
	Direct	.118*		.098*		.099*	
	Total	.444*		.250*		.303*	
t1-t5							
	Direct	.026		.034		.026	
	Total	.395*		.203*		.234*	
Cross-lagged paths		Self-concept → intrinsic value	Intrinsic value → self-concept	Self-concept → attainment value	Attainment value → self-concept	Intrinsic value → attainment value	Attainment value → intrinsic value
t1-t2		.145*	.008	.108*	.007	-.070*	-.009
t2-t3		.154*	.007	.111*	.007	-.069*	-.010
t3-t4		.162*	.007	.125*	.007	-.072*	-.010
t4-t5		.108*	.007	.118*	.007	-.068*	-.009
Correlations		Self-concept ↔ intrinsic value		Self-concept ↔ attainment value		Intrinsic Value ↔ attainment value	
t1		.646 *		.612*		.734*	
t2		.622*		.558*		.723*	
t3		.523*		.460*		.685*	
t4		.454*		.421*		.604*	
t5		.531*		.449*		.693*	
Covariates		Outcome: Self-concept		Outcome: Intrinsic value		Outcome: Attainment value	
Achievement t1 → outcome t1/t2/t3/t4/t5		.444*/.115*/.092*/-.022/.036		.197*/.036/-.017/-.064/-.018		.224*/.068*/.017/-.013/.022	
Total effects: Achievement t1 → outcome t2/t3/t4/t5		.354*/.346*/.274*/.296*		.172*/.128*/.082/.093*		.197*/.158*/.144*/.154*	

Note. * $p < .05$.

