# Supporting Adolescents' Career Choices: The Role of Motivational Beliefs and Relevance Interventions

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# ABSTRACT

Career choices represent important decisions for adolescents that can have a large impact on their later lives. However, many adolescents face difficulties regarding their career choice, which is why it is important to support them with this decision. As students' motivational beliefs are important predictors for their course and career choices, addressing these beliefs is one way to also foster their choices. Interventions focusing on students' motivational beliefs, such as their perceived relevance of a subject for their later lives and careers, have been shown to successfully promote students' course and career choices in the respective field. During such relevance interventions, students are encouraged to connect the course material to their own future careers, thereby reflecting on career-related questions. Thus, relevance interventions might be a promising way to foster students' career-related choices and behavior more broadly, which, however, has not been investigated yet. Next to students' motivational beliefs in the school context, their vocational interests are important precursors of their career choices. Bringing together insights on motivational beliefs, such as interests, regarding school subjects and interests regarding vocational activities might add to the knowledge about interest formation and subsequently deepen the understanding of adolescents' career choices.

This dissertation investigated how adolescents can be supported within their career choices. Three empirical studies were designed to examine several precursors of adolescents' career choices and to investigate the potential of relevance interventions to support these choices. Study 1 brought together interest constructs from two different research backgrounds, namely vocational interests and subject interests. Their development during early adolescence was examined, with a focus on the structural differentiation both constructs usually undergo during this period. Using data from a large longitudinal sample of low and middle track school students from fifth to eighth grade ($N$=3473), the structural development of vocational interests and subject interests in math, German, and English was examined separately and their interrelations over time were analyzed. Results revealed that vocational interests became more differentiated over time and showed the postulated structure in large part in higher grades. By contrast, subject interests showed only slight changes over time. The associations between the two interest constructs partly corresponded to the assumed pattern.

In Study 2, a relevance intervention was tested with respect to its potential to support adolescents' career choices. It was a parent-based intervention with the aim of helping parents to support their children within their career orientation. Parents were involved in the intervention as they have been shown to be important sources of support for their children and can have a large influence on their motivational beliefs and choices. The intervention was operationalized through a website, where parents and students could find information on the relevance of math, German, and English for students' later careers. In a cluster-randomized study with 357 eighth grade students of middle track schools, their motivational beliefs in the three subjects and their career orientation behavior as well as parents' motivational beliefs and career support were assessed before and after the intervention. The intervention was found to have a negative effect on parents' career support for their children as well as on their perceived importance of this support. No effects were found on other parent variables or on student variables.

In Study 3, another relevance intervention was tested, which focused on the usefulness of math for students' later lives and careers. It was a classroom-based intervention aiming to foster students' motivational beliefs for math and to support their career choices. The intervention effects were evaluated in a cluster-randomized trial with 78 classes of ninth grade students of academic track schools ($N$=1744). Students' motivational beliefs for math and physics, their vocational interests, career orientation and career aspirations were assessed before as well as 4 weeks and 3 months after the intervention. The results suggested that the intervention fostered students' perceived importance of math and physics for their career aspirations as well as their investigative interests. Negative intervention effects on students' realistic and enterprising interests were found. The intervention had no effects on students' career orientation and career aspirations in the field of math and science.

The findings of the three empirical studies are summarized and discussed with respect to the broader research context. Implications for future research and educational policy and practice are derived.

# ZUSAMMENFASSUNG

Die Wahl eines Berufes stellt für Jugendliche eine bedeutsame Entscheidung dar, die weitreichende Konsequenzen für ihr späteres Leben mit sich bringt. Da die Berufswahl jedoch viele Jugendliche auch vor Schwierigkeiten stellt, ist es wichtig, die Jugendlichen in diesem Prozess zu unterstützen. Die motivationalen Überzeugungen Jugendlicher haben sich als einflussreich für ihre späteren Kurs- und Berufswahlentscheidungen erwiesen. Eine Förderung der motivationalen Überzeugungen kann sich demnach auch positiv auf die Berufswahl auswirken. In Interventionen, die die motivationalen Überzeugungen Jugendlicher steigern sollten, wurde konkret die wahrgenommene Nützlichkeit eines Fachs für das spätere Leben und den Beruf angesprochen. Es hat sich gezeigt, dass diese Nützlichkeitsinterventionen die Kurs- und Berufswahlentscheidungen Jugendlicher im jeweiligen Fach fördern konnten. Während einer solchen Intervention werden die Schülerinnen und Schüler üblicherweise dazu angeregt, über den Nutzen des Fachs für ihre Zukunft nachzudenken, indem sie Verbindungen zwischen den Unterrichtsinhalten und möglichen späteren Berufen herstellen. Dabei beschäftigen sie sich mit der Frage nach ihrem künftigen Beruf, was eine ganzheitliche Förderung ihrer Berufsorientierung und letztlich ihrer Berufswahl mit sich bringen könnte. Dies wurde bisher jedoch nicht untersucht. Neben den motivationalen Überzeugungen bezüglich bestimmter Schulfächer sind die beruflichen Interessen der Jugendlichen wichtige Determinanten für ihre Berufswahl. Um die Entwicklung von motivationalen Überzeugungen, wie beispielsweise Interessen, im Hinblick auf Berufswahlen insgesamt besser zu verstehen, wäre es hilfreich, Erkenntnisse über schulische und berufliche Interessen zu verknüpfen. Dies könnte zu einem tieferen Verständnis der Berufswahlprozesse von Jugendlichen beitragen.

Die vorliegende Dissertation beschäftigt sich mit der Frage, wie Jugendliche in ihrer Berufswahl unterstützt werden können. Die drei empirischen Studien, die im Rahmen der Dissertation durchgeführt wurden, beleuchten verschiedene Vorläufer von Berufswahlentscheidungen und untersuchen, inwiefern diese Entscheidungen mithilfe von Nützlichkeitsinterventionen gefördert werden können. In Studie 1 wurden berufliche Interessen und Fachinteressen als zwei Interessenskonstrukte aus unterschiedlichen Forschungstraditionen miteinander verknüpft. Hier wurde die Entwicklung beider Konstrukte im frühen Jugendalter untersucht, wobei der Schwerpunkt auf der

strukturellen Ausdifferenzierung der Interessen lag, die üblicherweise für beide Interessenskonstrukte in dieser Lebensphase stattfindet. Die Daten stammten aus einer großen Längsschnittstudie mit 3473 Haupt-, Real- und Mittelschülerinnen und -schülern der 5. bis 8. Jahrgangsstufe. Die strukturelle Entwicklung von beruflichen Interessen und Fachinteressen in Mathematik, Deutsch und Englisch wurde jeweils getrennt betrachtet, bevor die Zusammenhänge zwischen beiden Interessenskonstrukten über die Zeit analysiert wurden. Die Ergebnisse zeigten, dass berufliche Interessen sich mit zunehmendem Alter ausdifferenzierten und größtenteils die zu erwartende Struktur in den höheren Klassen annahmen. Im Gegensatz dazu zeigten sich bei den Fachinteressen kaum Veränderungen über die Zeit. Die Zusammenhänge zwischen den beiden Interessenskonstrukten entsprachen teilweise den Erwartungen.

In Studie 2 wurde eine Nützlichkeitsintervention hinsichtlich ihres Potentials zur Berufswahlunterstützung von Jugendlichen untersucht. Die elternbasierte Intervention hatte zum Ziel, Eltern dabei zu helfen, ihre Kinder bestmöglich in deren Berufsorientierung zu unterstützen. Die Eltern wurden in die Intervention eingebunden, da sie wichtige Unterstützer für ihre Kinder darstellen und einen erheblichen Einfluss auf deren motivationale Überzeugungen und Berufsentscheidungen nehmen können. Die Intervention wurde mithilfe einer Webseite umgesetzt, die Informationen zur Nützlichkeit von Mathematik, Deutsch und Englisch für den zukünftigen Beruf der Jugendlichen enthielt. Zur Überprüfung der Wirksamkeit der Intervention wurde eine cluster-randomisierte Studie mit 357 Realschülerinnen und -schülern der 8. Jahrgangsstufe und deren Eltern durchgeführt. Jeweils vor und nach der Intervention wurden die motivationalen Überzeugungen von Jugendlichen und Eltern bezüglich der drei Fächer, das Berufsorientierungsverhalten der Jugendlichen sowie die Berufswahlunterstützung der Eltern erfasst. Die Eltern berichteten nach der Intervention eine geringere Unterstützung ihrer Kinder bei der Berufswahl und nahmen die Unterstützung als weniger wichtig wahr. Auf weitere Elternvariablen sowie Schülervariablen hatte die Intervention keinen Einfluss.

In Studie 3 wurde eine weitere Nützlichkeitsintervention evaluiert, die sich auf die Relevanz von Mathematik für das spätere Leben und den zukünftigen Beruf von Jugendlichen konzentrierte. Es handelte sich um eine Intervention im Klassenzimmer, die die motivationalen Überzeugungen und die Berufswahlentscheidungen von Schülerinnen und Schülern fördern sollte. In einer cluster-randomisierten Studie mit 78 Klassen der 9. Jahrgangsstufe, an der 1744 Gymnasiastinnen und Gymnasiasten teilnahmen, wurden die Effekte der Intervention auf die motivationalen Überzeugungen in Mathematik und Physik, die beruflichen Interessen, die Berufsorientierung und die Berufsaspirationen der Jugendlichen untersucht. Diese wurden vor und vier Wochen sowie drei Monate nach der Intervention erhoben. Es zeigte sich, dass die Schülerinnen und Schüler nach der Intervention Mathematik und Physik als wichtiger für ihre Berufsaspirationen einschätzten. Zudem berichteten sie ein höheres untersuchend-forschendes Interesse und ein niedrigeres praktisch-technisches sowie unternehmerisches Interesse. Die Intervention hatte keinen Einfluss auf die Berufsorientierung oder die Berufsaspirationen im mathematisch-naturwissenschaftlichen Bereich.

Die Ergebnisse der drei empirischen Studien werden zusammengefasst und in den breiteren Forschungsdiskurs eingeordnet. Zudem werden Implikationen für Wissenschaft und Praxis abgeleitet.

# CONTENT

# 1 Introduction and Theoretical Background

Choosing a career is an important decision for young people and can substantially affect their later life (Dietrich, Parker, & Salmela-Aro, 2012). Adolescents have to explore not only the characteristics of different careers and labor market conditions, but also their own interests and skills before choosing a career. However, in recent decades, the range of possible careers has increased considerably in Western societies (OECD, 2004), and career decisions have become more complex (Praskova, Creed, & Hood, 2015). In Germany, about a quarter of students who are about to graduate from high school indicate that they are not sure about their own skills and interests, and only 7% report having no problems with their career choice (Heine, Willich, & Schneider, 2010). Thus, it seems important to support adolescents in this decision.

One prominent framework to explain adolescents' career choices by means of their motivational beliefs is the expectancy-value theory of achievement-related choices by Eccles and colleagues (1983). According to this theory, students' subjective beliefs regarding the success expectancy as well as the value of a certain task or subject directly influence their educational and occupational choices. The model has inspired a large number of empirical studies that support its assumptions by showing that expectancy and value beliefs essentially predict students' achievement as well as course and career choices (for reviews, see Wigfield & Eccles, 2000; Wigfield, Tonks, & Klauda, 2009). In recent years, researchers have translated the findings on associations between motivational beliefs and achievement-related choices into interventions aimed at fostering students' motivation, performance, and career-related choices. In these interventions, students learn about the value of the course material for their own lives and future careers (e.g., Gaspard et al., 2015; Hulleman & Harackiewicz, 2009), thereby making connections to their own career plans. Previous research has shown that such interventions effectively promote students' motivation and performance as well as course choices and pursuit of careers in the corresponding subject (e.g., Gaspard et al., 2015; Hulleman & Harackiewicz, 2009; Rozek, Svoboda, Harackiewicz, Hulleman, & Hyde, 2017; for a review, see Rosenzweig & Wigfield, 2016). In addition to Eccles' (1983) motivational model, research grounded in vocational psychology has revealed that students' interests in occupational activities, or vocational interests, play an important role for their later career-related choices (Holland, 1997; Rounds & Su, 2014).

The present dissertation has the overarching goal of deepening our understanding of adolescents’ career choices and examining ways in which adolescents can be supported during this process. To this end, it takes a closer look at the antecedents of career choices and at the role motivational interventions can play for students’ career-related decisions. Thereby, the dissertation addresses several questions of relevance for both motivational and vocational research. First, in order to identify ways of supporting adolescents’ career choices, how precursors of this choice develop needs to be better understood. Thus, the development of two important predictors of career choices, namely vocational interests and subject interests, during adolescence is investigated. Next, an intervention focusing on the value of school content for students’ future lives was designed and tested. As parents are an important resource for students’ career decisions, this indirect parent-based intervention was aimed at helping parents support their children in choosing a career. Lastly, the effects of a second motivational intervention on students’ career-related outcomes were examined. This more direct intervention implemented in the classroom focused on the relevance of math for students’ later lives and careers. In both interventions, students were encouraged to engage in career-related activities and to draw connections between the intervention material and their own lives. Therefore, this dissertation investigates the potential of such interventions to support students in choosing a career.

