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What Matters When? Social and Dimensional Comparisons in the Context of University Major Choice

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Students compare their achievement to different standards in order to evaluate their ability. We built on the theoretical frameworks of situated expectancy-value theory, dimensional comparison theory, and the big-fish-little-pond effect literature to examine the role of social and dimensional comparisons for ability self-concept and subjective task value (STV) in secondary school and university major choice. We used two German longitudinal data sets from different cohorts with data collection in 12th grade and 2 years after high school graduation (Study 1: N = 2,207, Study 2: N = 1,710). Dimensional and social comparisons predicted students' self-concept and domain-specific STV in school: Individual achievement was positively related to ability self-concept and STV in the corresponding domain and negatively related in the noncorresponding domain. School-level mean achievement was negatively related to ability self-concept and STV in the corresponding domain. Dimensional comparisons were directly related to university major choice, social comparisons were only indirectly related.

Keywords: *dimensional comparisons, academic self-concept, university major choice, big-fish-little-pond effect, situated expectancy-value theory*

Understanding critical educational choices is of major interest to educational psychologists. Most such theorists, who ground their work in rational-choice perspectives, stress the role of ability self-concepts in educational decisions like university major choice. A few prominent self-theories are particularly relevant for understanding developmental influences on both ability self-concepts and major educational choices: situated expectancy-value theory (SEVT; Eccles, 1983; Eccles & Wigfield, 2020), Möller and Marsh's dimensional comparison theory (DCT; Möller & Marsh, 2013), and research on the big-fish-little-pond effect (BFLPE; Marsh, 1987; Marsh & Hau, 2003), based on social comparison theory (SCT; Festinger, 1954). This paper sought to bring all of these theories together in predicting university major choice.

SEVT predicts that ability self-concepts and subjective task values (STV) are the primary psychological influences on individual differences in university major choice. Evidence over 40 years has largely supported this hypothesis (Wigfield & Eccles, 2020). But what influences the formation of these self-concepts and task beliefs? Marsh, Möller, and their research teams have addressed this question in their work on social and dimensional comparison theories (Marsh et al., 2014; Marsh et al., 2018; Möller & Marsh, 2013). Social comparison theorists (SCT; Festinger, 1954) argue that people compare themselves to others in order to get relevant information about themselves, while dimensional comparison theorists (DCT; Möller & Marsh, 2013) argue that people compare their performance in one domain with their performance in another domain.

In recent years, several researchers have broadened the focus of self-concept research by demonstrating the relevance of these comparison processes in other contexts, such as students' STV and educational choices (Cambria et al., 2017; Dickhäuser et al., 2005; Gaspard et al., 2018; Möller et al., 2016; Umarji et al., 2018). Given the broad range of situations in which people use comparison processes, the question emerges whether people prefer different types of comparisons in different situations (Wolff, Helm, Zimmermann, et al., 2018). BFLPE research has repeatedly confirmed the relevance of social comparisons to students' peers for ability self-concept formation (Marsh & Hau, 2003; Seaton et al., 2009). Other researchers argue that dimensional comparisons and the hierarchical structure of ability self-concepts and STV in different domains are key for students' educational choices (Eccles & Wigfield, 2020; Wolff, Helm, & Möller, 2018). This suggests that dimensional comparison processes become particularly important for educational choices where self-differentiation is needed.

We built on recent integrative theories and models that focus on different comparison processes simultaneously (Marsh et al., 2018; Wolff et al., 2019), as well as work raising the question of whether students use different comparison processes in different situations (Wolff, Helm, & Möller, 2018). We used two longitudinal German data sets to investigate the role of social and dimensional comparisons in the context of ability self-concept and STV formation in high school and university major choice. We expected that social and dimensional comparisons would be powerful predictors of ability self-concepts and STV in high school. For university major choice, a decision where self-differentiation is needed, we expected dimensional comparisons to be particularly important.

Theoretical Background

Social and Dimensional Comparisons and Ability Self-Concepts

The term ability self-concept refers to a person's ability self-belief, which can be either broad or subject area-specific (Trautwein, Lüdtke, Köller, et al., 2006). In educational research, ability self-concepts are considered one of the most important motivational constructs. They predict various learning outcomes (Eccles, 1983, 2009; Seaton et al., 2014; Valentine et al., 2004), as well as students' aspirations (Eccles, 2009; Nagengast & Marsh, 2012) and educational choices (Eccles, 2009; Nagy et al., 2008; Parker et al., 2012). Furthermore, relative ability self-concepts across different academic domains predict university major and occupational choices.

To form domain-specific ability self-concepts, students use different sources of information, different kinds of comparison processes, and different comparison standards (Müller-Kalthoff et al., 2017). Social, dimensional, and temporal comparisons are considered the most important types of comparisons for self-concept formation (Parker et al., 2013; Wolff, Wigfield, et al., 2020; Wolff, Helm, Zimmermann, et al., 2018). In this study, we focused on social and dimensional comparisons in the context of ability self-concept, STV, and university major choice.

The role of social comparison processes for self-concept formation has widely been investigated in the context of the big-fish-little-pond effect (BFLPE): Equally able students develop different ability self-concepts depending on whether they are in a higher achieving or lower achieving peer group (Marsh, 1987; Marsh & Hau, 2003; Seaton et al., 2009). A student who compares herself/himself to very high-achieving students has a lower ability self-concept than an equally able student who compares herself/himself to low-achieving peers. Extensive literature on the BFLPE has shown a robust effect of social comparisons on students' ability self-concept (Chmielewski et al., 2013; Dicke et al., 2018; Marsh, 1987; Seaton et al., 2009; Trautwein, Lüdtke, Marsh, et al., 2006). Some authors have even called the BFLPE a panhuman theory (Seaton et al., 2009), and the extensive empirical evidence on this effect has informed debates about potential negative effects of high-achieving learning environments. However, compared with the large number of cross-sectional studies on the BFLPE in secondary school, little is known about long-term consequences of the BFLPE for students' educational pathways after high school graduation.

It is important to note that we refer to social comparisons as described in the BFLPE literature in this study. Following this line of research, the effect of social comparison processes is measured by regressing students' ability self-concept on the average achievement level of the students' frame of reference (e.g., class or school), while controlling for the students' individual achievement. In other theoretical frameworks, such as the prominent internal/external frame of reference model (I/E model; Marsh, 1986), social comparisons are also described as external comparisons. In this approach, social comparisons are commonly operationalized as the effect of students' individual grades or achievement scores on their ability self-concept in the corresponding domain (Marsh, 1986; Möller et al., 2020).