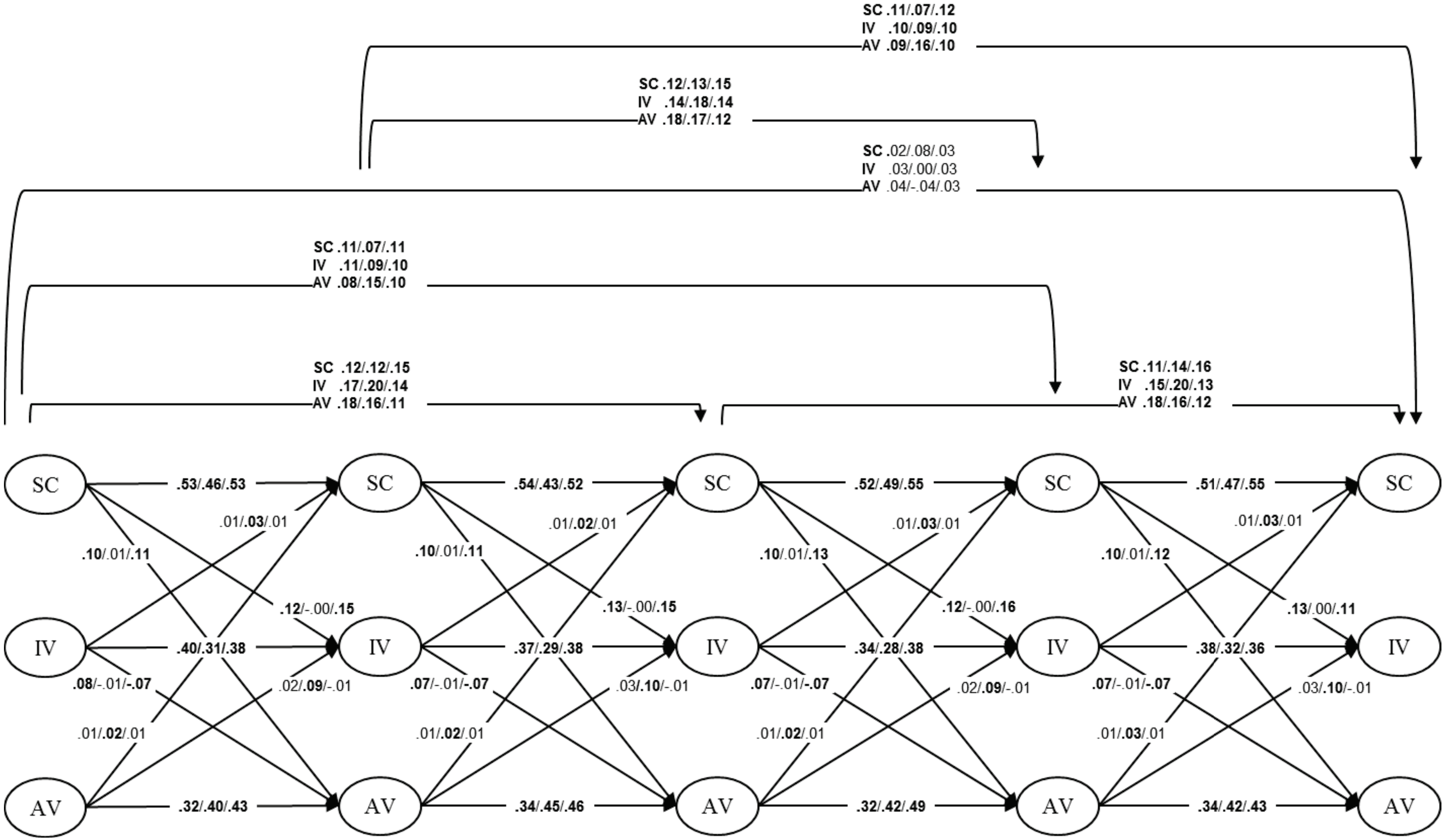

Figure 1. Results from the Cross-lagged Panel Models

Note. SC = Self-concept. IV = Intrinsic value. AV = Attainment value. Standardized parameters are shown for math/German/English; within each wave, the residuals of the constructs were allowed to correlate. All models included achievement measured at t1 as a covariate (for corresponding results, see Tables 3 to 5). Only direct stability paths are presented here; for the total effects, see Tables 3 to 5. Bold print $p < .05$.

Online Supplements to

Longitudinal Relations among Self-concept, Intrinsic Value, and Attainment Value across Secondary School Years in Three Academic Domains

Description of the Imputation Model

The imputation model used in the present analyses to estimate plausible values on the self-concept, intrinsic value, and attainment value measures as well on the achievement measures related to math, German, and English contained a variety of auxiliary variables. First, we used the students' ratings on self-concept, intrinsic value, and attainment value at the five measurement waves. Second, we used students' achievement. Here, we applied all available achievement indicators when the students attended grades 4 and 5. In grade 4, test scores related to reading, spelling/orthography, vocabulary, logical thinking, and math were available and included in the imputation model. In addition, teacher reported school grades in math and German were considered. In grade 5 (i.e., t1 of the present study), test scores related to English, reading, vocabulary, logical thinking, and math were available and included in the imputation model. In addition, teacher reported school grades in math, German, and English were considered. Third, we considered background variables in our imputation model which included gender, the federal state where the students lived, the attended secondary school ability track, socioeconomic status in terms of the highest rating on the *International Socio-Economic-Index of Occupational Status (ISEI*; Ganzeboom, Graaf, & Treiman, 1992) for the household in which a student lived (HISEI), and immigrant background of students' families.

Ganzeboom, H.B.G., Graaf, P.M. de, & Treiman, D.J. (1992). A standard international socio-economic index of occupational status. *Social Science Research, 21*, 1–56. https://doi.org/10.1016/0049-089X(92)90017-B