The present dissertation is structured as follows: The introductory chapter describes the theoretical background and empirical evidence informing the three empirical studies, thereby providing an overview of the broader research context. In the first section (1.1), the expectancy-value theory of achievement-related choices and associated constructs will be presented and the structural development of expectancy and value beliefs will be delineated. Next, empirical findings on their relevance for students’ choices will be presented, before taking a closer look at the role of parents for students’ beliefs and choices in the final part of the section. The second section (1.2) focuses on vocational interests and describes the structure and development of vocational interests as well as their influence on students’ educational and occupational choices. In the third section (1.3), the concept of interventions focusing on value will be presented together with empirical findings from previous studies and the specific career focus of these interventions will be discussed. The introductory chapter closes by specifying the research questions for this dissertation (1.4). In Chapters 2 to 4, the three empirical studies conducted as part of this dissertation will be presented: The first study examines the development of vocational interests and subject interests during early adolescence. The second study evaluates the effects of a parent-based motivation intervention on parents' and students' motivation and career-related behaviors. The third study investigates the potential of a motivation intervention in math to support students in choosing a career by testing the effects of the intervention on career-related outcomes. In the last chapter (5), the findings of the three studies are brought together and their relevance for future research and educational practice are discussed.

## 1.1 Expectancy-Value Theory of Achievement-Related Choices

Modern expectancy-value theory (EVT; Eccles et al., 1983) is an important theoretical framework in motivation research for explaining students' achievement-related behaviors and choices. It is based on previous work by Atkinson (1957, 1964) in that it links achievement behavior to subjective beliefs about expectancy and value related to a task. Modern EVT extended Atkinson's work by defining expectancy and value components more precisely and applying the model to real-world situations rather than only testing it in the laboratory setting (Wigfield et al., 2009). The model was originally developed to explain gender differences in students' course and career choices through their expectancies and value beliefs (Eccles, 2005). Thus, it encompasses both motivational beliefs and academic choices and can therefore be applied in motivational research as well as research on career choices. The theory suggests that students' expectancies for success and value beliefs are direct predictors of their performance, persistence, and choices, and are themselves influenced by multiple psychological, social and cultural factors (e.g., Eccles, 2005; Eccles & Wigfield, 2002; Wigfield & Eccles, 1992, 2000; Wigfield et al., 2009).

Figure 1.1 presents the most recent expectancy-value model by Eccles and colleagues (Eccles, 2005; Eccles & Wigfield, 2002). Moving from right to left in the model, achievement-related choices and performance are assumed to be directly influenced by expectancies of success and subjective task values, which are correlated with one another. Expectancies and value beliefs are themselves influenced by individuals' goals and self-schemata as well as by affective memories of achievement-related situations. These memories, goals and self-beliefs are affected by individuals' perceptions of other people's expectations and attitudes as well as by their own interpretations of previous achievement experiences. Stable characteristics such as gender also influence individuals' self-schemata and goals. Their perceptions and interpretations are in turn affected by several cultural and social factors, such as the cultural milieu they live in; the beliefs and behaviors of socializers, such as parents and teachers; as well as previous experiences. Finally, the model proposes a feedback loop across time from individuals' achievement-related choices and performance back to their experiences. Thus, the model includes a broad array of possible influences on achievement-related choices, ranging from individual characteristics to social and structural factors.

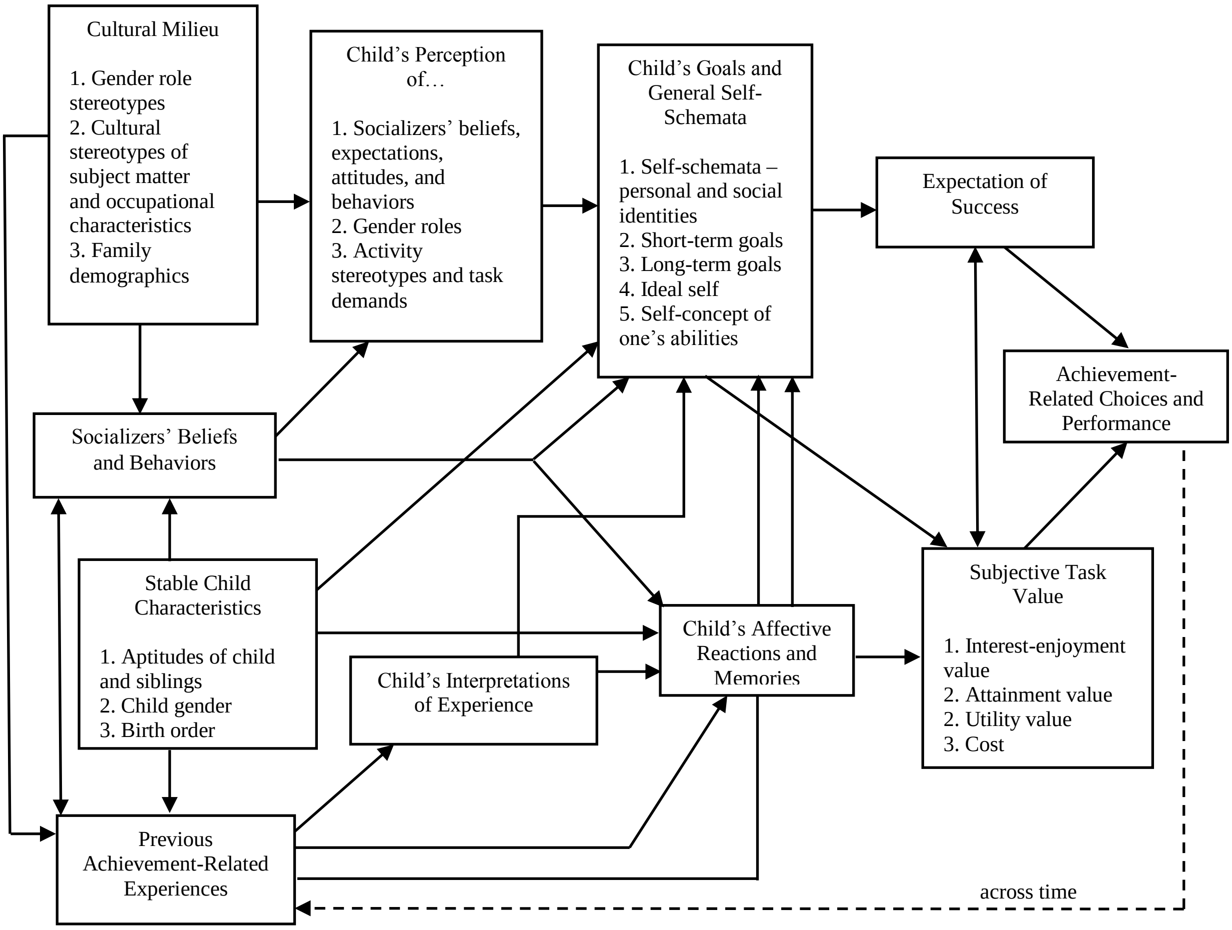


*Figure 1.1.* Eccles et al.'s expectancy-value model of achievement-related choices (from Eccles & Wigfield, 2002)

This dissertation primarily focuses on the right-hand portion of the model, that is, students' task-specific beliefs and academic choices, and also takes a closer look at parents, as they have been shown to play an important role in shaping the beliefs and choices of their children (e.g., Lazarides, Harackiewicz, Canning, Pesu, & Viljaranta, 2015). Therefore, the following section will detail students' expectancy and value beliefs and distinguish them from other motivational variables, such as interests, before describing the structural development of expectancy and value beliefs. Afterwards, empirical support for the ability of these beliefs to predict academic choices will be presented and the influence of parents and their motivation on students' academic choices will be discussed.

### 1.1.1 Theoretical conceptualization of expectancy and value beliefs

Student beliefs that have an influence on achievement-related behavior are addressed as part of a number of social cognitive theories of motivation. According to Pintrich, Marx, and Boyle (1993), these beliefs can be divided into two broad categories: beliefs about one's ability to fulfill a task and reasons for engaging in a task. Eccles et al.'s (1983) expectancy-value theory integrates both sets of beliefs as central components of its model: Expectancy beliefs refer to the question "Can I do this task?", whereas value beliefs are linked to the question "Do I want to do this task?". Both beliefs refer to a specific task or school subject and are thus highly domain-specific. This has been empirically confirmed in studies showing low correlations between beliefs in different subjects (e.g., Bong, 2001).

In EVT, expectancies for success are defined as individuals' beliefs about how well they will do on an upcoming task in the immediate or long-term future (Eccles & Wigfield, 2002). These beliefs are typically measured with questions about how well a person expects to perform in a specific subject in the next year or how good the person expects to be at learning a new topic in that subject (Wigfield & Eccles, 2000). The concept of expectancies for success is related to other self-evaluations of abilities, such as self-concept (Marsh & Shavelson, 1985) and self-efficacy (Bandura, 1997). In Eccles' model, expectancies for success are influenced by ability beliefs, which can be defined as a person's evaluation of his or her competence in a specific domain. Like self-concepts, these ability beliefs describe beliefs about competencies in broader domains. In contrast, like self-efficacy, expectancies for success refer to a specific, upcoming task. Despite these different framings, empirical studies have shown that ability beliefs and expectancies for success are highly correlated, which is why the two constructs have often been collapsed or used interchangeably (e.g., Eccles, Wigfield, Harold, & Blumenfeld, 1993; Nagengast et al., 2011). Eccles and Wigfield (2002) concluded that the constructs cannot be distinguished in real-world achievement situations. As the focus of the present dissertation is not on expectancy beliefs, this distinction will be disregarded and the term *expectancies* will be used to capture all competence-related beliefs.

Value beliefs are defined as subjective beliefs about a specific task or subject that lead individuals to engage in the task. More specific, task values refer to a person's perception of task characteristics that influence their desire to complete the task (Eccles, 2005). Eccles and colleagues (Eccles, 2005; Wigfield et al., 2009) point to the subjective nature of task values, as individuals can value the same activity differently. In their model, they propose four value components: intrinsic value, attainment value, and utility value—each representing positive values—as well as cost, which refers to negative aspects of engaging in a task (Eccles, 2005).

*Intrinsic value*, or interest value, represents the enjoyment a person gains from completing a task (Eccles, 2005) and can be seen as an affective component of value. It is similar to other motivational constructs such as intrinsic motivation (Deci & Ryan, 1985; Ryan & Deci, 2009) and interest (Renninger & Hidi, 2011). In self-determination theory (Deci & Ryan, 1985), intrinsic motivation refers to reasons for engaging in a task inherent within a person, such as the enjoyment or satisfaction the person experiences when doing the task. Thus, an activity is intrinsically valued if it is seen as an end in itself. Although this definition is similar to that of intrinsic value, the expectancy-value model conceptualizes intrinsic value as one of four value components, which implies that the association between intrinsic value and engagement in a task must be considered in relation to the other value components as well (Wigfield & Cambria, 2010). Intrinsic value also bears similarity to interest as described by Renninger and Hidi (2011) or Schiefele (2009). They distinguish between two major types of interest: situational interest and individual interest. Whereas situational interest refers to a short-term state of focused attention and positive emotion in a specific situation, individual interest is a more enduring tendency to engage in specific activities or tasks. In their four-phase model of interest development, Hidi and Renninger (2006) state that situational interest can develop into individual interest through repeated experience with the object of interest over time. Intrinsic value as defined in EVT encompasses both situational as well as individual interest. Like situational interest, it is context-specific and can differ between tasks or situations. Like individual interest, intrinsic value arises in relation to long-term engagement with certain activities (Wigfield & Cambria, 2010). However, the conceptualization of interest by Renninger and Hidi (2011) is more complex than intrinsic value, as it includes cognitive components in addition to affective ones (Wigfield & Cambria, 2010). According to Hidi and Renninger (2006), interest and intrinsic value are related in the sense that individual interest is characterized by stored value. This allows the authors to argue that value beliefs can lead to the development of interest over time, which is why they can be seen as antecedents of interest (Hidi & Renninger, 2006; see also Hulleman, Durik, Schweigert, & Harackiewicz, 2008). It should be acknowledged, however, that interest and intrinsic value stem from different theoretical frameworks in which they are embedded within different sets of constructs (for a detailed discussion on the relations between these constructs, see Wigfield & Cambria, 2010).

*Attainment value* represents the personal importance a person attaches to a specific task or to doing well in it (Eccles, 2005). It encompasses how the task relates to the person's identity and self-schema, which is why it has been linked to identity-related questions. Eccles (2005) postulates that individuals report a high attainment value for a task when they regard engaging in the task as important to their social or personal identities, thereby allowing them to express or confirm salient aspects of their self-schemata (Eccles & Wigfield, 2002). In this regard, attainment value is related to the construct of integrated regulation in self-determination theory, which refers to an individual's striving to integrate their actions so that they are congruent with their personal goals and sense of self (Ryan & Deci, 2009; Wigfield & Cambria, 2010).