Dimensional comparison theorists (Möller & Marsh, 2013) argue that students compare their achievement in one domain with their achievement in another domain when forming their domain-specific ability self-concepts. Research has shown that ability self-concepts are highly domain specific. Whereas achievement in the mathematical and verbal domains are highly correlated, math self-concept and verbal self-concept show low or zero correlations (Möller et al., 2020). Research on the I/E model has shown that students' ability self-concept in one domain is influenced by the relative position of their achievement in this domain compared to their achievement in other domains (Marsh et al., 2015; Möller et al., 2020). Dimensional comparisons are most pronounced between math-related domains and verbal domains (Arens et al., 2018; Gaspard et al., 2018). Hence, a student who is good in math but better in English will exhibit a lower math self-concept than a student who is equally able in math but worse in English.

Recent work by Wolff, Sticca, et al. (2020) further showed that dimensional comparisons are reciprocal. Alongside the dimensional comparison effects of achievement on subsequent self-concepts, the authors found evidence for dimensional comparisons effects of self-concepts on subsequent achievement: Self-concept in one domain positively predicted subsequent achievement in the corresponding domain, and negatively predicted subsequent achievement in a noncorresponding domain. Overall, both theories assume that students contrast their performance in one domain to different standards when evaluating their abilities (i.e., SCT and BFLPE: performance by other peers, DCT: performance in other domains).

In recent years, several authors have proposed integrated models including several types of comparisons (Chiu, 2012; Marsh et al., 2018; Parker et al., 2013; Wolff et al., 2019). These studies show that students use different types of comparison processes simultaneously, and that social and dimensional comparisons are most relevant for the formation of ability self-concepts. A meta-analysis revealed effect sizes of about $\beta = -.28$ for the BFLPE (social comparisons) on ability self-concepts (Fang et al., 2018), and $-.17 > \beta < -.20$ for dimensional comparisons across dissimilar domains, such as math and verbal domains (Möller et al., 2020).

Social and Dimensional Comparisons and STV

The authors of the generalized I/E model proposed that comparison processes not only affect students' ability self-concept in math and verbal domains but also their motivation, learning behavior, and educational decisions in other areas (Möller et al., 2016). The underlying idea is that comparisons—as psychological processes—are not only relevant for self-evaluation in academic domains but also in other areas in life.

In line with this assumption, research has shown that the BFLPE is related to students' STV (Schurtz et al., 2014; Trautwein, Lüdtke, Marsh, et al., 2006). Hence, equally able students in math reported lower STV for math when they were in classes with higher math-achieving peers than students who were in classes with lower math-achieving peers. Gaspard et al. (2018) investigated the role of dimensional comparisons for ability self-concepts and nine facets of STV in five academic subject domains with a large German data set of 5th- to 12th-grade students in academic track schools. Their results showed evidence for dimensional comparisons affecting students' ability self-concept and STV across dissimilar domains, such as the verbal and mathematical domains. The effect sizes of dimensional comparisons across distant domains, such as math and German or English, were of similar size for students' ability self-concept ($\beta = -.19$) and students' intrinsic values ($\beta = -.18$).

Social and Dimensional Comparisons and Educational Choices

Early sociological research showed that students with higher achieving peer groups in high school had lower college aspirations after high school graduation (i.e., frog pond metaphor: Alwin & Otto, 1977; Davis, 1966; Espenshade et al., 2005). A few scholars have investigated the BFLPE on domain-specific course and major choices. Trautwein et al. (2005) showed with a longitudinal German sample that the BFLPE predicted course choices in high school: Students with equal math achievement levels were less likely to choose advanced math courses in high schools with a higher mean math achievement. The results of another study (von Keyserlingk et al., 2020) showed that the association between the BFLPE and university major choice was quite small and mediated by its effect on students' high school ability self-concepts. Studies focusing on dimensional comparison processes have shown that academic achievement, ability self-concepts, and STV positively predicted university major choice in the corresponding domain (i.e., math achievement and beliefs predicted a greater likelihood of selecting a STEM major), but negatively predicted enrollment in majors in noncorresponding domains (Gaspard et al., 2019; Jansen et al., 2021; Parker et al., 2012).

Dimensional Comparisons and Self-Differentiation

In a recent article, Wigfield et al. (2020) connected DCT with SEVT (Eccles, 1983; Eccles & Wigfield, 2020; Wigfield et al., 2006). SEVT provides a framework for explaining individual educational engagement, performance, and choice. Subjective expectations of success and STV are described as the most proximal factors driving educational choices. Subjective expectations of success are often assessed with measures of domain-specific self-concepts (Wigfield & Eccles, 2000). STV encompass several facets, including attainment value, utility value, intrinsic value/interest, and costs. Eccles and Wigfield (2020) argue that dimensional comparisons should be particularly useful for students when they have to choose one alternative against others. For example, students usually cannot choose many university majors at the same time. Hence, they will select the major they value most and at which they expect to succeed compared with other majors.

This assumption builds on the argument that different motives drive the use of different comparisons (Möller & Marsh, 2013; Wolff, Helm, & Möller, 2018). Möller and Marsh (2013) described four motives for engaging in comparison processes: self-evaluation, self-enhancement, self-improvement, and self-differentiation. When students want to evaluate their current achievement level (self-evaluation), feel better about their own achievement (self-enhancement), or improve in a domain (self-improvement), they are more likely to engage in social comparisons. When students instead have to make educational choices, they must identify their strengths and weaknesses (self-differentiation) and are therefore more likely to engage in dimensional comparisons (Wigfield et al., 2020; Wolff, Helm, & Möller, 2018).

The Present Study

We used two German longitudinal data sets to investigate the role of social and dimensional comparisons for students' ability self-concepts and STV in high school and for university major choice. We built on integrated models of comparison processes (Chiu, 2012; Marsh et al., 2018; Parker et al., 2013) and used a multilevel modeling approach to simultaneously estimate the effects of social and dimensional comparisons on our outcomes. While the extensive BFLPE literature has consistently shown that social comparisons with high-achieving peers have detrimental effects on students' ability self-concepts (Marsh & Hau, 2003; Seaton et al., 2009), relatively little is known about potential long-term consequences of the BFLPE on students' educational pathways after leaving high school. Therefore, an important goal of this study was to investigate what comparison standards students consider when making an important decision about their postsecondary educational pathway: social comparisons with their peers, dimensional comparisons within themselves, or both?