Table S1

Standardized Parameter Estimates for the Math Models

Stability	Self-concept		Intrinsic value		Attainment value	
t1-t2	.624*/.626*/.637*/.575*		.461*/.455*/.430*/.405*		.282*/.284*/.303*/.323*	
t2-t3	.496 */.508*/.512*/.561*		.415*/.389*/.383*/.372*		.468*/.490*/.494*/.336*	
t1-3	.179*/.173*/.173*/.128*		.064/.118*/.118*/.165*		.169*/.136*/.136*/.179*	
t3-t4	.534*/.530*/.538*/.544*		.294*/.293*/.275*/.338*		.257*/.244*/.256*/.313*	
t2-t4	.136/.097*/.098*/.121*		.113/.167*/.169*/.138*		.193*/.249*/.249*/.173*	
t1-t4	.060/.118*/.117*/.116*		.163/.150*/.150*/.117*		.164*/.089*/.090*/.072*	
t4-t5	.419*/.464*/.479*/.539*		.442*/.423*/.380*/.382*		.312*/.266*/.292*/.341*	
t3-t5	.248*/.194*/.194*/.116*		.283*/.221*/.221*/.142*		.066/.165*/.165*/.175*	
t2-t5	.154*/.141*/.138*/.109*		.087/.054/.054/.110*		.018/.060/.059/.076*	
t1-t5	.008/-.019/-.015/.009		-.083/.019/.020/.028		.089/.051/.052/.042	
Cross-lagged paths	Self-concept → intrinsic value	Intrinsic value → self-concept	Self-concept → attainment value	Attainment value → self-concept	Intrinsic value → attainment value	Attainment value → intrinsic value
t1-t2	.161*/.163*/.169*/.125*	.062*/.056*/.009/.006	.121*/.123*/.128*/.089*	-.034/ -.031/.009/.006	.158*/.152*/.130*/.087*	-.039/-.033/-.011/.021
t2-t3	.055/.086*/.089*/.126*	.042/.017/.005/.005	.071/.119*/ .120*/.089*	-.036/ -.004/.006/.006	-.074/-.118*/-.123*/.080*	.023/ .040/.045/.023
t1-3	.055/--/--/--	-.033/--/--/--	.071/--/--/--	.068*/--/--/--	-.062/--/--/--	.041/--/--/--
t3-t4	.117/.078/.082/.118*	.055/.040/.008/.005	.024/.010/.013/.086*	-.037/-.017/.009/.006	.094/.135*/.119*/.074*	.010/.053/.068/ .021
t2-t4	-.003/--/--/--	-.011/--/--/--	.092/--/--/--	-.002/--/--/--	.071/--/--/--	.109/--/--/--
t1-t4	-.068/--/--/--	-.028/--/--/--	-.168*/--/--/--	.064/--/--/--	-.001/--/--/--	.009/--/--/--
t4-t5	.096/.143*/.156*/.130*	.083/.065/-.001/.005	.086/.111/.118*/.092*	-.005/-.054/-.001/.006	.141/.161*/.126*/.082*	.018/-.035/-.001/.023
t3-t5	.024/--/--/--	.001/--/--/--	-.022/--/--/--	-.104/--/--/--	.095/--/--/--	-.146/--/--/--
t2-t5	-.034/--/--/--	-.078/--/--/--	.018/--/--/--	.034/--/--/--	.021/--/--/--	-.044/--/--/--
t1-t5	.085/--/--/--	.030/--/--/--	.041/--/--/--	-.019/--/--/--	-.044/--/--/--	.096/--/--/--
Correlations	Self-concept ↔ intrinsic value		Self-concept ↔ attainment value		Intrinsic Value ↔ attainment value	
t1	.640*/.640*/.640*/.639*		.503*/.504*/.503*/.504*		.621*/.621*/.620*/.618*	
t2	.590*/.586*/.587*/.590*		.440*/.443*/.442*/.446*		.643*/.646*/.645*/.644 *	
t3	.540*/.540*/.541*/.539*		.405*/.405*/.404*/.397*		.561*/.558*/.557*/.549*	
t4	.576*/.578*/.580*/.577*		.471*/.473*/.472*/.466*		.569*/.569*/.569*/.572*	
t5	.674*/.666*/.672*/.663*		.495*/.493*/.493*/.494*		.504*/.510*/.512*/.518*	

Note. The first coefficient refers to the full-forward cross-lagged panel model, the second coefficient refers to Model 3 (Table 1 in the main manuscript), the third coefficient refers to Model 6 (Table 1 in the main manuscript), and the fourth coefficient refers to Model 7 (Table 1 in the main manuscript).

Table S2

Standardized Parameter Estimates for the German Models

Stability	Self-concept	Intrinsic value	Attainment value
t1-t2	.513*/.513*/.509*/.474*	.400*/.407*/.422*/.288*	.327*/.329*/.314*/.425*
t2-t3	.453*/.444*/.448*/.474*	.274*/.284*/.257*/.288*	.456*/.478*/.499*/.425*
t1-3	.141*/.149*/.151*/.127*	.130*/.087*/.088*/.184*	.155*/.127*/.127*/.165*
t3-t4	.479*/.484*/.500*/.474*	.421*/.357*/.318*/.288*	.265*/.358*/.391*/.425*
t2-t4	.112*/.106*/.097/.127*	.085/.250*/.249*/.184*	.362*/.135*/.133*/.165*
t1-t4	.184*/.143*/.143*/.075*	.074/.131*/.130*/.083*	.225*/.190*/.188*/.150 *
t4-t5	.496*/.513*/.512*/.474*	.195/.235*/.252*/.288*	.574*/.426*/.415*/.425*
t3-t5	.216*/.152*/.151*/.127*	.296*/.300*/.298*/.184*	.099/.251*/.251*/.165*
t2-t5	.002/.047/.048/.075*	.169/-0.005/-.005/.083*	.073/.131*/.132*/.150*
t1-t5	.047/.045/.046/.048	-.015/.015/.016/.007	-.073/-.035/-.033/ -.031