*Utility value* refers to an individual's perception of the usefulness of a task for reaching their subjective short- or long-term goals (Eccles, 2005). Thus, individuals can have high utility values for a task or subject without enjoying it, because it helps them achieve a desired aim, such as choosing a certain career (Eccles & Wigfield, 2002). The task is linked to future goals and is therefore a means to an end. Utility value is similar to extrinsic motivation (Ryan & Deci, 2009), which reflects reasons for engaging in an activity not for its own sake but due to external rewards, such as positive feedback or monetary incentives. With respect to behavioral regulation as proposed by Ryan and Deci (2009), Eccles related utility value to identified regulation because of the connection to personal goals. However, utility value can also refer to important parts of the self, such as working in a certain occupation.

*Cost* as the negative value component comprises all negative consequences that emerge from engaging in a task (Eccles, 2005). The perceived costs associated with the task include the amount of effort that is needed to successfully complete the task, the lost opportunities that result from choosing one option over another, and negative emotions associated with the activity, such as anxiety (Wigfield & Eccles, 2000). Although most empirical research has focused on the positive value components, with cost being neglected for many years (Wigfield & Cambria, 2010), more recently, researchers have discussed the important role cost can have for achievement-related behavior and especially for choices. Barron and Hulleman (2015) highlighted the unique contribution of cost to explaining individuals' engagement and proposed an updated expectancy-value-cost model, where cost is considered a major component alongside expectancies and positive values instead of a sub-component of value. A deeper discussion on cost and its relation to the other value components can be found in Barron and Hulleman (2015) as well as Wigfield, Rosenzweig, and Eccles (2017).

In summary, expectancy and value beliefs are important predictors of achievement-related choices and are themselves influenced by a number of social and cultural factors. Individuals place more value on tasks that are consistent with their future long-term goals, such as career goals, and prefer those tasks to others with lower value (Eccles, 2005). This implies that relative expectancies and values for different tasks or subjects play a role in individuals' choices, a notion which will be further examined within the following sections.

### 1.1.2 Structural development of expectancy and value beliefs

The comprehensive model of EVT includes a wide variety of influencing factors that determine whether an individual expects to do well in a task or places value on it. As described above, socio-cultural processes, family characteristics, the individual's perception of these processes and characteristics, and different learning experiences all have an influence on whether and how expectancy and value beliefs emerge (Eccles, 2005). Alongside research on the emergence of beliefs, the development of expectancy and value beliefs over time has been the object of previous research. The development of expectancy and value beliefs has mostly been examined in terms of two aspects, that is, changes in the structure of beliefs and in their overall level across time (Wigfield & Eccles, 2000). In line with the focus of this dissertation, the following section will concentrate on the structure of expectancy and value beliefs and will present empirical findings on this structure and its development (for findings on mean level changes, see Section 1.3, or, e.g., Wigfield et al., 2009).

The structure of expectancy and value beliefs can be examined from different frames of reference, namely the structure of expectancy beliefs and value components within a given subject, or expectancy and value beliefs across multiple subjects. With respect to the former, Eccles, Wigfield, and colleagues (Eccles & Wigfield, 1995; Eccles et al., 1993) used factor analyses to investigate how students of different ages could distinguish between different sets of beliefs within a subject. They found that students could differentiate between expectancy and value beliefs in a domain (e.g., mathematics) as early as first grade, but that children could not distinguish between different value components (Eccles et al., 1993). Older students, however, were found to be able to differentiate between intrinsic value, attainment value, and utility value from secondary school on (Eccles & Wigfield, 1995), a finding which has been confirmed in other studies (e.g., Gaspard, Häfner, Parrisius, Trautwein, & Nagengast, 2017). Additionally, there is evidence that expectancy and value beliefs in a domain are positively related to each other and that this association increases over time (e.g., Denissen, Zarrett, & Eccles, 2007; Eccles & Wigfield, 1995; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). This was also postulated by Eccles and colleagues (1983) in the theoretical model of EVT. They suggest that students' cumulative experiences result in increased associations, such that students will perceive greater value and experience greater interests in subjects they think they are good at and will perceive lower value in subjects they do not feel competent in (Hidi & Renninger, 2006; Wigfield et al., 2009). As the opposite direction of effect (i.e., students become good at subjects they value) also seems plausible, researchers have raised the question of the causal ordering of expectancy and value beliefs (Wigfield et al., 2009). However, more evidence has been found for the former direction, that is, expectancies affecting value beliefs (Jacobs et al., 2002; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). For instance, Jacobs and colleagues (2002) examined the development of expectancy and value beliefs in various domains from Grades 1 through 12 and found that changes in expectancies accounted for a considerable share of changes in value beliefs.

The second aspect is the structure of expectancy and value beliefs across domains. Students differentiate between these beliefs in different subjects from primary school onwards, and their beliefs become more distinct over the course of time (Bong, 2001; Marsh & Ayotte, 2003). This is also true for students' interests in different school subjects, which show a more differentiated pattern as students grow older (Wigfield & Cambria, 2010). Why does this differentiation process occur? Generally, expectancies and values develop on the basis of experiences with different tasks or subjects. Feedback from socializers, such as parents and teachers, is another important source of information for students to evaluate their thoughts and feelings regarding different subjects (Wigfield et al., 2009). Finally, expectancies and values are also influenced by cultural norms (Eccles, 2005). These experiences students have with different tasks provide them with potential objects of comparison that can serve as sources of information (Möller & Marsh, 2013). On the one hand, students rely on social or external comparisons, which means that they compare their competence and interests in a subject with those of other people, such as their peers. On the other hand, students engage in dimensional or internal comparisons, which means that they compare their competence and interests in one subject (e.g., math) with their competence or interests in another subject (e.g., language arts). Research grounded in dimensional comparison theory (Möller & Marsh, 2013) states that intraindividual comparisons between subjects have an effect on students' attitudes towards these subjects (e.g., "How good am I in English compared to math?"). These dimensional comparisons, originally postulated and successfully tested for self-concepts in different domains (e.g., Guo, Marsh, Parker, Morin, & Dicke, 2017; Jansen, Schroeders, Lüdtke, & Marsh, 2015), have been transferred to other domain-specific motivational variables (Möller, Müller-Kalthoff, Helm, Nagy, & Marsh, 2016), such as students' values and interests (Gaspard et al., 2018; Nagy, Trautwein, Baumert, Köller, & Garrett, 2006; Schurtz, Pfost, Nagengast, & Artelt, 2014). Most researchers examining dimensional comparisons and cross-domain associations have looked at math or science subjects on the one hand and verbal subjects on the other hand (e.g., Bong, 2001; Marsh et al., 2015; Schurtz et al., 2014).

### 1.1.3 Relevance of expectancy and value beliefs for academic choices

Numerous studies have shown that expectancy and value beliefs are important predictors of students' achievement-related behavior and choices (for overviews, see Wigfield & Eccles, 2000; Wigfield et al., 2009). Although expectancy and value beliefs are both important for several achievement-related outcomes, a more differentiated pattern emerges when their unique predictive power is examined. It has been shown that expectancies are especially important for achievement (Marsh et al., 2005; Trautwein et al., 2012), whereas value beliefs are more closely linked to academic choices (Meece, Wigfield, & Eccles, 1990; for an overview, see Eccles, & Wigfield, 2002). Choices or intended choice that have been found to be influenced by expectancy and value beliefs include course enrollment intentions and course choices in secondary school (Meece et al., 1990; Nagy et al., 2006; Simpkins, Davis-Kean, & Eccles, 2006), choice of university major (Parker, Nagy, Trautwein, & Lüdtke, 2014), and career aspirations (Chow, Eccles, & Salmela-Aro, 2012; Lauermann, Chow, & Eccles, 2014; Watt et al., 2012). Importantly, expectancy and value beliefs are not only associated with contemporaneous course choices or career aspirations, they also predict choices at later time points, such as course selection in high school or university major choice (Durik, Vida, & Eccles, 2006; Nagy et al., 2006; Parker et al., 2014). These findings highlight the significance and applicability of EVT as an approach to explaining adolescents' career choices.

Most of these studies have examined how subject-specific expectancy and value beliefs influence choices in the respective domain. Nonetheless, in EVT, Eccles (2005; Eccles et al., 1983) argues that students usually make their choices by comparing different options, that is, various courses or subjects that they might take. This implies that expectancy and value beliefs not only for the subject at hand come into play, but also for other subjects. As outlined with respect to the structure of beliefs across domains, students make dimensional comparisons between different subjects, which in turn influence their attitudes toward these subjects (Möller et al., 2016). Students make their choices based on intraindividual hierarchies of expectancy and value beliefs, which is why considering beliefs about multiple subjects might help us understand why students prefer one option to another. Research examining beliefs about two or more subjects has included different domains, although most studies have investigated choices in the field of math and science (Chow et al., 2012; Nagy et al., 2006). For instance, Nagy and colleagues (2006) examined how self-concept and intrinsic value in math and biology predicted advanced course selection in a German high school sample and found that beliefs in math had a positive effect on course choices in math, but a negative effect on course choices in biology (and vice versa). Taking a closer look at samples from the U.S. and Finland, Chow and colleagues (2012) showed that students' patterns of value beliefs in multiple subjects predicted their later aspirations in the physical and information technology-related sciences. Gaspard and colleagues (2019) examined expectancy-value profiles in math and English in upper secondary school, finding that they predicted students' selection of university majors in math- and science-related subjects two years later. Studies by Lauermann and colleagues (2014) and Parker and colleagues (2014), who additionally considered beliefs in English and career plans in the verbal and human services field, similarly found positive effects of beliefs on choices in the matching domain and negative effects on the other, nonmatching domain. All these results underscore that adolescents consider beliefs in different subjects when weighing various career options against each other. Thus, it is important to consider students' beliefs and interests in more than one subject to better understand the intraindividual processes underlying their career choices.

As educational and occupational choices are usually made over a longer time period, multiple external factors can influence students' beliefs and thus also their choices. Besides students' own beliefs, the beliefs of significant others can have an impact on their educational and occupational choices. Parents, as important socializers, can play a central role in shaping students' beliefs and choices, which will be described in the next subsection.

### 1.1.4 Parents' influences on students' beliefs and career choices

According to EVT, parents can have an important influence on students' motivational beliefs and achievement-related choices (Eccles, 2005; Eccles et al., 1983; Eccles & Wigfield, 2002). Previous research has found that parents can shape their children's motivation, achievement, and career-related decisions through their own beliefs and behaviors (Dietrich & Kracke, 2009; Lazarides et al., 2015; Wigfield et al., 2009). Several mechanisms through which parents can influence their children's beliefs have been identified (Eccles, 1993; for an overview of empirical findings, see Simpkins, Fredricks, & Eccles, 2012): First, parents can serve as role models for their children, for example, in leisure time activities or occupations. Second, they can encourage and reinforce specific behavior, for example, by providing verbal encouragement of certain leisure time activities or engagement in certain school subjects. For instance, parents express their expectations for their children and their values when they talk with their children about school (Jacobs & Eccles, 2000). That is, they can stress the importance of a specific subject or of good performance in it. Third, through coactivity (i.e., parent and child participating in an activity together), parents can support children's engagement in specific behavior, which also affects their motivational beliefs. Fourth, parents can actively provide their children with materials and opportunities for certain experiences. This directly affects children's expectancy and value beliefs, which arise from experiences with different tasks over time (Wigfield et al., 2009). Simpkins and colleagues (2006) showed that participation in out-of-school activities in the area of math and science predicted subsequent expectancy and value beliefs in these subjects. Parents decide on the activities their children engage in, especially in their early years, and are therefore important initializers of their children's experiences, which then affect their beliefs. Several pathways have been found as to how parental beliefs are transmitted to their children and affect their children's beliefs and behaviors, and the empirical findings do not provide a clear picture. In a longitudinal study, Simpkins and colleagues (2012) demonstrated that parental beliefs predicted parental behavior, which in turn predicted students' motivational beliefs and academic behavior. Conversely, Jodl and colleagues (2001) found direct effects of parents' value beliefs on students' value beliefs.

In addition to the essential role parents play for their children's motivational beliefs, they also influence adolescents' career decision processes via their attitudes and values (Gniewosz & Noack, 2012; Jodl et al., 2001) and their behavior (Dietrich & Kracke, 2009; Noack, Kracke, Gniewosz, & Dietrich, 2010). In their study, Jodl and colleagues (2001) found that parents' value beliefs predicted not only their children's beliefs, but also their career aspirations. When adolescents were asked about potential sources of support and influence with respect to choosing a career, they listed parents as important supporters and reported that they spoke most frequently about career-related topics with their parents (Dietrich & Kracke, 2009; Tynkkynen, Nurmi, & Salmela-Aro, 2010). How exactly can parents influence their children's career-related decisions? There is evidence that students engage more in activities regarding career decision-making, such as exploring various career options, when they feel supported by their parents (Dietrich & Kracke, 2009) and when parents are open to their career ideas (Kracke & Schmitt-Rodermund, 2001). Child-centered parenting, which involves parents communicating reciprocally with their children and supporting them in their career decision-making, has also been shown to promote adolescents' maturity and self-initiative (Kracke, 2002). These characteristics are central to adolescents' career-decision processes and activities.