Our study builds on von Keyserlingk et al.'s (2020) work about long-term effects of the BFLPE on university major choices and extends their findings in several ways. First, we address a research gap they identified, and focus on the role of social and dimensional comparisons for university major choices simultaneously. Second, we use an alternative coding of university majors—the central outcome variables in our study. Rather than using a binary indicator for STEM versus non-STEM majors, we coded math intensity of university majors. This approach overcomes a common critique of grouping all STEM majors together into one category, despite very different characteristics of STEM majors. The nonbinary format of our outcome variable further enables us to use state-of-the-art latent manifest multilevel models, which allow for a more precise estimation of the BFLPE. Third, we used two data sets in our study that followed participants through the transition from high school to university and included the measures needed to address our research questions. The available variables in each data set were not identical, which allowed us to focus on different aspects in each study: In Study 1, we included STV variables; thus, our model in Study 1 is relevant for predictions based on SEVT. Study 2 included achievement and self-concept measures in two domains (German and math) and therefore provided a more rigorous test of the ability self-concept aspects of the DCT. The two data sets were collected at different time periods, which allowed us to investigate our research questions across different cohorts (Study 1: 1997–2000, Study 2: 2013–2015). Longitudinal studies in educational settings are costly and time-consuming. Secondary analyses of existing longitudinal data are needed in order to make use of high-quality existing data rather than generating new data on the same topics. However, a common concern by reviewers is that older data sets do not adequately reflect current educational settings and the results might not be generalizable to today. While this might be the case for some topics (e.g., media use in schools), it might be less of a concern for topics addressing basic psychological phenomena. Our study makes an important contribution to this issue by using two data sets from the late 1990s and the mid–2010s in order to assess whether the phenomena we are studying are historically time-dependent or time-independent.

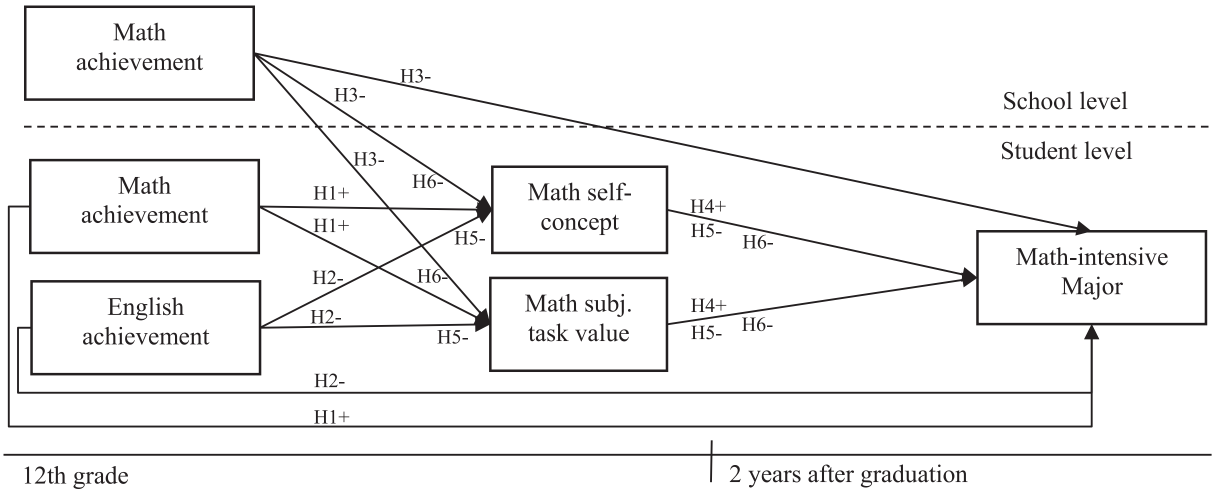
Study 1

In Study 1, we focused on the role of social and dimensional comparisons for math self-concept and math STV at the end of high school and for the choice of a math-intensive university major. Our specific hypotheses about direct and indirect effects can be found in Figure 1. Both social and dimensional comparisons should be relevant for math self-concept and math STV in high school (Cambria et al., 2017; Marsh & Hau, 2003; Möller et al., 2009; Schurtz et al., 2014). Based on the assumptions of SEVT (Eccles, 1983, 2009) and previous research (Musu-Gillette et al., 2015; Parker et al., 2012), we expected math self-concepts and math STV to positively predict subsequent choice of a math-intensive university major. Based on existing literature (Wigfield et al., 2020; Wolff, Helm, & Möller, 2018), we predicted that dimensional comparisons would be particularly important for university major choice. Furthermore, we investigated the extent to which the effects of social and dimensional comparisons on major choice were mediated by students' math self-concept and math STV.

Method

In Study 1, we used a subsample from the *Bildungsverläufe und psychosoziale Entwicklung im Jugendalter* (BIJU) study. Data for this German longitudinal study were collected in four federal states in seven waves. The first data collection took place in 1991/1992, when students were in 7th grade, with follow-up data collection conducted in 10th grade, 12th grade, 2 years and 10 years after high school graduation. A stratified random sample from each school type was drawn in the participating federal states. During the 12th-grade data collection, all 12th-grade students at each participating high school participated in the study. Baumert et al. (1996) provide a more detailed study description.

Sample. We used data from two waves of the BIJU study: in 1997, when students were in 12th grade (T1) and in 1999, 2 years after students graduated from high school (T2, age: $M = 21.9$, $SD = 0.7$). In 12th grade, $N = 6{,}652$ students



Hypotheses about direct effects:

H1.1: Individual math achievement in high school positively predicts students' math self-concept, subjective task values in math, and choice of a math-intensive university major.

H1.2: Individual English achievement in high school negatively predicts students' math self-concept, subjective task values in math, and choice of a math-intensive university major (dimensional comparisons).

H1.3: School-level math achievement in high school negatively predicts students' math self-concept, subjective task values in math, and choice of math-intensive university major, after controlling for individual math achievement (BFLPE).

H1.4: Math self-concept and subjective task values in math in high school positively predict students' enrollment in a math-intensive university major.

Hypotheses about indirect effects:

H1.5: Individual English achievement in high school has indirect negative predictive effects on students' enrollment in a math-intensive university major through math self-concept and subjective task values in math.

H1.6: School-level math achievement in high school has indirect negative predictive effects on students' enrollment in a math-intensive university major through math self-concept and subjective task values in math, after controlling for individual math achievement.

FIGURE 1. *Estimated paths from individual achievement in math and English and school-level mean achievement in math to math self-concept, math subjective task value, and the choice of a math-intensive major at university with the BIJU (Bildungsverläufe und psychosoziale Entwicklung im Jugendalter) data (Study 1).*

participated in the data collection at high schools, and N = 3,008 of these students participated in later waves of the study. We only included students who enrolled at university after graduating from high school in our subsample. This subsample consisted of N = 2,207 students from 93 academic track and comprehensive schools (60% female).