Cross-lagged paths	Self-concept → intrinsic value	Intrinsic value → self-concept	Self-concept → attainment value	Attainment value → self-concept	Intrinsic value → attainment value	Attainment value → intrinsic value
t1-t2	.044/.040/.039/.002	-.015/-.023/.020/.015*	-.015/-.020/-.022/.015	.051/.058/.017/.015*	.118/.120*/.136*/-.010	.001/-.003/-.018/.098*
t2-t3	-.039/.054/.055/.002	.085/.093*/.030/.015*	.094*/.058/.061/.015	-.021/-.033/.028/.015*	-.018/-.036/-.060/-.010	.101/.093/.120*/.098*
t1-3	.080/--/--/--	.004/--/--/--	-.062/--/--/--	-.019/--/--/--	-.016/--/--/--	-.045/--/--/--
t3-t4	-.014/-.085/-.079/.002	.146*/.100/-.008/.015*	-.043/-.045/-.040/.015	-.121*/-.109*/-.007 /.015*	.164*/.069/.033/-.010	.066/-.016/.022/.098*
t2-t4	-.104/--/--/--	-.100*/--/--/--	.032/--/--/--	.061/--/--/--	-.270*/--/--/--	.216*/--/--/--
t1-t4	.003/--/--/--	-.059/--/--/--	.019/--/--/--	.002/--/--/--	-.058/--/--/--	-.116/--/--/--
t4-t5	-.064/-.014/-.013/.002	.006/.005/.044/.015*	.001/.029/.025/.015	.103/.079/.039/.015*	-.236*/-.094/-.081/-.010	.293*/.208*/.193/.098*
t3-t5	.026/--/--/--	-.067/--/--/--	.093/--/--/--	-.014/--/--/--	.127/--/--/--	.000/--/--/--
t2-t5	.017/--/--/--	.106*/--/--/--	-.110/--/--/--	-.052/--/--/--	.120/--/--/--	-.202*/--/--/--
t1-t5	.017/--/--/--	-.062/--/--/--	-.041/--/--/--	.065/--/--/--	.097/--/--/--	.022/--/--/--

Correlations	Self-concept ↔ intrinsic value	Self-concept ↔ attainment value	Intrinsic Value ↔ attainment value
t1	.595*/.593*/.592*/.572*	.530*/.528*/.528*/ .424*	.731*/.728*/.728*/.847*
t2	.461*/.456*/.455*/.314*	.425*/.426*/.426*/.275*	.719*/.723*/.722*/.703*
t3	.456*/.458*/.462*/.291*	.390*/.397*/.393*/.222*	.637*/.642*/.643*/.506*
t4	.418*/.422*/.427*/.232*	.399*/.406*/.404*/.186*	.642*/.635*/.636*/.493*
t5	.494*/.486*/.486*/.206*	.375*/.364*/.369*/.154*	.588*/.587*/.588* /.397*

Note. The first coefficient refers to the full-forward cross-lagged panel model, the second coefficient refers to Model 11 (Table 1 in the main manuscript), the third coefficient refers to Model 14 (Table 1 in the main manuscript), and the fourth coefficient refers to Model 15 (Table 1 in the main manuscript).

Table S3

Standardized Parameter Estimates for the English Models

Stability	Self-concept	Intrinsic value	Attainment value
t1-t2	.531*/.529*/.530*/.560*	.445*/.448*/.444*/.388*	.371*/.375*/.377*/.428*
t2-t3	.525*/.527*/.526*/.542*	.328*/.340*/.350*/.389*	.544*/.557*/.548*/.452*
t1-3	.179*/.183*/.183*/.159*	.066/.058/.056/.136*	.122*/.098*/.096*/.108*
t3-t4	.565*/.578*/.563*/.555*	.456*/.430*/.482*/.383*	.447*/.508*/.470*/.485*
t2-t4	.178*/.117*/.111*/.158*	.066/.119*/.116*/.134*	.150/.077/.077/.122*
t1-t4	.057/.085*/.089*/.101*	.116/.090/.093*/.096*	.121/.098*/.100*/.095*
t4-t5	.607*/.587*/.591*/.566*	.163/.199*/.247*/.367*	.472*/.430*/.389*/.432*
t3-t5	.181*/.183*/.182*/.165*	.309*/.273*/.273*/.127*	.128/.216*/.217*/.117*
t2-t5	.149*/.120*/.115*/.102*	-.025/.039/.037/.091*	.186/.070/.068/.096*
t1-t5	-.033/.015/.017/.039	.194*/.049/.051/.035	-.107/.046/.046/.032