### 1.1.5 Conclusion

This chapter has shown that the model of EVT is a comprehensive framework that has gained ample empirical support. The proposed definition of expectancy and value beliefs enables them to be linked concretely to students' achievement-related choices. Moreover, the model includes a wide range of psychological and sociocultural determinants of these choices, allowing the complex processes underlying such choices to be investigated. Thus, EVT, which includes students' motivational beliefs, their achievement-related choices, and parental motivation, is a suitable model to serve as the theoretical basis of the present dissertation.

## 1.2 Theory of Vocational Personalities and Work Environments

In the field of vocational psychology, probably the most influential theoretical framework is the theory of vocational personalities and work environments by Holland (1959, 1997). In this theory, vocational interests represent the central construct used to describe people's occupational preferences and career pathways. Therefore, the term *theory of vocational interests* will be used hereinafter for simplicity. Like EVT, Holland's theory of vocational interests aims at explaining individuals' career choices through motivational variables. In this section, the theoretical assumptions of Holland's model will be described and the structure and development of vocational interests will be outlined. Afterwards, empirical evidence that vocational interests can predict career-related outcomes will be presented.

### 1.2.1 Four key assumptions of Holland's theory of vocational interests

Holland's theory is based on the proposition that vocational interests are important expressions of personality (Holland, 1997), that is, they are central aspects of individual differences that influence individuals' choices and behavior, not only in the area of work, but also in other life domains (Rounds & Su, 2014; Stoll & Trautwein, 2017). Holland (1997) formulates four key assumptions that form the basis of his theory. First, he assumes that most people can be categorized into one of six interest orientations, namely Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. These interest orientations can be understood as preferences for certain activities and include skills and abilities, characteristics and attitudes. People of the same interest type usually share life goals and values, have abilities in the same area and prefer similar activities and tasks. The second assumption is that there are six models of work environments: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. The environmental models represent the demands and opportunities that are dominant in a specific occupation and constitute the working atmosphere, which influences the experiences and behavior of the people working in the occupation. These processes foster and reinforce the specific abilities, skills and values that people working in the environment already exhibit. The third assumption brings together individuals' interests and work environments: people search for environments that align with their attitudes and values, let them exercise their skills and take on roles in which they feel comfortable. Thus, they seek out environments that fit their interests, creating a situation where persons of one interest type are strongly represented in a corresponding occupation. The fourth assumption is that individuals' behavior is determined by the interaction between their vocational interests and the environment. This implies that a person's interests and the work environment model predict his or her educational and vocational achievement, career choices, and social behavior (Holland, 1997).

Table 1.1

*Characteristics of Interest Orientations and Work Environments*

| | Persons with this interest orientation prefer… / This environment entails/reinforces… | Typical field of work |
|---|---|---|
| Realistic | … explicit or systematic manipulation of objects, tools, machines, and animals<br>… activities that require strength and coordination and lead to visible outcomes, including being outdoors or working with one's hands | technology, skilled trades |
| Investigative | … observational, symbolic, systematic, and creative investigation of physical, biological, and cultural phenomena<br>… activities in (natural) science | research, development |
| Artistic | … manipulation of physical, verbal, or human materials to create art forms or products<br>… ambiguous, free, and unsystematized activities that involve creativity, sensitivity, or expression | arts, languages |
| Social | … manipulation of others to inform, train, develop, cure, or enlighten<br>… interpersonal and educational activities | education, care |
| Enterprising | … manipulation of others to attain organizational goals or economic gain<br>… activities in business and leadership | business, commerce |
| Conventional | … explicit, ordered, systematic manipulation of data<br>… computational and business system activities | administration, law |

*Note.* Adapted from Stoll & Trautwein (2017) and Holland (1997).

Table 1.1 provides short characterizations of the six interest types and environmental models as well as examples of typical fields of work for each type. For instance, a person with realistic interests prefers "activities that entail explicit, ordered, or systematic manipulation of objects, tools, machines, and animals" and exhibits an "aversion to educational or therapeutic activities" (Holland, 1997, p. 21). Similarly, a realistic environment involves demands and opportunities linked to "realistic activities, such as using machines and tools" and fosters technical competencies (Holland, 1997, p. 43). In contrast, a person with high social interests prefers activities that involve "the manipulation of others to inform, train, develop, cure, or enlighten" and is interested in social and educational activities (Holland, 1997, p. 24). Similarly, a social environment encourages people to exhibit social attitudes and values and to engage in social activities (Holland, 1997, p. 46).

### 1.2.2 Structure of the six interest dimensions

The six interest types, often referred to as RIASEC according to their initials, are postulated to relate to one another in a hexagon model (Holland, 1997). The RIASEC hexagon is presented in Figure 1.2. In the model, each angle represents one interest dimension, and the order of and distances between the angles symbolize the degree of similarity among the various interest types. Holland (1997) postulates that adjacent interests are most closely related, nonadjacent interests are more weakly related, and opposite interests are the least related to one another. For example, realistic interests are supposedly most closely related to investigative and conventional interests, somewhat more weakly related to artistic and enterprising interests, and most weakly related to social interests (see Figure 1.2, where the different line widths represent the different relations between interest dimensions). These similarities and differences correspond to the preferences and aversions of persons with specific interests described in the previous section.

Individuals are assumed to express interests in more than just one of the interest dimensions and can be assigned to all of the interest types to some degree (Holland, 1997). However, they typically exhibit a different degree of interests in different activities and objects, with some interests more pronounced than others, resulting in an individual interest profile. In applied settings, the three interest dimensions in which a person expresses the highest interests are often used to form a three-letter code (e.g., SIA) that indicates the area of activities and occupational options that best align with the person's interests (Holland, 1997).

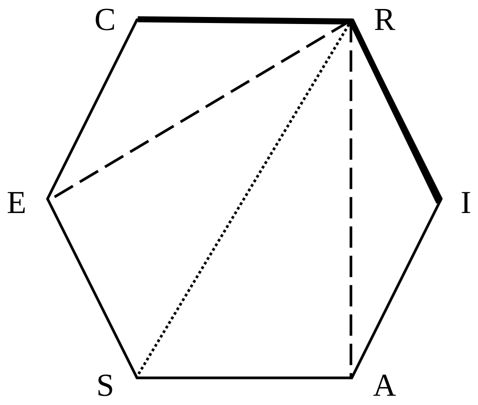


*Figure 1.2*. The RIASEC hexagon displaying the differently assumed similarities between dimensions, exemplified for R interests.

Empirical studies have tested and confirmed the postulated ordering of the interest types (R-I-A-S-E-C), although they could not always find support for the assumption of equal distances between the angles of the hexagon (Darcy & Tracey, 2007). Therefore, a circumplex model has been proposed as an alternative (Guttman, 1954). In this model, the vocational interests are placed on a circle, but the distances between the interest types are not constrained to be equal, as displayed in Figure 1.3. This model has often been used to examine RIASEC interests and has been found to represent its structure well (Armstrong, Hubert, & Rounds, 2003; Darcy & Tracey, 2007).

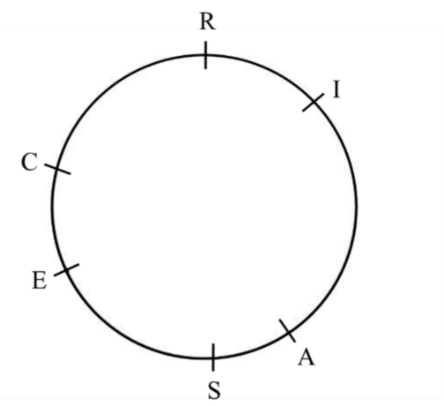


*Figure 1.3.* The RIASEC circumplex with the postulated order, but unequal distances between dimensions (example demonstration).

The circular structure of vocational interests has gained empirical support across gender, age groups and cultures, although some contradictions have also been revealed.

In a meta-analysis, Tracey and Rounds (1993) evaluated the structure of 104 RIASEC correlation matrices and their fit to the assumed circular interest model. They found support for the RIASEC ordering as well as the circular structure of interest types in a large number of samples from different age groups (Tracey & Rounds, 1993). In contrast, Tracey and Ward (1998) found that the circular structure was not appropriate for elementary school students. Furthermore, there is evidence that the circular structure holds for both males and females (Anderson, Tracey, & Rounds, 1997; Darcy & Tracey, 2007), although some findings point to slight differences between men and women in the circular arrangement and the distances between single RIASEC types (Armstrong et al., 2003). In the same study, Armstrong and colleagues also examined the circular interest structure for different U.S. racial-ethnic groups and found that the RIASEC circumplex, especially when constrained to have equal distances between types, was appropriate for Caucasians and Asian Americans, whereas it was not well suited for samples of African Americans and Hispanics. In line with this finding, studies from countries other than the U.S. have yielded diverse results that were not always in favor of the structural validity of the RIASEC circle (Fouad & Dancer, 1992; Glidden-Tracey & Parraga, 1996; Lent, Tracey, Brown, Soresi, & Nota, 2006). Examining the interest structure of German adolescents and young adults, Nagy and colleagues (2010) found support for the circular representation of RIASEC interests. Taken together, a number of studies support the circular structure postulated by Holland (1997), but have also revealed some inconsistencies for different groups of students, for example regarding age.

### 1.2.3 Development of the RIASEC interest structure

Vocational interests as preferences for certain activities start to develop in early childhood. Even before they enter school, children develop gender-based preferences, for example for different toys, and avoid activities and objects that do not match their gender identity (Gottfredson, 1981). They enter school with relatively high interests overall, but later, their interests become more specific and differentiated (Tracey, 2002). This differentiation process during children’s school years applies to vocational interests as well as interests regarding school subjects (Krapp, 2002; Tracey, Robbins, & Hofsess, 2005). Especially from middle school on, a re-evaluation of interests takes place and adolescents become aware of what they do not like, which leads to a decrease in some interest areas and an overall drop in mean interest levels (Tracey, 2002; Tracey & Ward, 1998). Holland's (1997) theory also introduces the differentiation of interests, with adolescents' interest profiles becoming more differentiated over time as they reduce their interest levels in some areas and increase their interests in other areas. This process of interest differentiation has also been described as a process of continuous elimination of interests that do not fit one's self-concept or personal identity (Todt, 1990). A differentiated interest profile exhibits clear peaks in some interest dimensions rather than being flat and undifferentiated with similar levels of interest in all dimensions. Such a differentiated pattern is helpful for successfully choosing a career, as it facilitates the decision in favor of a specific career or field of study (Holland, 1997). A number of studies have found empirical support for interest profile differentiation (Tracey, 2002; Tracey et al., 2005), although Xu and Tracey (2016) found that students' interest profiles did not crystallize further from Grade 7 onwards, which suggests that most of the change seems to take place at earlier ages. This is in line with findings by Tracey, Robbins and Hofsess (2005), who showed that adolescents' interest patterns were fairly stable in Grades 8 to 12.

In addition to interest profiles, the circular structure of the RIASEC interests changes over time. Tracey and Ward (1998) investigated the vocational interest structure of elementary school, middle school, and college students and found that the fit of the circular model improved with age: Whereas the circular RIASEC model was not an adequate representation of elementary school children's vocational interests, it had a better fit among middle and high school students. Similarly, in a longitudinal study with fifth- and eighth-grade students, Tracey (2002) showed that the circular interest structure became more distinct over time. Nagy and colleagues (2010) examined the structure of vocational interests in Germany. They compared two samples of high school and university students and found that the circular structure was a good representation for both groups. In line with these results, Darcy and Tracey (2007), who investigated the circular RIASEC structure with students from Grades 8, 10, and 12, found that the fit of the circular model only slightly varied among these cohorts. They concluded that the circular interest structure proposed by Holland is formed by eighth grade, which corresponds to the finding of Tracey and colleagues (2005) that interests become highly stable around Grade 8.

When taking a closer look at the stability of vocational interests, it appears that after much change and development during childhood, these interests become relatively stable in adolescence and adulthood. This has also been acknowledged in a meta-analytic study (Low, Yoon, Roberts, & Rounds, 2005). The authors found that vocational interests are quite stable during adolescence, and afterwards become even more stable during and after students' college years, with stability coefficients up to $\rho=0.83$ between the ages of 25 and 30. Thus, there seems to be the most room for changes in vocational interests, such as maintaining students' interests and buffering against the overall interest decline, at earlier ages, before interests become highly stable.