Instruments

University Major. Two years after high school graduation, students were asked in which university major they were currently enrolled. In Germany, students choose their major when they enroll at university. The majors were coded according to the classification of university majors from the German Federal Statistical Office (Statistisches Bundesamt, 2018). We classified the majors into four categories based on the level of math required (1 = *no math required*, 2 = *some math required*, 3 = *moderate math required*, 4 = *intensive math required*). We followed the categorization used by Musu-Gillette et al. (2015) and Umarji et al. (2018) and adapted it to German university majors. Two researchers independently assigned the majors to the categories. In the few cases where both researchers assigned a major to different categories, the differences were discussed until all majors had been assigned to a single category. The categorization of majors can be found in Table 1.

TABLE 1
Categorization of University Majors According to the Level of Math Required

(1) No math	(2) Some math	(3) Moderate math	(4) Intensive math
humanities	political science	economics	mathematics
languages and linguistics	sociology	chemistry	physics, astronomy
cultural studies	psychology	pharmacy	engineering
sports	education	biology	
art	law	geosciences	
music	medicine	architecture	
		computer science	

Math Self-Concept. Math self-concept was measured in 12th grade with five items developed by Jerusalem (1984) and Jopt (1978). Students responded to the five items on a 4-point Likert-type scale. Cronbach's α of the items was good ($\alpha = .86$). All math self-concept items are included in online Appendix B.

Math Subjective Task Value. Math STV was measured with five items. The items were based on the conceptualization of interest by Krapp and Schiefele (1986, April) and Krapp et al. (1992). Students responded to the items on a 4-point Likert-type scale. Cronbach's α of the items to measure math STV was good ($\alpha = .84$). All STV items are included in online Appendix B.

Achievement in Math and English. Students' math achievement was assessed with a standardized curriculum-validated test. The items used in this test originally came from the First International Mathematics Study, the Second International Mathematics Study, the Third International Mathematics Study (TIMS), and the "Schulleistungsstudie" (School Achievement Study) conducted by the Max Planck Institute for Human Development in Berlin. Math achievement was scaled as weighted likelihood estimates scores (WLE; Warm, 1989) based on a one-parameter item response model. Cronbach's α of the math achievement test was satisfactory ($\alpha = .73$; Kuder–Richardson Formula 20). To obtain a measure of peers' achievement level, we aggregated achievement scores on the school level. To avoid overestimating schools' achievement level, we aggregated the achievement scores on the school level before selecting our subsample of students who enrolled at university after high school graduation.

English achievement was assessed in 12th grade (T1) with three subscales from the Test of English as a Foreign Language. Achievement was scaled as WLE scores. Cronbach's α of the achievement test in English was good ($\alpha = .92$; Kuder–Richardson Formula 20).

Gender and Socioeconomic Status (SES). Gender (female = 1, male = 0) and SES were included in the analyses. As a measure of students' SES, we used the International Socio-Economic Index of Occupational Status (ISEI) scores of the students' parents (Ganzeboom et al., 1992). We used the highest ISEI of the students' parents in our analyses. This information was provided by the students in 12th grade.

Statistical Analyses. To investigate the role of social and dimensional comparisons for math self-concept, math STV, and university major choice, we applied multilevel structural equation models (SEMs) in M*plus* (Version 7.4, Muthén & Muthén, 1998–2012). First, we conducted confirmatory factor analyses to specify latent measurement models for math self-concept and math STV. Both models fulfilled Hu and Bentler's (1999) criteria for good model fit (root mean square error of approximation $< .08$; comparative fit index $> .95$; Tucker–Lewis index $> .95$; standardized root mean residual $< .06$). Second, we used latent-manifest multilevel models as described by Marsh et al. (2009), with students nested in schools, to investigate the role of social and dimensional comparisons for students' math self-concept, math STV, and university major choice. Figure 1 shows the estimated paths in the SEM. Gender and students' SES were included as control variables in the model. To estimate the predictive effect of high school social comparisons, we estimated the BFLPE on math self-concept and math STV in 12th grade as well as on math-intensive university major choice 2 years after high school graduation. To do so, we regressed math self-concept, math STV, and university major on individual and school mean math achievement. We centered individual achievement measures on the group mean. To obtain an estimate of the BFLPE, we subtracted the beta coefficient of individual achievement from the beta coefficient of school mean achievement. For better interpretation, we calculated Tymms' delta as the effect size of the BFLPE. This effect size is comparable to Cohen's *d*. To operationalize the effect of dimensional comparisons on students' self-concept, STV, and major choice, we regressed high school math self-concept, high school math STV, and university major on students' high school English achievement. We calculated the indirect predictive BFLPE and indirect effects of dimensional comparisons on students' university major choice. Additional information about the effect size, calculation of the indirect effects, and the

TABLE 2

Multilevel SEM to Estimate the Effects of Social and Dimensional Comparisons on Students' Self-Concept, Subjective Task Value, and Major Choice With the BIJU Data

	DV: Math self-concept	DV: Math subjective task value	DV: Math-intensive major
	β (*SE*)	β (*SE*)	β (*SE*)
Math achievement	.49 (.02)**	.44 (.02)**	.08 (.03)**
English achievement	−.05 (.02)*	−.08 (.02)*	−.07 (.02)**
Math self-concept			.18 (.05)**
Math subjective task value			.15 (.04)**
Male	.13 (.02)**	.04 (.03)	.40 (.03)**
SES	.04 (.02)	.002 (.02)	−.05 (.02)**
Math BFLPE	−.32 (.04)**	−.27 (.04)**	.07 (.06)
Indirect effects			
School level math achievement * Math self-concept			−.09 (.03)**
School level math achievement * Math subjective task value			−.06 (.02)**
Individual math achievement * Math self-concept			−.01 (.005)*
Individual math achievement * Math subjective task value			−.01 (.006)*
R^2 within	.27	.19	.20
R^2 between	.07	.40	.82

Note. DV = dependent variable; SES = highest ISEI of both parents. Big-fish-little-pond effect (BFLPE) in math was calculated by subtracting the beta coefficient of individual achievement on math self-concept (math subjective task value, math-intensive major) from the beta coefficient of school mean achievement on math self-concept (math subjective task value, math-intensive major). Individual math achievement was centered at the group mean. Effect size of math BFLPE on math self-concept = .49. Effect size of math BFLPE on math subjective task value = .37.
*$p < .05$. **$p < .01$.

M*plus* syntax of the multilevel SEM can be found in online Appendices C to E.

The rate of missing data in our subsample was low. Missing rates for the items measuring math self-concept ranged between 1% and 2%. Items measuring math STV had missing rates between 2% and 2.5%, and achievement measures had missing rates between 1% and 4%. We used the full information maximum likelihood approach to deal with missing data.