Cross-lagged paths	Self-concept → intrinsic value	Intrinsic value → self-concept	Self-concept → attainment value	Attainment value → self-concept	Intrinsic value → attainment value	Attainment value → intrinsic value
t1-t2	.124*/.125*/.124*/.136*	.034/.037/.026/.006	.138*/.134*/.136*/.117*	.013/.013/.023/.005	-.003/-.005/-.009/-.072*	-.060/-.065/-.060/-.012
t2-t3	.142*/.147*/.147*/.140*	-.040/-.029/-.012/.006	.092/.085*/.084*/.118*	.018/.005/-.012/ .005	-.172*/-.187*/-.176*/-.070*	.059/.046/.036/-.013
t1-3	.036/--/--/--	.022/--/--/--	-.024/--/--/--	-.016/--/--/--	-.013/--/--/--	-.041/--/--/--
t3-t4	.138/.113*/.103/.147*	-.030/-.077/.032/.005	.178*/.184*/.178*/.131*	.113/.132*/.033/.005	-.012/-.082/-.035/-.073*	.000/.025/-.024/-.013
t2-t4	.079/--/--/--	-.010/--/--/--	.115/--/--/--	-.064/--/--/--	-.179/--/--/--	-.028/--/--/--
t1-t4	-.169/--/--/--	-.136*/--/--/--	-.138/--/--/--	.142*/--/--/--	.080/--/--/--	.097/--/--/--
t4-t5	.240*/.176*/.172*/.145*	-.157/-.099/-.018/.005	.121/.073/.078/.127*	.149*/.068/-.016/.005	-.177/-.119/-.079/-.069*	.036/.033/-.018/-.012
t3-t5	-.007/--/--/--	.071/--/--/--	-.040/--/--/--	-.113/--/--/--	.100/--/--/--	-.039/--/--/--
t2-t5	-.071/--/--/--	-.060/--/--/--	.011/--/--/--	-.004/--/--/--	-.162/--/--/--	.086/--/--/--
t1-t5	-.070/--/--/--	.106/--/--/--	-.034/--/--/--	-.043/--/--/--	.216*/--/--/--	-.056/--/--/--

Correlations	Self-concept ↔ intrinsic value	Self-concept ↔ attainment value	Intrinsic Value ↔ attainment value
t1	.653*/.653*/.652*/.653*	.627*/.628*/.628*/.634*	.741*/.744*/.744*/.745*
t2	.626*/.622*/.622*/.621*	.563*/.561*/.561*/.562*	.729*/.728*/.728*/.725*
t3	.519*/.526*/.523*/.517*	.456*/.457*/.460*/.461*	.682*/.689*/.689*/.684*
t4	.463*/.462*/.454*/.454*	.405*/.406*/.420*/.419*	.595*/.600*/.607*/.603*
t5	.538*/.537*/.536*/.529*	.447*/.458*/.467*/.452*	.685*/.687*/.690*/.691*

Note. The first coefficient refers to the full-forward cross-lagged panel model, the second coefficient refers to Model 19 (Table 1 in the main manuscript), the third coefficient refers to Model 22 (Table 1 in the main manuscript), and the fourth coefficient refers to Model 23 (Table 1 in the main manuscript).

Table S4

Goodness-of-fit Indices for the Models Testing Invariance across Gender

	χ^2	df	CFI	TLI	RMSEA
Math					
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; free factor loadings across time and gender	2669.594	770	.970	.954	.048
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender	2757.198	806	.970	.955	.048
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are freely estimated across gender	3416.168	992	.963	.953	.048
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are set to invariance across gender	3430.341	1009	.963	.954	.048
German					
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; free factor loadings across time and gender	2794.626	770	.958	.935	.050
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender	2880.372	806	.957	.936	.049
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are freely estimated across gender	3588.857	992	.946	.932	.050
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are set to invariance across gender	3603.033	1009	.946	.933	.049

(continued)

Table S4 (continued)

	χ^2	df	CFI	TLI	RMSEA
English					
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; free factor loadings across time and gender	3075.007	770	.959	.937	.053
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender	3171.002	806	.958	.939	.053
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are freely estimated across gender	3779.497	992	.952	.939	.052
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are set to invariance across gender	3788.968	1009	.952	.940	.051

Note. The grouping factor considered in these models was defined by students' gender (*N* = 1021 boys and *N* = 1095 girls). All models are estimated with the Robust Maximum Likelihood (MLR) estimator; all χ^2 are significant ($p < .05$). CFA = confirmatory factor analyses; CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

Table S5

Goodness-of-fit Indices for the Models Testing Invariance across Secondary School Ability Tracks

	χ^2	df	CFI	TLI	RMSEA
Math					
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; free factor loadings across time and secondary school ability tracks	2734.211	770	.971	.955	.049
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and secondary school ability tracks	2790.949	806	.971	.957	.048
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are freely estimated across secondary school ability tracks	3489.573	992	.963	.954	.049
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are set to invariance across secondary school ability tracks	3515.635	1009	.963	.954	.048
German					
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; free factor loadings across time and secondary school ability tracks	2822.033	770	.959	.937	.050
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and secondary school ability tracks	2912.276	806	.958	.938	.050
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are freely estimated across secondary school ability tracks	3627.084	992	.948	.934	.050
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are set to invariance across secondary school ability tracks	3640.443	1009	.948	.935	.050