### 1.2.4 Relevance of vocational interests for educational and occupational choices

The important role of vocational interests for achievement-related and occupational outcomes is well-established (Rounds & Su, 2014). Vocational interests predict academic achievement and job performance, as they "direct, energize, and sustain individuals' effort on academic and work activities" (Rounds & Su, 2014, p. 19), which underscores their motivational function for career-related behavior and decisions. According to Holland (1997), people select environments that are congruent with their interests. At the same time, environments attract certain kinds of people with specific interests, which implies that people actively select and are selected by the specific demands of environments based on their interests. Vocational interests are assumed to predict career choices as a result of these selection processes.

A large number of studies have shown that vocational interests, conceptualized as Holland's (1997) RIASEC interests, predict vocational choices, such as the choice of university major (Humphreys & Yao, 2002; Päßler & Hell, 2012), vocational training (Volodina & Nagy, 2016) or high school course selection (Volodina, Nagy, & Retelsdorf, 2015) as well as job and college performance (Nye, Butt, Bradburn, & Prasad, 2018; Van Iddekinge, Roth, Putka, & Lanivich, 2011). In an early meta-analysis, Lent and colleagues (1994) examined the relation between interests and career choices, including career aspirations and expressed choices. They found an average association of $r=.60$, emphasizing the important role vocational interests play for career decisions. Päßler and Hell (2012) could show that both vocational interests and ability measures significantly contributed to predicting university major choice and that interests had an even higher unique association with this choice than ability measures. In a longitudinal study by Bergmann (1994), high school students were followed over 3.5 years during their transition from high school to college. The results showed that their vocational interests measured in high school were associated with the career aspirations they expressed at that time as well as with the field of study they chose later in college. In addition to choices in postsecondary education, decision processes during school, such as course choices, are also associated with vocational interests. Volodina, Nagy, and Retelsdorf (2015) examined the role vocational interests play in students' choice of thematic profiles in upper secondary school. They investigated a sample of German academic track school students who had to choose a thematic profile, such as the natural sciences or language arts, for their final two years of school when they entered Grade 11. Their study showed that RIASEC interest profiles assessed in Grade 9 were associated with the choice of thematic profiles two years later. For example, students who showed high interests in dimensions related to the natural sciences, such as R (e.g., working with machines) and I (e.g., doing research), were more likely to choose the natural sciences profile, whereas students with high A (e.g., writing texts) and S (e.g., caring for others) interests had a higher chance of selecting the language profile.

More generally, there is evidence that vocational interests are associated with individuals' level of educational achievement and the type of school students attend. For instance, a study from Switzerland revealed that students in different school tracks differed in their vocational interests: Students enrolled in a school type with advanced academic requirements exhibited higher I and A interests than students from a school type with more basic academic requirements (Hirschi & Läge, 2007). Similar results were found by von Maurice and Bäumer (2015), who examined primary school children before and after their transition to secondary school. They found that children who later chose the highest secondary school track already scored higher on I interests in primary school compared to children who later chose the lowest secondary school track. These results are in line with Holland's (1997) assumptions that I and A interests are related to higher educational achievement and that these associations inform educational decisions. They point to the fact that educational and occupational choices are interest-driven and that students' early interest profiles clearly influence later choices, both on a substantial level (e.g., the choice of a specific field of study) and on a qualification level (e.g., the choice of a specific school track).

### 1.2.5 Conclusion

It can be concluded from this chapter that vocational interests are central to educational and occupational choices, both during and after school. They develop throughout childhood and adolescence, undergoing changes with regard to both their mean levels and their structure. Although some researchers have postulated that vocational interests are relatively stable by Grade 8 and that their structure corresponds to the circular model, not much is known about the structural development of interests before this period, that is, in early adolescence. As students usually intensify their reflection upon occupational options during this phase, their vocational interests at this time can have a large impact on their educational and occupational choices in the following years.

## 1.3 Promoting Students' Motivational Beliefs and Career Choices

Choosing a specific career is an important and challenging task for adolescents. As students approach the transition from school to work or further education, they usually intensify their engagement in career decision behavior (Dietrich et al., 2012). The timing of such decisions as well as the specific options available can vary depending on students' school type. For example, students choose to enroll in an advanced course, a field of study at university, or select an apprenticeship after school. In either case, choosing a career or university field of study is an important developmental challenge that can substantially affect adolescents' lives (Dietrich et al., 2012). However, many students experience this decision as complex (Praskova et al., 2015) and face difficulties choosing a specific career path (Oechsle, 2009). For this reason, it is important to support them in this process. Resources for support can include individuals with whom students have a close relationship, such as friends or parents (see Section 1.1.4), but also services and programs offered by public institutions, such as career counseling. Questions related to career choices are also addressed in school, where career choice is usually a mandatory topic (Oechsle, 2009). Another way of helping students with their career decisions are intervention programs specifically designed for this purpose. A number of such interventions have been developed to help students choose a career. These intervention programs are usually grounded in vocational and career decision theories and focus on students' ability to make an informed decision (e.g., Hirschi & Läge, 2008; Koivisto, Vuori, & Nykyri, 2007). Often organized as career workshops spanning several days or even weeks, they aim at enhancing adolescents' knowledge about their own skills and interests as well as promoting their career planning activities. Empirical studies have supported the positive effects of such programs on students' career choice readiness and career-related activities (Hirschi & Läge, 2008; Mayhack, 2011). However, these intervention programs are often relatively time-consuming and require additional resources such as special settings.

Research grounded in expectancy-value theory of achievement-related choices has also generated interventions aimed at fostering students' motivational beliefs in the first place. These interventions usually try to help students see the value of what they are learning in a specific school subject for their future life and career. Such value interventions have been developed to maintain students' motivation, which often declines during adolescence (e.g., Jacobs et al., 2002). However, as students' motivational beliefs are directly connected to their educational and occupational choices, these interventions may affect students' career choices in the long term as well. In fact, some of these value interventions—the majority of which have focused on motivation in math and science subjects—have specifically been implemented to address students' tendency to not take math and science courses in high school or college (Harackiewicz, Tibbetts, Canning, & Hyde, 2014). Empirical studies have shown that such interventions can promote not only students' motivational beliefs (e.g., Gaspard et al., 2015; Hulleman & Harackiewicz, 2009), but also their later course choices in the subject addressed in the intervention (e.g., Harackiewicz, Rozek, Hulleman, & Hyde, 2012; for a review, see Rosenzweig & Wigfield, 2016). Thus, interventions targeting students' value beliefs seem to be one way to promote and support adolescents' career-related choices.

This section will describe interventions based on EVT and their effects on students' achievement-related outcomes. Afterwards, the career focus of these interventions and their potential to support students' career choices will be discussed.

### 1.3.1 Relevance interventions to promote students' motivational beliefs and achievement-related choices

A great amount of research based on EVT has demonstrated that expectancy and value beliefs play an important role for students' educational and occupational choices (see Section 1.1.3). At the same time, students' beliefs in different school subjects have been found to decline over time: There is evidence from several longitudinal studies that the mean levels of students' expectancy and value beliefs already begin to decrease in elementary school (Wigfield et al., 1997) and drop even further during adolescence (Jacobs et al., 2002; Watt, 2004). Several reasons for this decline have been discussed (for an overview, see Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006), such as increased social interests conflicting with students' school-related interests and interest differentiation across several subjects, which leads to an overall decline (see also section 1.1.2).

To counteract this decline, a number of interventions based on EVT have been developed with the goal of helping to maintain students' motivation. These interventions have mostly focused on value beliefs rather than the expectancy component and aimed to help students to see the value of the subject content for their lives (Harackiewicz et al., 2014; for a meta-analysis on self-concept interventions, see O'Mara, Marsh, Craven, & Debus, 2006). More specifically, these interventions usually address the utility value component. As utility value is seen as more extrinsic in nature than the other value beliefs (Eccles & Wigfield, 2002), it seems to be more amenable to external interventions (Harackiewicz et al., 2014) than individuals' enjoyment or the personal importance of a specific task or subject, which seem to be strongly influenced by a students' personal preferences and characteristics (Eccles, 2005). This is why it appears to be easier to encourage students to think of the usefulness of a subject for their life and future.

A number of value interventions, mostly in the area of science, technology, engineering, and math (STEM), have been tested in the laboratory as well as in classroom settings in randomized controlled trials (for reviews, see Harackiewicz et al., 2014; Rosenzweig & Wigfield, 2016). These interventions applied different strategies to promote students' utility value beliefs. Students were either provided with information on the utility of the subject content (e.g., Durik, Shechter, Noh, Rozek, & Harackiewicz, 2015, study 1; Shechter, Durik, Miyamoto, & Harackiewicz, 2011) or were encouraged to find arguments for the usefulness of the subject on their own (e.g., Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Hulleman & Harackiewicz, 2009). For example, in a study by Hulleman and Harackiewicz (2009), students assigned to the intervention condition wrote essays about the meaning of the course content to their lives, whereas students in the control condition only had to summarize the learning material. During the intervention, students were encouraged to reflect on the relevance of the learning material and to draw personal connections to their own life and future. Such relevance interventions have been shown to successfully promote value and expectancy beliefs, subject interest and performance as well as course choices and the pursuit of careers among high school and college students (for reviews, see Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016).

However, some of the studies testing different relevance interventions also uncovered unexpected or even unintended effects, raising several questions regarding the effectiveness of such interventions. For instance, Hulleman and colleagues (Hulleman et al., 2010; Hulleman & Harackiewicz, 2009) found that their intervention was especially beneficial among students with low expected or actual performance or that the effect was limited to those students. Other results even indicated negative effects of relevance interventions on interest or course-taking among students with low initial expectations or performance (Durik et al., 2015; Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz, 2015). It thus seems that students' initial success expectancies might affect how they respond to relevance interventions. In addition, the strategies of telling students about the relevance of the subject vs. making them self-generate relevance arguments had not been compared to each other. Thus, it was unclear how exactly relevance interventions should be designed in order to be most effective.

To address some of these questions, an innovative relevance intervention was designed and successfully implemented in two large randomized controlled field trials, the *Motivation in Mathematics* (*MoMa*) studies. The MoMa intervention, which was implemented in ninth grade classrooms, combined the two strategies of providing students with some arguments for the usefulness of math and letting them find further examples themselves (Brisson et al., 2017; Gaspard et al., 2015; Gaspard, Parrisius, et al., 2019). During the intervention, which lasted 90 minutes, students first watched a psychoeducative presentation that told them about several situations in which they might need math skills in their daily life and future. In addition, students were shown research findings on the role success expectations and effort play in math achievement. This was done to buffer against potential negative intervention effects among students with low performance expectations. Afterwards, students worked on relevance-inducing tasks, which slightly differed between the two MoMa studies. In the first trial (MoMa 1), two intervention conditions were compared: Students either wrote a text about the usefulness of math or evaluated interview quotations by young adults who explained how they use math in their job and daily life. The intervention was found to promote students' value beliefs, self-concept, effort and achievement in math up to five months later, with the quotations condition being more successful (Brisson et al., 2017; Gaspard et al., 2015). Therefore, in the second trial (MoMa 2), only the quotations condition was implemented. Again, two intervention conditions were compared: Students in both groups received the same intervention (i.e., the presentation and the quotations task), but the intervention was implemented by different persons. Whereas in MoMa 1, the intervention was implemented by researchers, in MoMa 2, it was implemented by either master's students or regular math teachers. Again, the intervention was found to successfully foster students' utility value and performance, although the effects were smaller compared to the first trial and some unintended effects, such as an increase of perceived cost, also occurred (Gaspard, Parrisius, et al., 2019). Taken together, it seemed that the powerful approach of the MoMa intervention prompted students to find connections between the course material and their lives, although the findings of MoMa 2 could only partly replicate the positive findings of MoMa 1. In addition, the researchers also tested intervention effects on several outcome variables that were not within the scope of previous studies, such as self-concept, effort and value beliefs apart from utility value.

In addition to studies in the school context, intervention studies have taken advantage of another important resource for influencing students' values, namely their parents. As parents can have a large impact on their children's motivational beliefs and academic choices, including career choices (see Section 1.1.4), they represent a promising means of helping students place more value on what they learn at school. Harackiewicz and colleagues (2012; Rozek et al., 2015, 2017) developed and tested a parent-based relevance intervention with the aim of promoting value beliefs among parents and their high-school-aged children and thereby enhancing students' course choices in math and science. They provided parents with information on the utility of math and science for their children's future careers and encouraged them to discuss this topic with them. They assumed that persuading parents of the usefulness of these subjects and helping them convey this to their children would lead adolescents to take more math and science courses afterwards. Indeed, the researchers demonstrated that the intervention promoted parents' utility value for STEM and interactions between parents and their children about the value of math and science. Moreover, students in the intervention group took more STEM courses in the following years and exhibited better test performance as well as higher pursuit of careers in STEM fields in the long term (Harackiewicz et al., 2012; Rozek et al., 2017). These results firstly highlight how parents are an influential and mostly untapped resource for promoting students' value beliefs and career decisions. They also highlight how downstream variables, such as course choices and career pursuit, can be influenced by relevance interventions. Another study examining such variables was conducted with college students and showed that a relevance intervention implemented in an introductory biology course had positive effects on students' subsequent course enrollment and continuance of their STEM major up to two years later (Canning et al., 2018; Hecht et al., 2019). The two studies presented here were the only ones to examine career-related outcomes of relevance interventions. As such interventions address value beliefs, which are in turn important precursors of career-related behaviors, more research is needed to further investigate the associations between value beliefs and career-related behavior in the context of interventions. The rationale behind this idea will be presented in the following subsection.