Results

Results of the multilevel SEM to investigate the role of social and dimensional comparisons for students' high school math self-concept, math STV, and enrollment in a math-intensive university major can be found in Table 2. A correlation matrix of all variables included in the SEM can be found in online Appendix F. In 12th grade, the results revealed statistically significant evidence for dimensional comparisons affecting students' high school math self-concept and math STV. Individual high school math achievement positively predicted students' math self-concept and math STV, whereas individual high school English achievement negatively predicted students' high school math self-concept and math STV. Further tests showed that these effects did not differ statistically from each other, $\chi^2(1, N = 2{,}207) = 3.3$, $p = .07$. In addition, the results showed a statistically significant BFLPE for math self-concept and math STV in high school. Although individual math achievement in high school positively predicted students' concurrent math self-concept and math STV, school mean math achievement negatively predicted students' math self-concept and math STV. The size of the BFLPE on math self-concept and math STV did not significantly differ from each other, $\chi^2(1, N = 2{,}207) = 1.2$, $p = .28$. Results of a χ^2–Wald test showed that the BFLPE and dimensional comparison effects on math self-concept and math STV were statistically significantly different—effects on math self-concept: $\chi^2(1, N = 2{,}207) = 46.48$, $p < .001$; effects on math STV: $\chi^2(1, N = 2{,}207) = 22.76$, $p < .001$. These results indicate that the BFLPE was more relevant for students' math self-concept and math STV than dimensional comparison effects.

Moving on to the longitudinal effects, results showed positive predictive effects of individual high school math achievement, math self-concept, and math STV on enrollment in a math-intensive university major 2 years after high school graduation. Individual English achievement in 12th grade was a negative predictor of enrollment in a math-intensive university major, whereas high school mean math achievement was not predictive for selecting a math-intensive university major when controlling for individual math achievement. The results of a χ^2–Wald test confirmed that the BFLPE and dimensional comparison effects on enrollment in a math-intensive university major were statistically different from each other, $\chi^2(1, N = 2{,}207) = 5.93, p = .01$; dimensional comparisons had a statistically significant predictive effect on university major choice, but the BFLPE was not directly related to university major choice. These findings are congruent with our hypothesis that dimensional comparisons are particularly relevant in situations where educational choices must be made.

Regarding the indirect effects, results revealed some interesting findings. Whereas the direct BFLPE on major choice was not statistically significant, the indirect effects of school mean achievement on enrollment in a math-intensive university major through math self-concept and math STV were negative and statistically significant. Hence, the BFLPE in high school had a negative effect on students' high school math self-concept and math STV, which in turn decreased the probability of these students enrolling in math-intensive university majors. The results further indicated statistically significant negative indirect effects of dimensional comparisons on major choice. Individual high school English achievement was negatively related to math self-concept and math STV in 12th grade, which in turn predicted a decreased probability of enrolling in a math-intensive major at university. χ^2–Wald tests showed that the indirect effects of dimensional comparisons were smaller than the indirect BFLPE.

Summary

In this study, we aimed to investigate the role of social and dimensional comparisons in the context of self-concept and STV at the end of high school, which are both important predictors for university major choice (Wigfield & Eccles, 2020). Furthermore, we investigated the role of social and dimensional comparisons for university major choice after high school graduation. The results showed that social and dimensional comparisons were important for students' math self-concept and math STV. The effects of dimensional comparison processes on students' math self-concept were slightly smaller than expected based on the existing literature. This might be explained by the achievement measures used. We used standardized test scores as individual achievement measures. Effects of dimensional comparisons have been shown to be larger when school grades rather than standardized achievement test scores are used (Möller et al., 2020). Dimensional comparisons were directly related to university major choice (i.e., statistically significant direct and indirect predictive effects), whereas social comparisons were only indirectly related to university major choice (i.e., only statistically significant indirect predictive effects). However, the direct effect of individual English achievement on major choice and the indirect effect of school mean achievement through math self-concept and math STV were of similar size. These results suggest that students use dimensional comparisons directly when it comes to college major choice, whereas social comparisons matter only in an indirect way. The results showed a direct BFLPE on students' self-concept and STV in high school, which had a delayed indirect effect on students' university major choice after high school graduation. These findings are in line with our hypotheses and support the assumption that dimensional comparison processes play a particularly important role in situations in which self-differentiation is needed (Wolff, Helm, & Möller, 2018). Our results suggest that students were more likely to compare their own ability in different domains when choosing a university major than to compare their ability in one domain with the ability of their peers.

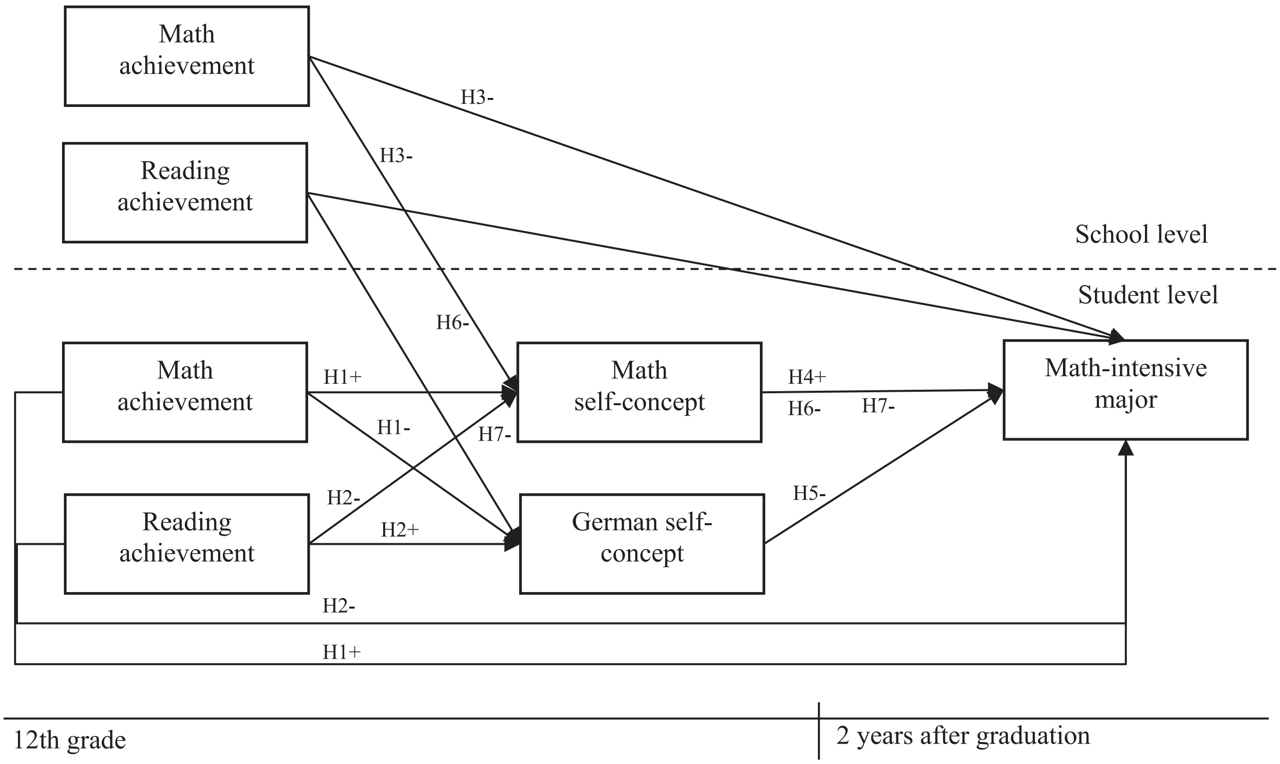
In Study 1, we focused on social and dimensional comparisons in the context of math self-concept, math STV, and university major choice. The model we used was strongly oriented toward SEVT, including both math self-concept and math STV. However, neither English self-concept nor English STV was assessed in the BIJU study in 12th grade. These measures would be needed to fully investigate the dimensional comparisons proposed in the DCT. The data available from Study 2 allowed us to overcome this limitation.