(continued)

Table S5 (continued)

	χ^2	df	CFI	TLI	RMSEA
English					
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; free factor loadings across time and secondary school ability tracks	3088.512	770	.959	.937	.053
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and secondary school ability tracks	3177.857	806	.958	.939	.053
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are freely estimated across secondary school ability tracks	3817.522	992	.951	.938	.052
Separate factors for self-concept, intrinsic value, and attainment value at each measurement wave; invariant factor loadings across time and gender; cross-lagged panel model including first-order and higher-order stability paths and first-order cross-lagged paths; invariance restriction of the paths from intrinsic value respectively attainment value to self-concept to control for multicollinearity; invariance of cross-lagged paths and stability paths across time; inclusion of achievement as a covariate; all path coefficients are set to invariance across secondary school ability tracks	3836.382	1009	.951	.939	.051

Note. The grouping factor considered in these models was defined by students' secondary school ability track. For this purpose, we separated the students into two groups. The first group consisted of students attending the academic track ($N = 1150$); the second group consisted of students attending any kind of non-academic track (i.e., intermediate track, vocational track, comprehensive track, and schools for children with special needs; $N = 966$). All models are estimated with the Robust Maximum Likelihood (MLR) estimator; all χ^2 are significant ($p < .05$). CFA = confirmatory factor analyses; CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

Table S6

Factor Correlations from a CFA Model including Self-concept, Intrinsic Value, and Attainment Value Factors in Math, German, and English at Each Measurement Wave

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	-																			
2	.645*	-																		
3	.490*	.625*	-																	
4	.159*	-.021	.136*	-																
5	-.051	.099*	.163*	.594*	-															
6	.058*	.161*	.474*	.526*	.723*	-														
7	.086*	-.044	.089*	.328*	.161*	.184*	-													
8	-.025	.104*	.155*	.134*	.356*	.286*	.645*	-												
9	.050	.111*	.440*	.193*	.295*	.519*	.618*	.734*	-											
10	.649*	.441*	.314*	.001	-.061*	.013	-.005	-060*	-.021	-										
11	.454*	.544*	.328*	-.029	.055	.051	-.050	.025	-.026	.675*	-									
12	.366*	.416*	.443*	.018	.085*	.196*	.021	.041	.151*	.529*	.698*	-								
13	.018	-.031	.063*	.523*	.327*	.307*	.207*	.134*	.151*	.063	.002	.111*	-							
14	-.016	.065*	.080*	.297*	.430*	.312*	.093*	.189*	.107*	-.039	.199*	.211*	.506*	-						
15	-.006	.116*	.216*	.227*	.341*	.399*	.104*	.166*	.206*	-.013	.182*	.444*	.462*	.728*	-					
16	.002	-056*	.053	.190*	.081*	.115*	.558*	.395*	.364*	.062	-.025	.074*	.327*	.110*	.145*	-				
17	.007	.014	.061*	.125*	.170*	.117*	.383*	.486*	.343*	-.007	.148*	.156*	.157*	.299*	.245*	.677*	-			
18	.023	.010	.152*	.171*	.161*	.241*	.369*	.367*	.451*	.027	.112*	.422*	.235*	.305*	.495*	.623*	.750*	-		
19	.518*	.351*	.279*	.014	.022	.053	-.010	.002	.023	.630*	.437*	.331*	-.004	-.004	-.007	.005	-.010	.004	-	
20	.340*	.379*	.260*	.035	.166*	.123*	-.001	.114*	.048	.417*	.533*	.392*	.029	.194*	.152*	-.014	.121*	.070*	.619*	-