### 1.3.2 The career focus of relevance interventions

The potential of relevance interventions to promote career-related outcomes has not been the focus of previous research. This is somewhat surprising for two reasons. First, EVT, which forms the theoretical basis for this type of intervention, postulates a direct influence of value beliefs on academic choices, an argument which has been largely confirmed empirically (Wigfield et al., 2009). Fostering students' perceptions of the importance and usefulness of a subject might therefore also affect their ideas about course or career preferences. Relevance interventions have often even explicitly aimed to influence students' course and career choices, for example, to increase their selection of STEM courses or keep them in STEM careers (e.g., Harackiewicz et al., 2014; Hulleman & Harackiewicz, 2009). Thus, although it seems obvious to investigate whether such interventions can promote career-related variables, few studies have done this so far. Second, the content and material of most relevance interventions are directly oriented towards students' careers. During the interventions, students are encouraged to reflect on the usefulness of the subject for their own life and future. Thereby, a strong emphasis is placed on different career possibilities as well as connections between the course material and students' own career ideas (e.g., Gaspard et al., 2015; Harackiewicz et al., 2012). Thus, in such interventions students deal with questions regarding their future careers, which are an important element of preparing to make career-related decisions.

### 1.3.3 Conclusion

Several intervention programs have been developed to support students' career choices. These have been shown to be effective, but also require high resources. Relevance interventions based on EVT are well-established measures that have been shown to successfully promote students' motivational beliefs, effort, and achievement. There is also first evidence that it is possible to promote students' course and career-related choices with such interventions. Due to the specific career focus of relevance interventions and their encouragement that students think about their own future careers, such interventions might be a promising way to support students' career-related behaviors and choices. However, this has not yet been examined empirically, which is why research is needed to explore relevance interventions' potential to support students in choosing a career.

## 1.4 Research Questions of the Present Dissertation

The present dissertation investigates how adolescents can be supported in choosing a career. This is a matter of great importance given the substantial influence adolescents' career choices can have on their later lives and in light of the complexity of these decisions. A specific focus is on adolescents' motivational beliefs as antecedents of these choices and the potential of addressing motivational beliefs through interventions to support adolescents' career choices. Using the expectancy-value theory of achievement-related choices (Eccles et al., 1983) as a guiding framework, the effects of two relevance interventions on students' career-related outcomes are examined. Furthermore, the development of central precursors of career choices (i.e., interests) during adolescence is investigated in order to deepen our understanding of how adolescents decide on their career paths.

Hence, this dissertation is based on a comprehensive model, the expectancy-value framework, that explains career choices with individual factors, such as students' beliefs, as well as social factors, such as parents. A large body of research has found empirical support for the proposed associations between students' beliefs and achievement-related behaviors as well as with parents' beliefs and behaviors. Whereas previous studies have clearly demonstrated the importance of expectancy and value beliefs for educational and occupational choices (see Section 1.1.3) and have successfully tested interventions to foster these beliefs (see Section 1.3.1), only a few studies have looked at intervention effects on career-related outcomes.

In addition to the expectancy-value model, which is widely used in educational psychology, this dissertation applies the theory of vocational interests (Holland, 1959, 1997). This approach, which is mainly applied in vocational psychology, is also quite prominent, and much empirical support has been garnered for the assumptions of the RIASEC model (see Sections 1.2.2 and 1.2.3) as well as for the importance of vocational interests for adolescents' career-related choices (see Section 1.2.4). However, most research has focused on the vocational interests of older adolescents and young adults and not much is known about the development of RIASEC interests in early adolescence as well as their relations to other individual interests.

The present dissertation aims to extend previous research on adolescents' career choices by taking a closer look at their antecedents and investigating how career choices can be supported by relevance interventions. Thereby, this work goes beyond previous studies and aims at bridging their gaps in two ways: First, it combines central constructs from vocational and educational psychology, namely students' vocational interests and subject interests, which have only been investigated separately so far. Vocational interests and subject interests, which are both important predictors of adolescents' educational and occupational choices, exhibit similar developmental paths. Therefore, investigating the joint development of these constructs could bring new insights and help us better understand the formation of adolescents' interests (see Hidi & Ainley, 2002; Su, 2018). Second, relevance interventions are applied to support students in choosing a career. Such interventions have been found to successfully promote students' motivational beliefs and achievement, but not much is known about their effectiveness concerning career-related outcomes. Apart from the indirect positive effect relevance interventions in fields such as math can have on career choices in the STEM field by fostering students' value beliefs, they might directly influence students' career-related behavior due to their inherent career focus. Therefore, it seems important to examine the potential of relevance interventions to support adolescents' choices of a career and to investigate what kind of intervention is most effective for this purpose. Compared to other intervention programs aiming to support adolescents' career choices, relevance interventions have the advantage of often being relatively short and easy to implement in the classroom context, without requiring any special settings.

The research topic of this dissertation is investigated by means of three empirical studies. These studies use data from three different samples spanning the period of early adolescence from Grade 5 to Grade 9, and thus represent a phase that is important, first, for the development of students' motivational beliefs and interests, and second, as preparation for their later career decisions. The three studies' participants attended different German school types, namely lower-track (*Hauptschule*), middle-track (*Realschule*), and academic track schools (*Gymnasium*), and therefore differed regarding the exact career-related decisions they had to make as well as the timing of these decisions. This makes it possible to gain insights into students' career decisions at different stages and different levels of education. The two relevance interventions being tested were implemented in Grades 8 and 9, due to the importance of this period for career-related choices. The interventions had two different foci and modes of implementation. While the first was a parent-based intervention that took place at home, focused on the usefulness of different school subjects for students' careers, and aimed at supporting parents and students in their career decision-making, the second was implemented in the classroom and focused on the relevance of math for students' later lives and careers. It is possible to compare the potential of these two approaches for supporting students' career choices. Both are tested with cluster-randomized controlled field trials including assessments before and after the intervention. The specific research questions for the three empirical studies are described below.

Study 1 (*The Structural Differentiation of Interests in Early Adolescence: Vocational Interests and Subject Interests*) investigated the joint development of vocational interests and subject interests in early adolescence, which are both important antecedents of adolescents' career choices, but have been studied in separate research traditions. Therefore, not much is known about how these two interests are interrelated and no previous studies have looked at their development simultaneously. This study answers the call for researchers to bring together insights from the fields of educational and occupational psychology to deepen our understanding of interest development during early adolescence. To this end, the structural development of RIASEC interests and subject interests in math, German, and English was examined with a large longitudinal sample of 3473 low- and middle-track school students. The study focused on the differentiation of interests and investigated how the separate correlational patterns of vocational and subject interests change from Grade 5 to Grade 8 as well as how their interrelations develop over time.

Study 2 (*Helping Parents Support Adolescents' Career Orientation: Effects of a Parent-Based Utility-Value Intervention*) examined the effects of a parent-based relevance intervention on students' and parents' motivational beliefs and career orientation behavior, that is, preparation to make a career decision. The study tested whether an intervention focusing on the relevance of math, German, and English for students' future careers could help parents support their children during their career orientation process. Hence, the study built upon previous research demonstrating the role of parents as important socializers and as a source of support for adolescents regarding career-related choices. The intervention took place via a website providing information for parents and students encouraging them to reflect on the usefulness of school for students' careers. The motivational beliefs and career orientation behavior of 357 eighth grade students from middle-track schools and their parents were assessed before and four weeks after the intervention.

Study 3 (*How Can a Relevance Intervention Support Students' Career Choices?*) examined the effects of a more specific relevance intervention focusing on the usefulness of math for students' later lives and careers. The study investigated whether a classroom-based relevance intervention could serve to support students in choosing a career. Data from the MoMa 2 study were used, an intervention that has previously been shown to successfully enhance students' motivational beliefs in math. During the intervention, students were encouraged to make personal connections between the subject content in math and their own lives and careers. Data was analyzed from a large sample of 1744 ninth grade students from academic track schools who were surveyed before as well as four weeks and three months after the intervention. Intervention effects on students' motivational beliefs in math and physics, their STEM career aspirations, as well as their career orientation behavior and vocational interests were evaluated.

**References**

Anderson, M. Z., Tracey, T. J. G., & Rounds, J. (1997). Examining the invariance of Holland’s vocational interest model across gender. *Journal of Vocational Behavior, 50,* 349–364. https://doi.org/10.1006/jvbe.1996.1550

Armstrong, P. I., Hubert, L., & Rounds, J. (2003). Circular unidimensional scaling: A new look at group differences in interest structure. *Journal of Counseling Psychology*, *50*(3), 297–308. https://doi.org/10.1037/0022-0167.50.3.297

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review*, *64*, 359–372. https://doi.org/10.1037/h0043445

Atkinson, J. W. (1964). *An introduction to motivation*. Princeton, NJ: Van Nostrand.

Bandura, A. (1997). *Self-efficay: The excercise of control*. New York, NY: Freeman.

Barron, K. E., & Hulleman, C. S. (2015). Expectancy-value-cost model of motivation. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences, Second Edition: Motivational Psychology* (pp. 503–509). Oxford: Elsevier Ltd. https://doi.org/10.1016/B978-0-08-097086-8.26099-6

Bergmann, C. (1994). Gemessene versus artikulierte Interessen als Prädiktoren der Berufs- bzw. Studienfachwahl und Anpassung im Studium [Measured vs. articulated interests as predictors of course and career choices and adaptation during studies]. *Zeitschrift für Arbeits- und Organisationspsychologie*, *38*(4), 142–151.

Bong, M. (2001). Between- and within-domain relations of academic motivation among middle and high school students: Self-efficacy, task value, and achievement goals. *Journal of Educational Psychology*, *93*(1), 23–34. https://doi.org/10.1037/0022-0663.93.1.23

Brisson, B. M., Dicke, A.-L., Gaspard, H., Häfner, I., Flunger, B., Nagengast, B., & Trautwein, U. (2017). Short intervention, sustained effects: Promoting students’ math competence beliefs, effort, and achievement. *American Educational Research Journal*, *54*(6), 1048–1078. https://doi.org/10.3102/0002831217716084

Canning, E. A., Harackiewicz, J. M., Priniski, S., Hecht, C. A., Tibbetts, Y., & Hyde, J. S. (2018). Improving performance and retention in introductory biology with a utility-value intervention. *Journal of Educational Psychology*, *110*(6), 834–849. https://doi.org/10.1037/edu0000244

Chow, A., Eccles, J. S., & Salmela-Aro, K. (2012). Task value profiles across subjects and aspirations to physical and IT-related sciences in the United States and Finland.

*Developmental Psychology*, *48*(6), 1612–1628. https://doi.org/10.1037/a0030194

Darcy, M. U. A., & Tracey, T. J. G. (2007). Circumplex structure of Holland's RIASEC interests across gender and time. *Journal of Counseling Psychology*, *54*(1), 17–31. https://doi.org/10.1037/0022-0167.54.1.17

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum Press.

Denissen, J. J. A., Zarrett, N. R., & Eccles, J. S. (2007). I like to do it, I'm able, and I know I am: Longitudinal couplings between domain-specific achievement, self-concept, and interest. *Child Development*, *48*(2), 430–447. https://doi.org/10.1111/j.1467-8624.2007.01007.x

Dietrich, J., & Kracke, B. (2009). Career-specific parental behaviors in adolescents' development. *Journal of Vocational Behavior*, *75*(2), 109–119. https://doi.org/10.1016/j.jvb.2009.03.005

Dietrich, J., Parker, P., & Salmela-Aro, K. (2012). Phase-adequate engagement at the post-school transition. *Developmental Psychology*, *48*(6), 1575–1593. https://doi.org/10.1037/a0030188

Durik, A. M., Shechter, O. G., Noh, M., Rozek, C. S., & Harackiewicz, J. M. (2015). What if I can't? Success expectancies moderate the effects of utility value information on situational interest and performance. *Motivation and Emotion*, *39*(1), 104–118. https://doi.org/10.1007/s11031-014-9419-0

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology*, *98*(2), 382–393. https://doi.org/10.1037/0022-0663.98.2.382

Eccles, J. S. (1993). School and family effects on the ontogeny of children's interests, self-perceptions, and activity choices. In J. E. Jacobs (Ed.), *Nebraska Symposium on Motivation, 1992: Developmental Perspectives on Motivation.* (Vol. 40, pp. 145–208). Lincoln, NE: University of Nebraska Press.

Eccles, J. S. (2005). Subjective task values and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York, NY: Guilford.