Study 2

In Study 2, we wanted to replicate and extend the findings of Study 1 with a different and newer data set. Thus, our goal was to assess the robustness of our findings concerning ability self-concepts and major choice across a historical time period that has seen significant cultural changes.

Differences in the variables available in each data set also allowed us to take a slightly different focus in Study 2: We investigated the predictive effects of social and dimensional comparisons on students' math self-concept, German self-concept, and choice of a math-intensive university major using student data for math and German achievement and ability self-concepts. This enabled us to investigate the role of dimensional comparison processes for ability self-concepts more precisely. Because no measures of STV were available, we were not able to investigate the potential role of STV as an outcome or mediator of choosing a math-intensive university major. Our specific hypotheses about direct and indirect effects can be found in Figure 2.

Based on the assumptions of the BFLPE and DCT, we expected to find evidence for effects of social and dimensional comparisons on students' math self-concept and German self-concept at the end of high school (Marsh et al., 2018; Möller et al., 2009; Möller & Marsh, 2013). As in Study 1, we expected that social and dimensional comparisons would be related to students' university major choice. Based on the literature on reciprocal dimensional comparisons (Wolff, Sticca, et al., 2020) and university major choice (Umarji et al., 2018), we expected to find evidence for dimensional comparison effects for both achievement measures and



Hypotheses about direct effects:

H2.1: Individual math achievement positively predicts math self-concept and enrollment in a math-intensive university major, and negatively predicts German self-concept (dimensional comparison).

H2.2: Individual reading achievement negatively predicts math self-concept and enrollment in a math-intensive university major, and positively predicts German self-concept (dimensional comparison).

H2.3: School-level math achievement negatively predicts math self-concept and enrollment in a math-intensive university major after controlling for individual math achievement (BFLPE).

H2.4: Math self-concept positively predicts enrollment in a math-intensive university major.

H2.5: German self-concept negatively predicts enrollment in a math-intensive university major (dimensional comparison).

Hypotheses about indirect effects:

H2.6: School-level math achievement negatively predicts enrollment in a math-intensive university major through math self-concept, after controlling for individual math achievement.

H2.7: Individual reading achievement negatively predicts enrollment in a math-intensive university major through math self-concept.

FIGURE 2. *Estimated paths from individual achievement in math and reading and school-level mean achievement in math to math self-concept, German self-concept, and the choice of a math-intensive major at university with the National Educational Panel Study data (Study 2).*

self-concept measures on subsequent major choices. We estimated both direct and mediated effects through students' math self-concept and German self-concept.

Method

We used a subsample of the National Educational Panel Study (NEPS), a German multicohort longitudinal study. We used data from a cohort primarily assessed in 2010, when students were in ninth grade (Weinert, 2018). Participants were sampled using a multistage sampling design. First, schools of every school type in all federal states in Germany were sampled; in a second step, two classes in each selected school were randomly sampled to participate in the study. A more detailed study description can be found in Blossfeld (2011).

Sample. We used data from two waves: In 2013/2014, when students were in 12th grade (T1), and in 2015/2016, 1 year after high school graduation (T2). In 2013/2014, $N = 3{,}798$ students participated in the data collection in schools, and $N = 2{,}736$ of these students also participated in 2015/16. As in Study 1, we only included students in the sample who enrolled at university after graduating from high school. Our subsample consisted of $N = 1{,}710$ students from 163 schools (55% female).

Instruments

University Major. One year after high school graduation, students were asked in which major they were currently enrolled. As in Study 1, the majors were classified into four categories based on the level of math required.

Math and German Self-Concept. Math self-concept and German self-concept were measured in 12th grade with three items each. Students responded to these items on a 4-point Likert-type scale. Cronbach's α of these items was good (math self-concept: $\alpha = .90$, German self-concept $\alpha = .89$). The items to measure math and German self-concepts can be found in online Appendix H.

Math and Reading Achievemen. High school math achievement was measured with a standardized achievement test. This test consisted of 22 items and measured students' competencies in four mathematical domains. Math achievement was scaled as WLE scores (Warm, 1989). The reliability of the test was satisfactory (EAP/PV reliability = .766). To obtain a measure of peers' achievement level, the math achievement scores were aggregated on the school level. To avoid overestimating schools' achievement levels, we aggregated math achievement scores on the school level before selecting our subsample.

Reading achievement was measured with a standardized achievement test that consisted of 29 items. The test's reliability was satisfactory (EAP/PV reliability = .795). Reading achievement was again scaled as WLE scores.

Gender and SES. Gender (female = 1, male = 0) and SES were included as control variables in the analyses. We used the ISEI scores of the students' parents (Ganzeboom et al., 1992) as an SES measure. We used the highest ISEI of the students' two parents in our analyses. This information was provided by the students.