Table S6 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	.302*	.276*	.362*	.099*	.118*	.195*	.028	.067*	.172*	.344*	.357*	.526*	.099*	.175*	.307*	.071*	.088*	.237*	.488*	.616*
22	-.054*	-.099*	.023	.384*	.249*	.208*	.194*	.139*	.135*	-.089*	-.071*	-.002	.549*	.327*	.277*	.202*	.129*	.142*	.005	-.031
23	-.010	.076*	.093*	.171*	.270*	.181*	.098*	.192*	.113*	-.050	.128*	.108*	.266*	.413*	.342*	.075*	.224*	.146*	-.059*	.269*
24	.002	.086*	.203*	.152*	.237*	.313*	.102*	.170*	.219*	-.001	.147*	.299*	.303*	.385*	.530*	.104*	.188*	.264*	-.019	.229*
25	-.019	-.057*	.052	.177*	.079*	.084*	.470*	.319*	.299*	-.031	-.048	.007	.229*	.070*	.056	.611*	.410*	.376*	.015	-.007
26	.048	.088*	.120*	.153*	.185*	.110*	.287*	.298*	.214*	.030	.150*	.114*	.179*	.235*	.159*	.429*	.506*	.397*	-.023	.256*
27	.007	.040	.167*	.122*	.122*	.160*	.221*	.217*	.304*	-.001	.081*	.261*	.208*	.179*	.259*	.332*	.338*	.501*	-.015	.178*
28	.445*	.303*	.265*	-.004	.010	.037	-.035	-.021	.004	.522*	.358*	.284*	-.046	.005	.033	-.018	-.042	-.023	.673*	.437*
29	.307*	.386*	.269*	.020	.129*	.123*	.049	.107*	.080	.370*	.457*	.382*	.019	.201*	.204*	.029	.129*	.079	.420*	.518*
30	.198*	.267*	.332*	-.099*	.058	.161*	.034	.077	.123*	.322*	.400*	.467*	-.016	.057	.208*	.037	.069*	.139*	.319*	.405*
31	-.001	-.064	-.047	.384*	.189*	.166*	.203*	.084*	.111*	-.105*	-.136*	-.016	.433*	.198*	.182*	.241*	.132*	.163*	-.032	-.039
32	.038	.172*	.051	.163*	.290*	.239*	.032	.085	.057	.029	.139*	.167*	.143*	.362*	.336*	.097*	.200*	.164*	.005	.231*
33	.033	.119*	.167*	.179*	.214*	.359*	.124*	.068	.148*	.057	.120*	.287*	.217*	.203*	.432*	.050	.048	.189*	.018	.200*
34	-.011	-.087*	.071*	.224*	.058	.077*	.414*	.248*	.299*	-.056	-.103*	.021	.290*	.088*	.079*	.537*	.326*	.337*	-.019	-.030
35	-.019	.050	.115*	.097*	.167*	.174*	.230*	.296*	.261*	.017	.067	.145*	.235*	.201*	.150*	.377*	.406*	.317*	.016	.160*
36	-.046	.005	.164*	.076	.109*	.202*	.222*	.231*	.325*	.005	.027	.234*	.196*	.023	.177*	.341*	.239*	.406*	-.017	.035
37	.406*	.279*	.212*	-.049	-.066	-.031	-.017	.002	-.025	.501*	.319*	.247*	-.046	-.001	-.018	-.015	-.018	-.030	.597*	.360*
38	.324*	.325*	.264*	-.050	.053	.115*	-.004	.134*	.077*	.353*	.410*	.281*	-.009	.092*	.086	-.043	.061	-.038	.430*	.524*
39	.265*	.270*	.300*	-.030	.037	.100*	-.016	.108*	.083*	.321*	.356*	.359*	.017	.162*	.213*	.026	.044	.117*	.343*	.412*
40	-.034	-.047	.056	.343*	.190*	.201*	.185*	.119*	.148*	-.096*	-.142*	.018	.389*	.246*	.203*	.162*	.094*	.155*	-.064	-.052
41	.050	.147*	.089*	.158*	.222*	.189*	.030	.112*	.042	.041	.143*	.125*	.175*	.303*	.224*	.008	.112*	.086	.033	.212*
42	-.009	.174*	.188*	.123*	.215*	.241*	.043	.189*	.119*	-.023	.119*	.220*	.179*	.304*	.386*	.064	.145*	.211*	-.022	.184*
43	-.071*	-.078*	.038	.168*	.050	.049	.395*	.276*	.269*	-.089*	-.135*	-.026	.225*	.084*	.030	.530*	.309*	.294*	-.052	-.061
44	.010	.059	.100*	.142*	.205*	.214*	.221*	.305*	.212*	.009	.109*	.126*	.191*	.235*	.160*	.307*	.344*	.295*	-.028	.168*
45	-.054	-.040	.110*	.120*	.109*	.200*	.195*	.243*	.234*	-.050	.008	.113*	.177*	.164*	.175*	.260*	.210*	.355*	-.045	.072

Table S6 (continued)