Eccles, J. S., Adler, T., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence

(Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 74–146). New York, NY: Freeman.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin*, *21*(3), 215–225. https://doi.org/10.1177/0146167295213003

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*, 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. C. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development*, *64*(3), 830–847. https://doi.org/10.1111/j.1467-8624.1993.tb02946.x

Fouad, N. A., & Dancer, L. S. (1992). Cross-cultural structure of interests: Mexico and the United States. *Journal of Vocational Behavior*, *40*(2), 129–143. https://doi.org/10.1016/0001-8791(92)90061-4

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. *Developmental Psychology*, *51*(9), 1226–1240. https://doi.org/10.1037/dev0000028

Gaspard, H., Häfner, I., Parrisius, C., Trautwein, U., & Nagengast, B. (2017). Assessing task values in five subjects during secondary school: Measurement structure and mean level differences across grade level, gender, and academic subject. *Contemporary Educational Psychology*, *48*, 67–84. https://doi.org/10.1016/j.cedpsych.2016.09.003

Gaspard, H., Parrisius, C., Piesch, H., Wille, E., Nagengast, B., Trautwein, U., & Hulleman, C. S. (2019). The effectiveness of a relevance intervention in math classrooms: A cluster-randomized trial. *Manuscript in preparation*.

Gaspard, H., Wigfield, A., Jiang, Y., Nagengast, B., Trautwein, U., & Marsh, H. W. (2018). Dimensional comparisons: How academic track students' achievements are related to their expectancy and value beliefs across multiple domains. *Contemporary Educational Psychology*, *52*, 1–14. https://doi.org/10.1016/j.cedpsych.2017.10.003

Gaspard, H., Wille, E., Wormington, S. V., & Hulleman, C. S. (2019). How are upper secondary school students' expectancy-value profiles associated with achievement and university STEM major? A cross-domain comparison. *Contemporary*

*Educational Psychology*, *58*, 149–162. https://doi.org/10.1016/j.cedpsych.2019.02.005

Glidden-Tracey, C. E., & Parraga, M. I. (1996). Assessing the structure of vocational interests among Bolivian University students. *Journal of Vocational Behavior*, *48*(1), 96–106. https://doi.org/10.1006/jvbe.1996.0010

Gniewosz, B., & Noack, P. (2012). The role of between-parent values agreement in parent-to-child transmission of academic values. *Journal of Adolescence*, *35*(4), 809–821. https://doi.org/10.1016/j.adolescence.2011.11.007

Gottfredson, L. S. (1981). Circumscription and compromise: A developmental theory of occupational aspirations. *Journal of Counseling Psychology*, *28*(6), 545–579. https://doi.org/10.1037/0022-0167.28.6.545

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J. S., & Dicke, T. (2017). Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional comparison processes and expectancy-by-value interactions. *Learning and Instruction*, *49*, 81–91. https://doi.org/10.1016/j.learninstruc.2016.12.007

Guttman, L. (1954). A new approach to factor analysis: The radix. In P. F. Lazarsfeld (Ed.), *Mathematical thinking in the social sciences* (pp. 258–348). Glencoe, IL: Free Press.

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899–906. https://doi.org/10.1177/0956797611435530

Harackiewicz, J. M., Tibbetts, Y., Canning, E. A., & Hyde, J. S. (2014). Harnessing values to promote motivation in education. In S. A. Karabenick & T. C. Urdan (Eds.), *Motivational Interventions - Advances in Motivation and Achievement (Vol. 18)* (pp. 71–105). Bingley, UK: Emerald Group Publishing Limited. https://doi.org/10.1108/S0749-742320140000018002

Hecht, C. A., Harackiewicz, J. M., Priniski, S. J., Canning, E. A., Tibbetts, Y., & Hyde, J. S. (2019). Promoting persistence in the biological and medical sciences: An expectancy-value approach to intervention. *Journal of Educational Psychology*. Advance online publication. https://doi.org/10.1037/edu0000356

Heine, C., Willich, J., & Schneider, H. (2010). *Informationsverhalten und Entscheidungsfindung bei der Studien- und Berufswahl. Studienberechtigte 2008 ein* *halbes Jahr vor dem Erwerb der Hochschulreife [Information seeking and decision making regarding course and career choices. 2008's high school graduates half a year before graduation]*. HIS Forum Hochschule.

Hidi, S., & Ainley, M. (2002). Interest and adolescence. In F. Pajares & T. Urdan (Eds.), *Academic Motivation of Adolescents* (pp. 247–275). Greenwich: Information Age Publishing.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hirschi, A., & Läge, D. (2007). Holland's secondary constructs of vocational interests and career choice readiness of secondary students: Measures for related but different constructs. *Journal of Individual Differences*, *28*(4), 205–218. https://doi.org/10.1027/1614-0001.28.4.205

Hirschi, A., & Läge, D. (2008). Increasing the career choice readiness of young adolescents: An evaluation study. *International Journal for Educational and Vocational Guidance*, *8*(2), 95–110. https://doi.org/10.1007/s10775-008-9139-7

Holland, J. L. (1959). A theory of vocational choice. *Journal of Counseling Psychology*, *6*, 35–45. https://doi.org/10.1037/h0040767

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources. https://doi.org/10.1016/0022-4405(74)90056-9

Hulleman, C. S., Durik, A. M., Schweigert, S. A., & Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of Educational Psychology*, *100*(2), 398–416. https://doi.org/10.1037/0022-0663.100.2.398

Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology*, *102*(4), 880–895. https://doi.org/10.1037/a0019506

Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science*, *326*(5958), 1410–1412. https://doi.org/10.1126/science.1177067

Humphreys, L. G., & Yao, G. (2002). Prediction of graduate major from cognitive and self-report test scores obtained during the high school years. *Psychological Reports*, *90*(1), 3–30. https://doi.org/10.2466/PR0.90.1.3-30

Jacobs, J. E., & Eccles, J. S. (2000). Parents, task values, and real-life achievement-related choices. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 405–439). San Diego, CA: Academic Press. https://doi.org/10.1016/b978-012619070-0/50036-2

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development*, *73*(2), 509–527. https://doi.org/10.1111/1467-8624.00421

Jansen, M., Schroeders, U., Lüdtke, O., & Marsh, H. W. (2015). Contrast and assimilation effects of dimensional comparisons in five subjects: An extension of the I/E Model. *Journal of Educational Psychology, 107*(4), 1086–1101. https://doi.org/10.1037/edu0000021

Jodl, K. M., Michael, A., Malanchuk, O., Eccles, J. S., & Sameroff, A. (2001). Parents' roles in shaping early adolescents' occupational aspirations. *Child Development*, *72*(4), 1247–1265. https://doi.org/10.1111/1467-8624.00345

Koivisto, P., Vuori, J., & Nykyri, E. (2007). Effects of the School-to-Work Group Method among young people. *Journal of Vocational Behavior*, *70*, 277–296. https://doi.org/10.1016/j.jvb.2006.12.001

Kracke, B. (2002). The role of personality, parents and peers in adolescents career exploration. *Journal of Adolescence*, *25*(1), 19–30. https://doi.org/10.1006/jado.2001.0446

Kracke, B., & Schmitt-Rodermund, E. (2001). Adolescents' career exploration in the context of educational and occupational transitions. In J.-E. Nurmi (Ed.), *Navigating through adolescence: European perspectives*. New York, NY: Falmer Press.

Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and Instruction*, *12,* 383–409. https://doi.org/10.1016/S0959-4752(01)00011-1

Lauermann, F., Chow, A., & Eccles, J. S. (2014). Differential effects of adolescents' expectancy and value beliefs about math and English on math/science-related and human-services-related career plans. *International Journal of Gender, Science and Technology*, *7*(2), 205–228.

Lazarides, R., Harackiewicz, J. M., Canning, E. A., Pesu, L., & Viljaranta, J. (2015). The role of parents in students' motivational beliefs and values. In *The Routledge International Handbook of Social Psychology of the Classroom* (pp. 53–66). https://doi.org/10.4324/9781315716923

Lazowski, R. A., & Hulleman, C. S. (2016). Motivation interventions in education: A meta-analytic review. *Review of Educational Research*, *86*(2), 602–640. https://doi.org/10.3102/0034654315617832

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance. *Journal of Vocational Behavior*, *45*(1), 79–122. https://doi.org/10.1006/jvbe.1994.1027

Lent, R. W., Tracey, T. J. G., Brown, S. D., Soresi, S., & Nota, L. (2006). Development of interests and competency beliefs in Italian adolescents: An exploration of circumplex structure and bidirectional relationships. *Journal of Counseling Psychology*, *53*(2), 181–191. https://doi.org/10.1037/0022-0167.53.2.181

Low, K. S. D., Yoon, M., Roberts, B. W., & Rounds, J. (2005). The stability of vocational interests from early adolescence to middle adulthood: A quantitative review of longitudinal studies. *Psychological Bulletin*, *131*(5), 713–737. https://doi.org/10.1037/0033-2909.131.5.713

Marsh, H. W., Abduljabbar, A. S., Parker, P. D., Morin, A. J. S., Abdelfattah, F., Nagengast, B., Möller, J., & Abu-Hilal, M. M. (2015). The internal/external frame of reference model of self-concept and achievement relations: Age-cohort and cross-cultural differences. *American Educational Research Journal*, *52*(1), 168–202. https://doi.org/10.3102/0002831214549453

Marsh, H. W., & Ayotte, V. (2003). Do multiple dimensions of self-concept become more differentiated with age? The differential distinctiveness hypothesis. *Journal of Educational Psychology*, *95*(4), 687–706. https://doi.org/10.1037/0022-0663.95.4.687

Marsh, H. W., & Shavelson, R. (1985). Self-concept: Its multifaceted, hierarchical structure. *Educational Psychologist*, *20*(3), 107–123.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standarized test scores. Reciprocal effects models of causal ordering. *Child Development*, *76*(2), 397–416. https://doi.org/0009-3920/2005/7602-0007

Mayhack, K. (2011). *Gemeinsam auf dem Weg zum Beruf. Intervention zur Förderung* *berufswahlrelevanter Kompetenzen von Schülern durch den Elterneinbezug in die Schule [Together towards a career. An intervention to promote students' career-related competencies by involving parents in school]* (Dissertation). Retrieved from https://d-nb.info/1017972362/34.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology*, *82*(1), 60–70. https://doi.org/10.1037/0022-0663.82.1.60

Möller, J., & Marsh, H. W. (2013). Dimensional comparison theory. *Psychological Review*, *120*, 544–560. https://doi.org/10.1037/a0032459

Möller, J., Müller-Kalthoff, H., Helm, F., Nagy, N., & Marsh, H. W. (2016). The generalized internal/external frame of reference model: An extension to dimensional comparison theory. *Frontline Learning Research*, *4*(2), 1–11. https://doi.org/10.14786/flr.v4i2.169

Nagengast, B., Marsh, H. W., Scalas, L. F., Xu, M. K., Hau, K.-T., & Trautwein, U. (2011). Who took the "x" out of expectancy-value theory? A psychological mystery, a substantive-methodological synergy, and a cross-national generalization. *Psychological Science*, *22*(8), 1058–1066. https://doi.org/10.1177/0956797611415540

Nagy, G., Trautwein, U., Baumert, J., Köller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. *Educational Research and Evaluation*, *12*(4), 323–345. https://doi.org/10.1080/13803610600765687

Nagy, G., Trautwein, U., & Lüdtke, O. (2010). The structure of vocational interests in Germany: Different methodologies, different conclusions. *Journal of Vocational Behavior*, *76*, 153–169. https://doi.org/10.1016/j.jvb.2007.07.002

Noack, P., Kracke, B., Gniewosz, B., & Dietrich, J. (2010). Parental and school effects on students' occupational exploration: A longitudinal and multilevel analysis. *Journal of Vocational Behavior*, *77*(1), 50–57. https://doi.org/10.1016/j.jvb.2010.02.006

Nye, C. D., Butt, S. M., Bradburn, J., & Prasad, J. (2018). Interests as predictors of performance: An omitted and underappreciated variable. *Journal of Vocational Behavior*, *108*, 178–189. https://doi.org/10.1016/j.jvb.2018.08.003

O'Mara, A. J., Marsh, H. W., Craven, R. G., & Debus, R. L. (2006). Do self-concept interventions make a difference? A synergistic blend of construct validation and meta-analysis. *Educational Psychologist*, *41*(3), 181–206. https://doi.org/10.1207/s15326985ep4103_4

OECD. (2004). *Career guidance and public policy: Bridging the gap*. Paris: OECD Publishing. https://doi.org/10.1787/9789264105669-en

Oechsle, M. (2009). Berufsorientierungsprozesse unter Bedingungen entgrenzter Arbeit und entstandardisierter Lebensläufe – subjektives Handeln und institutionelle Einflüsse [Career orientation processes under conditions of delimited work and de-standardised CVs - subjective action and institutional influences]. In M. Oechsle, H. Knauf, C. Maschetzke, & E. Rosowski (Eds.), *Abitur und was dann?* (pp. 23–44). Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-91750-4_2