Statistical Analyses. The statistical analyses in Study 2 are similar to those in Study 1. To investigate the role of social and dimensional comparisons for math self-concept, German self-concept, and university major choice, we applied multilevel SEMs in M*plus* (Version 7.4, Muthén & Muthén, 1998–2012). First, we conducted a confirmatory factor analysis to specify a latent measurement model for math self-concept and German self-concept. Second, we used a latent-manifest multilevel model with students nested in schools to investigate the role of the BFLPE and dimensional comparisons for students' math self-concept, German self-concept, and university major choice. Students' gender and SES were included as control variables in the model. Figure 2 shows the estimated paths in the SEM with NEPS data. We estimated the BFLPE on students' math self-concept, German self-concept, and university major choice to investigate the effect of social comparisons. To investigate dimensional comparison effects on ability self-concepts in high school, we estimated the predictive effects of individual achievement in one subject on students' ability self-concept in the other subject. Moreover, we estimated the predictive effects of achievement and ability self-concepts in math and German on math-intensive university major choice. We further calculated the indirect BFLPE and indirect effects of dimensional comparisons in school through high school math self-concept and German self-concept on university major choice. The M*plus* syntax for the statistical analyses with the NEPS data can be found in online Appendix I.

Missing rates of the items used to measure math self-concept and German self-concept were lower than 1%. The achievement measures in math and reading also had missing rates below 1%. We used the full information maximum likelihood approach to deal with missing data.

Results

Results of the multilevel SEM with the NEPS data can be found in Table 3. A correlation matrix with all variables used in the multilevel SEM can be found in online Appendix J. Individual high school math achievement was positively related to students' math self-concept and negatively related to students' German self-concept in high school. Individual high school reading achievement was positively related to German self-concept, but not to math self-concept. Hence, the results only partially supported our hypothesis, because we only found statistically significant evidence for dimensional comparison effects on students' German self-concept. High school mean math achievement had a negative effect on students' own math self-concept when controlling for individual math achievement, indicating a statistically significant BFLPE on math self-concept in 12th grade. Similar, the results showed a statistically significant negative effect of school mean reading achievement on students' German self-concept. Similar to the results in Study 1, χ^2–Wald tests indicated that the effects

TABLE 3
Multilevel SEM to Estimate the Effects of Social and Dimensional Comparisons on Students' Self-Concept and Major Choice With the NEPS Data

	DV: Math self-concept	DV: German self-concept	DV: Math-intensive major
	β (*SE*)	β (*SE*)	β (*SE*)
Math achievement	.47 (.02)**	−.10 (.03)**	.07 (.03)**
Reading achievement	−.01 (.02)	.20 (.03)**	−.04 (.02)
Math self-concept			.23 (.03)**
German self-concept			−.26 (.03)**
Male	.10 (.05)**	−.31 (.03)**	.42 (.05)**
SES	.03 (.03)	.06 (.03)	−.04 (.03)
Math BFLPE	−.25 (.06)**		−.01 (.08)
Reading BFLPE		−.22 (.06)**	
Indirect effects			
School level math achievement * Math self-concept			−.07 (.02)**
Individual reading achievement * Math self-concept			−.01 (.01)
Individual math achievement * Reading self-concept			.03 (.01)**
R^2 within	.24	.13	.25
R^2 between	.17	.02	.10

Note. DV = dependent variable; SES = highest ISEI of both parents. Big-fish-little-pond effect (BFLPE) in math and reading were calculated by subtracting the beta coefficient of individual achievement on self-concept (math-intensive major) from the beta coefficient of school mean achievement on self-concept (math-intensive major). Individual achievement measures were centered at the group mean. Effect size of math BFLPE on math self-concept = .29. Effect size of reading BFLPE on German self-concept = .28.
$^*p < .05$. $^{**}p < .01$.

of the BFLPE and dimensional comparisons on students' math self-concept, $\chi^2(1, N = 1{,}710) = 12.78$, $p < .001$, and German self-concept, $\chi^2(1, N = 1{,}710) = 7.89$, $p = .005$, were statistically different from each other, with a larger effect of social comparison processes.

The results further showed that individual high school math achievement and math self-concept were positive predictors for choosing a math-intensive university major, whereas German self-concept was a negative predictor for choosing a math-intensive major. This finding supports our hypothesis that dimensional comparisons drive university major choice. The predictive effect of individual German reading achievement on enrollment in a math-intensive major was negative, but not statistically significant. Similar to the findings in Study 1, high school BFLPE was not directly related to university major choice. Once again, however, we found statistically significant evidence for an indirect BFLPE and for indirect effects of dimensional comparisons on major choice through math self-concept and German self-concept: The BFLPE in high school negatively predicted students' math self-concept, which in turn decreased the probability of enrolling in math-intensive university majors. The indirect effect of dimensional comparisons was mediated by students' German self-concept in high school. Individual high school math achievement had a negative effect on German self-concept, and a lower German self-concept increased the probability of enrolling in a math-intensive university major.

Summary

We used NEPS data to investigate the role of social and dimensional comparisons for students' self-concept in high school and university major choice. As in Study 1, we included ability self-concepts and achievement measures in two domains in our model. Unlike Study 1, the verbal subject area was German rather than English. Similar to Study 1, our findings suggested that social and dimensional comparisons were related to students' ability self-concepts in high school. The results indicated that dimensional comparisons were related only to German self-concept, not to math self-concept. A possible explanation for this finding could be the achievement measure used. In the NEPS data, achievement in the verbal domain was assessed with measures of reading competence. Reading is only one facet of achievement in German, and it is an important skill for all other high school subjects as well. Research on dimensional comparisons has shown that dimensional comparison effects are typically more pronounced when grades are used instead of achievement tests because grades provide more salient feedback about students' achievement (Möller et al., 2009; Wolff et al., 2019). We investigated the effects of dimensional comparisons on students' ability self-concepts in math and in German using grades instead of achievement tests in an additional analysis (online Appendix K). In support of this suggestion, results showed statistically significant predictive effects of dimensional comparisons on both math and German self-concepts when grades were used as achievement measures. The absence of a dimensional comparison effect on math self-concept in high school can therefore be explained by the fact that reading achievement in the language of instruction is not an optimal measure for achievement in the verbal domain in dimensional comparison research. The predictive effect of dimensional comparisons on choice of a math-intensive university major was very pronounced for students' German self-concept, whereas the predictive effect of reading achievement was negative, but not statistically significant. The effect of dimensional comparisons on major choice was fully explained by German self-concept. In a reduced model with only math and reading achievement as predictors of major choice, the predictive effect of individual math achievement was statistically significant and positive. The predictive effect of individual reading achievement was statistically significant and negative, as expected (see online Appendix L).

Similar to the results of Study 1, dimensional comparisons were directly related to the choice of a university major, whereas social comparisons were only indirectly related to such choices. This pattern of results supported the assumption that dimensional comparison processes become particularly important when students need to choose one domain or major over another (Wigfield et al., 2020; Wolff, Helm, & Möller, 2018).