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
21	-																							
22	.056	-																						
23	.174*	.509*	-																					
24	.483*	.448*	.656*	-																				
25	.049	.381*	.112*	.135*	-																			
26	.219*	.208*	.395*	.319*	.617*	-																		
27	.519*	.245*	.277*	.542*	.500*	.695*	-																	
28	.341*	-.056	-.008	-.014	-.056	-.050	-.035	-																
29	.371*	.071	.225*	.219*	.075	.168*	.150*	.640*	-															
30	.484*	-.024	.122*	.259*	.017	.084*	.213*	.522*	.650*	-														
31	.058	.600*	.328*	.232*	.295*	.186*	.211*	-.038	-.009	-.015	-													
32	.164*	.223*	.453*	.291*	.159*	.263*	.169*	-.037	.293*	.132*	.415*	-												
33	.354*	.223*	.346*	.507*	.053	.112*	.275*	.052	.208*	.433*	.394*	.605*	-											
34	.082*	.308*	.129*	.142*	.714*	.446*	.421*	.004	.014	.076*	.397*	.128*	.147*	-										
35	.170*	.223*	.262*	.159*	.480*	.612*	.435*	-.003	.235*	.183*	.177*	.307*	.210*	.586*	-									
36	.295*	.200*	.104*	.271*	.443*	.429*	.602*	.061	.115*	.422*	.262*	.160*	.438*	.577*	.638*	-								
37	.236*	-.073*	-.086*	-.065	-.049	-.058	-.035	.675*	.453*	.340*	-.085*	-.016	.039	-.085*	-.018	-.028	-							
38	.286*	.009	.159*	.113*	.002	.138*	.065	.518*	.648*	.432*	-.120*	.137*	.150*	-.062	.150*	.007	.716*	-						
39	.394*	.037	.150*	.204*	-.002	.124*	.171*	.436*	.514*	.561*	-.048	.038	.246*	-.046	.120*	.197*	.577*	.648*	-					
40	.073*	.536*	.262*	.232*	.247*	.154*	.187*	-.089*	-.048	.015	.663*	.311*	.333*	.322*	.153*	.236*	-.073*	-.067	.011	-				
41	.184*	.257*	.480*	.365*	.089*	.219*	.180*	-.013	.153*	.096*	.260*	.472*	.445*	.063	.093	.072	-.005	.252*	.194*	.492*	-			
42	.282*	.274*	.387*	.484*	.100*	.211*	.293*	.029	.190*	.244*	.234*	.288*	.561*	.123*	.165*	.223*	.007	.211*	.453*	.418*	.661*	-		
43	.001	.255*	.069*	.043	.663*	.401*	.335*	-.065	.004	.000	.359*	.180*	.131*	.770*	.429*	.466*	-.037	-.059	-.010	.406*	.115*	.125*	-	
44	.106*	.221*	.330*	.210*	.421*	.527*	.372*	.010	.145*	.110*	.192*	.300*	.263*	.461*	.520*	.401*	-.009	.250*	.246*	.252*	.417*	.396*	.614*	-
45	.177*	.188*	.162*	.249*	.327*	.347*	.469*	.031	.100*	.153*	.236*	.136*	.272*	.376*	.318*	.556*	-.003	.117*	.435*	.296*	.275*	.524*	.526*	.702*

Note. For better reading, we had to separate the tables and to use numbers to denominate the constructs: 1= Math self-concept t1; 2= Math intrinsic value t1; 3= Math attainment value t1; 4 = German self-concept t1; 5 = German intrinsic value t1; 6 = German attainment value t1; 7 = English self-concept t1; 8 = English intrinsic value t1; 9 = English attainment value t1; 10= Math self-concept t2; 11= Math intrinsic value t2; 12= Math attainment value t2; 13 = German self-concept t2; 14 = German intrinsic value t2; 15 = German attainment value t2; 16 = English self-concept t2; 17 = English intrinsic value t2; 18 = English attainment value t2; 19= Math self-concept t3; 20= Math intrinsic value t3; 21= Math attainment value t3; 22 = German self-concept t3; 23 = German intrinsic value t3; 24 = German attainment value t3; 25 = English self-concept t3; 26 = English intrinsic value t3; 27 = English attainment value t3; 28= Math self-concept t4; 29= Math intrinsic value t4; 30= Math attainment value t4; 31 = German self-concept t4; 32 = German intrinsic value t4; 33 = German attainment value t4; 34 = English self-concept t4; 35 = English intrinsic value t4; 36 = English attainment value t4; 37 = Math self-concept t5; 38 = Math intrinsic value t5; 39 = Math attainment value t5; 40 = German self-concept t5; 41 = German intrinsic value t5; 42 = German attainment value t5; 43 = English self-concept t5; 44 = English intrinsic value t5; 45 = English attainment value t5.
The fit of this model was χ^2 (3630) = 23953.413; CFI = .901; TLI = .851; RMSEA = .051.
CFA = confirmatory factor analysis. * $p < .05$.