General Discussion

The aim of our study was to investigate the role of social and dimensional comparisons for students' ability self-concepts and STV in high school as well as university major choice. Following the existing literature, we assumed that both social and dimensional comparisons would be related to students' ability self-concepts and STV in high school. Building on theoretical and empirical work by Wigfield et al. (2020) and Wolff, Helm, and Möller (2018), we assumed that dimensional comparisons would be particularly important when students choose a university major. This decision is related to self-differentiation, as students have to choose one major over multiple alternatives. The results of both presented studies supported this assumption. Ability self-concept and achievement in math were positive predictors of the choice of a math-intensive university major, whereas ability self-concept and achievement in verbal domains were negative predictors for this choice. In contrast, the BFLPE was not directly related to university major choice. While social comparisons with high-achieving peers had statistically significant negative effects on students' self-concepts and STV, the longitudinal effects on students' major choice after high school graduation were small and completely mediated by students' self-concept and STV. This finding is contrary to the study by Trautwein et al. (2005), which showed that the BFLPE affected students' course choice in high school. Possibly, the frame of reference is more important for educational choices during school, when students remain in the same peer group (i.e., their high school), than for educational choices after high school graduation, when students leave their prior frame of reference.

Many previous studies have examined single aspects of the model we used in our two studies. Several studies have focused on social and dimensional comparisons in the context of ability self-concepts and task values in high school (Cambria et al., 2017; Gaspard et al., 2018; Marsh et al., 2018; Trautwein, Lüdtke, Marsh, et al., 2006). Other studies have investigated dimensional comparisons in the context of major and course choices at university (Dickhäuser et al., 2005; Parker et al., 2014; Umarji et al., 2018), while still others have focused on social comparisons in the context of educational choices (Marsh, 1991; Marsh & O'Mara, 2010; Trautwein et al., 2005). In real life, these processes are very likely to occur simultaneously rather than independently of each other. In our study, we used longitudinal data to investigate the role of social and dimensional comparisons for ability self-concept and STV in high school as well as an important educational choice after high school graduation–university major choice. This is an important contribution to the literature integrating existing theories and models about comparison processes (Marsh et al., 2018; Wolff et al., 2019) and outcomes other than domain-specific self-concept (Möller et al., 2016; Wigfield et al., 2020).

We addressed our research question with two German longitudinal data sets that included similar measures and followed participants through the transition from high school to university. Although data collection for the BIJU study (T1: 1997, T2: 2000) took place 15 years before data collection for the NEPS data (T1: 2013/14, T2: 2015/16), the pattern of results was very similar in both studies, indicating that these processes are stable across cohorts and contexts. We consider these data sets to be a major strength of our study.

Limitations and Future Research

The two data sets included similar measures and followed participants over the same transition from high school to university. However, because the available variables in the two data sets were not identical, we were not able to conduct a precise replication of Study 1 in Study 2. We used different achievement measures in the verbal domain. It is important to note that we were interested in dimensional comparisons between distant domains, rather than specific subjects (e.g., English vs. German). The literature on dimensional comparison processes shows that contrasting dimensional comparisons are most pronounced between distant domains, such as science domains versus verbal domains. Furthermore, Gaspard et al. (2018) showed that dimensional comparisons between English versus math and German versus math are highly similar. We therefore argue that both English achievement and German achievement are appropriate indicators for achievement in the broader domain of verbal skills. The results concerning the relations between achievement in English and German and the choice of a math-intensive university major pointed in the same direction, but were not identical. Differences in the achievement tests used could explain the variance in the results: Whereas the English achievement test included items measuring different dimensions, the German achievement test focused solely on reading competence. However, reading in the language of instruction is an important skill not only for German class but also for other subjects in high school. Further research could explore in more detail the predictive effects of dimensional comparisons on educational choices when using different achievement measures.

We noticed that the correlations between achievement in English and math (Study 1) and in reading and math (Study 2) were smaller than expected based on the literature. A possible explanation could be reduced variance in achievement measures in the subsample of only higher achieving adolescents in academic track schools. The correlations between English and math achievement in 10th grade in the larger BIJU sample (including students from vocational track schools) were as high as we would expect based on the literature (r = .55).

We used the BFLPE framework to estimate the effect of social comparisons. As frame of reference, we used the school level rather than the class level. In BFLPE research, both frames of references are common. However, research on the so-called local dominance effect has shown that students are more likely to use a closer frame of reference (i.e., class) for social comparisons (Liem et al., 2013; Zell & Alicke, 2010). In Germany, high school students are no longer taught in fixed classes with the same peers in every subject, but attend courses with different peers in each subject. The data sets we used did not contain information about students' specific courses and the peers enrolled in each course. Thus, a limitation of this approach could be a slight underestimation of the BFLPE due to use of the larger frame of reference. We strongly based our operationalization of social comparisons in the BFLPE literature. Future research should broaden this approach and integrate approaches from the BFLPE framework and the I/E model to operationalize social comparisons and investigate their relevance for postsecondary educational choices.

To compare the effects with each other, we used the established approach of conducting χ^2–Wald tests in M*plus*. A limiting factor of this approach is that the effects of dimensional comparisons were estimated on the individual level, whereas the BFLPE was estimated as a cross-level effect. Therefore, these effects do not have a common metric. Future research is needed to replicate our findings and to identify alternative methodological approaches to compare such effects with one another.

Finally, we decided to code university majors based on their math intensity, but not based on verbal skill requirements (e.g., English or German intensity). While English language becomes more and more relevant in German universities, it is not included in the curriculum in most majors. German, instead, is the language in which most university majors are being taught. However, unlike in high school, where German is a mandatory subject, only few university majors require students to take German courses. We found it difficult to code English or German-intensity across all university majors, where English and German are only a part of the curriculum for a small number of university majors. Future research on social and dimensional comparisons in the context of domain-specific university major choice could also develop classifications of university majors based on verbal skills requirements.

Conclusion

Theoretical and experimental studies on integrated models of comparison processes improve our understanding of students' preferences for different kinds of comparisons. Our study contributed to this literature. The results of both studies indicated that students used both social and dimensional comparisons in the context of ability self-concept and STV in high school. In situations where self-differentiation is needed, dimensional comparisons were directly related to students' choices, whereas social comparisons had only indirect effects. These findings suggest that when choosing a university major, students are more likely to compare their ability in math with their ability in other domains than they are to compare their own ability in math with that of their peers. Given that the studies used data from different time periods, our findings also point to the stability and persistence of these processes across time and contexts.

Authors' Note

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