Parker, P., Nagy, G., Trautwein, U., & Lüdtke, O. (2014). Predicting career aspirations and university majors from academic ability and self-concept: A longitudinal application of the internal-external frame of reference model. In I. Schoon & J. S. Eccles (Eds.), *Gender Differences in Aspirations and Attainment: A Life Course Perspective* (pp. 224–246). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139128933.015

Päßler, K., & Hell, B. (2012). Do interests and cognitive abilities help explain college major choice equally well for women and men? *Journal of Career Assessment*, *20*(4), 479–496. https://doi.org/10.1177/1069072712450009

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, *63*, 167–199. https://doi.org/10.3102/00346543063002167

Praskova, A., Creed, P. A., & Hood, M. (2015). Career identity and the complex mediating relationships between career preparatory actions and career progress markers. *Journal of Vocational Behavior*, *87*, 145–153. https://doi.org/10.1016/j.jvb.2015.01.001

Renninger, K. A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist*, *46*(3), 168–184. https://doi.org/10.1080/00461520.2011.587723

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist*, *51*(2), 146–163. https://doi.org/10.1080/00461520.2016.1154792

Rounds, J., & Su, R. (2014). The nature and power of interests. *Current Directions in Psychological Science*, *23*(2), 98–103. https://doi.org/10.1177/0963721414522812

Rozek, C. S., Hyde, J. S., Svoboda, R. C., Hulleman, C. S., & Harackiewicz, J. M. (2015). Gender differences in the effects of a utility-value intervention to help parents motivate adolescents in mathematics and science. *Journal of Educational Psychology*, *107*(1), 195–206. https://doi.org/10.1037/a0036981

Rozek, C. S., Svoboda, R. C., Harackiewicz, J. M., Hulleman, C. S., & Hyde, J. S. (2017). Utility-value intervention with parents increases students' STEM preparation and career pursuit. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(5), 909–914. https://doi.org/10.1073/pnas.1607386114

Ryan, R. M., & Deci, E. L. (2009). Promoting self-determined school engagement: Motivation, learning, and well-being. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 171–195). New York: Routledge.

Schiefele, U. (2009). Situational and individual interest. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 197–222). New York: Routledge.

Schurtz, I. M., Pfost, M., Nagengast, B., & Artelt, C. (2014). Impact of social and dimensional comparisons on student's mathematical and English subject-interest at the beginning of secondary school. *Learning and Instruction*, *34*, 32–41. https://doi.org/10.1016/j.learninstruc.2014.08.001

Shechter, O. G., Durik, A. M., Miyamoto, Y., & Harackiewicz, J. M. (2011). The role of utility value in achievement behavior: The importance of culture. *Personality and Social Psychology Bulletin*. https://doi.org/10.1177/0146167210396380

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, *42*(1), 70–83. https://doi.org/10.1037/0012-1649.42.1.70

Simpkins, S. D., Fredricks, J. A., & Eccles, J. S. (2012). Charting the Eccles' expectancy-value model from mothers' beliefs in childhood to youths' activities in adolescence. *Developmental Psychology*, *48*(4), 1019–1032. https://doi.org/10.1037/a0027468

Stoll, G., & Trautwein, U. (2017). Vocational interests as personality traits: Characteristics, development, and significance in educational and organizational environments. In J. Specht (Ed.), *Personality Development Across the Lifespan* (pp. 401–417). London: Academic Press. https://doi.org/10.1016/B978-0-12-804674-6.00025-9

Su, R. (2018). The three faces of interests: An integrative review of interest research in vocational, organizational, and educational psychology. *Journal of Vocational Behavior*. Advance online publication. https://doi.org/10.1016/j.jvb.2018.10.016

Todt, E. (1990). Development of interest. In H. Hetzer (Ed.), *Applied developmental psychology of children and youth*. Wiesbaden: Quelle & Meyer.

Tracey, T. J. G. (2002). Development of interests and competency beliefs: A 1-year longitudinal study of fifth- to eighth-grade students using the ICA-R and structural equation modeling. *Journal of Counseling Psychology*, *49*(2), 148–163. https://doi.org/10.1037/0022-0167.49.2.148

Tracey, T. J. G., Robbins, S. B., & Hofsess, C. D. (2005). Stability and change in interests: A longitudinal study of adolescents from grades 8 through 12. *Journal of Vocational Behavior*, *66*, 1–25. https://doi.org/10.1016/j.jvb.2003.11.002

Tracey, T. J. G., & Rounds, J. (1993). Evaluating Holland's and Gati's vocational-interest models: A structural meta-analysis. *Psychological Bulletin*, *113*, 229–246. https://doi.org/10.1037/0033-2909.113.2.229

Tracey, T. J. G., & Ward, C. C. (1998). The structure of children's interests and competence perceptions. *Journal of Counseling Psychology*, *45*(3), 290–303. https://doi.org/10.1037/0022-0167.45.3.290

Trautwein, U., Marsh, H. W., Nagengast, B., Lüdtke, O., Nagy, G., & Jonkmann, K. (2012). Probing for the multiplicative term in modern expectancy–value theory: A latent interaction modeling study. *Journal of Educational Psychology*, *104*(3), 763–777. https://doi.org/10.1037/a0027470

Tynkkynen, L., Nurmi, J.-E., & Salmela-Aro, K. (2010). Career goal-related social ties during two educational transitions: Antecedents and consequences. *Journal of Vocational Behavior*, *76*(3), 448–457. https://doi.org/10.1016/j.jvb.2009.12.001

Van Iddekinge, C. H., Roth, P. L., Putka, D. J., & Lanivich, S. E. (2011). Are you interested? A meta-analysis of relations between vocational interests and employee performance and turnover. *Journal of Applied Psychology*, *96*, 1167–1194. https://doi.org/10.1037/a0024343

Volodina, A., & Nagy, G. (2016). Vocational choices in adolescence: The role of gender, school achievement, self-concepts, and vocational interests. *Journal of Vocational Behavior*, *95–96*, 58–73. https://doi.org/10.1016/j.jvb.2016.07.005

Volodina, A., Nagy, G., & Retelsdorf, J. (2015). Berufliche Interessen und der Übergang in die gymnasiale Profiloberstufe: Ihre Struktur und Vorhersagekraft für das individuelle Wahlverhalten [Vocational interests and the transition to upper secondary school: Their structure and predictive power for choices]. *Zeitschrift für Pädagogische Psychologie*, *29*(2), 89–100. https://doi.org/10.1024/1010-0652/a000154

von Maurice, J., & Bäumer, T. (2015). Entwicklung allgemeiner Interessenorientierungen beim Übergang von der Grundschule in den Sekundarbereich [Development of general interests at the transition from primary to secondary school]. In C. Tarnei & F. G. Hartmann (Eds.), *Berufliche Interessen. Beiträge zur theorie von J. L. Holland* (pp. 63–85). Münster: Waxmann.

Watt, H. M. G. (2004). Development of adolescents' self-perceptions, values, and task perceptions according to gender and domain in 7th- through 11th-grade Australian students. *Child Development*, *75*(5), 1556–1574. https://doi.org/10.1111/j.1467-8624.2004.00757.x

Watt, H. M. G., Shapka, J. D., Morris, Z. A., Durik, A. M., Keating, D. P., & Eccles, J. S. (2012). Gendered motivational processes affecting high school mathematics participation, educational aspirations, and career plans: A comparison of samples from Australia, Canada, and the United States. *Developmental Psychology*, *48*(6), 1594–1611. https://doi.org/10.1037/a0027838

Wigfield, A., & Cambria, J. (2010). Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Developmental Review*, *30*, 1–35. https://doi.org/10.1016/j.dr.2009.12.001

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review*, *12*(3), 265–310. https://doi.org/10.1016/0273-2297(92)90011-P

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68–81. https://doi.org/10.1006/ceps.1999.1015

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R. W., & Davis-Kean, P. (2006). Development of achievement motivation. In N. Eisenberg (Ed.), *Handbook of child* *psychology*. *Volume 3: Social, emotional, and personality development* (pp. 933–1002). Hoboken, NJ: Wiley.

Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A. J. A., Freedman-Doan, C., & Blumenfeld, P. C. (1997). Change in children's competence beliefs and subjective task values across the elementary school years : A 3-year study, *89*(3), 451–469.

Wigfield, A., Rosenzweig, E. Q., & Eccles, J. S. (2017). Achievement values: Interactions, interventions, and future directions. In An. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation: Theory and application. (2nd ed.)* (pp. 116–134). New York, NY: Guilford Press.

Wigfield, A., Tonks, S., & Klauda, S. L. (2009). Expectancy-value theory. In K. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 55–75). New York, NY: Routledge.

Xu, H., & Tracey, T. J. G. (2016). Stability and change in interests: A longitudinal examination of grades 7 through college. *Journal of Vocational Behavior*, *93*, 129–138. https://doi.org/10.1016/j.jvb.2016.02.002

# 2 Study 1: The Structural Differentiation of Interests in Early Adolescence: Vocational Interests and Subject Interests

Piesch, H., Stoll, G., Gaspard, H., Gfrörer, T., Nagengast, B., & Trautwein, U. (to be submitted). The Structural Differentiation of Interests in Early Adolescence: Vocational Interests and Subject Interests.

## Abstract

Vocational interests and subject interests are both important predictors of educational and occupational choices and have some conceptual similarities. For both interest constructs, adolescence is an important phase of development because interests become more differentiated during this time period. Jointly investigating the development of the two constructs and their interrelations could add to the understanding of interest development. This study combined the two interest constructs by looking at the structural development and differentiation of vocational and subject interests in early adolescence. Vocational interests and subject interests in math, German, and English were assessed each year from Grade 5 to Grade 8 in a sample of 3,473 students from German low and middle track schools ($M_{\text{Age}}$ = 11.1 in Grade 5). Inspections of correlational patterns as well as circular unidimensional scaling analyses revealed partial support for a differentiation in interests over time. Subject interests showed similar correlations between verbal subjects and correlations with math that changed only slightly from Grade 5 to Grade 8. By contrast, the pattern for vocational interests showed a larger process of differentiation over time. The circular structure represented the data well at all time points with increasing fit in the higher grades, although the degree of differentiation differed between the vocational interest dimensions. Associations between the two interest constructs were somewhat as expected. The findings suggest that early adolescence is an important period for interest differentiation, the understanding of which might benefit from examining vocational and subject interests together.

## The Structural Differentiation of Interests in Early Adolescence: Vocational Interests and Subject Interests

What am I interested in? Which topics do I want to know more about? These are typical questions for adolescents who are exploring their interests, for example, when thinking about various school subjects or future career options. Interests guide why and how a person chooses to engage in an activity (Krapp, 2000) and can refer to a multitude of objects. They are central predictors of learning and achievement (e.g., Hidi, 2001; Köller, Baumert, & Schnabel, 2001) and play an important role in determining career choices (e.g., Rounds & Su, 2014). Adolescence is known to be crucial for interest development, as young people develop more differentiated interests during this time (Krapp, 2002; Tracey, Robbins, & Hofsess, 2005). As differentiated interests guide later educational and occupational choices, it is especially important to understand how interests develop and differentiate during adolescence.

The construct of interest has been conceptualized in different ways in the fields of educational and vocational psychology. In educational psychology, interests usually refer to different school subjects and have been investigated in the school context (Hidi, 2006). In vocational psychology, where Holland's (1997) RIASEC taxonomy is central, vocational interests indicate preferences for specific work activities (Rounds & Su, 2014). Stemming from different theoretical backgrounds, vocational interests and subject interests have rarely been investigated together in one study. To our knowledge, no previous study has looked at the joint development of vocational interests and subject interests or has examined their interrelations over time. However, the two constructs show similar development. Researchers from both educational and vocational psychology have found that adolescents show a more differentiated interest pattern compared with younger children and develop a clearer structure of different interest domains over time (Krapp, 2002; Tracey et al., 2005). Bringing together insights from the two perspectives could expand the understanding of the development of interests during adolescence (Hidi & Ainley, 2002). Especially knowledge about the associations between different interest domains and their development over time could add to the understanding of how adolescents' interests are organized. This might provide the chance to identify why students' interests in specific subjects or activities tend to increase or decrease and help identify ways to promote or maintain adolescents' interests.

In this study, we investigated the structural development of vocational interests according to Holland's (1997) RIASEC model and subject interests in math, German, and English. We examined the differentiation of vocational and subject interests as well as associations between the two constructs during early adolescence in a large sample of German low and middle track school students in Grades 5 to 8.

**Vocational Interests: Holland's RIASEC Model**

Holland's (1959, 1997) theory of vocational interests, which is one of the most important theories for describing people and their work environments, suggests that individuals can be categorized according to six interest dimensions: realistic (R), investigative (I), artistic (A), social (S), enterprising (E), and conventional (C). These interest dimensions represent preferences for activities and contexts and are seen as trait-like (Holland, 1997). At the same time, working environments can be described by the same six dimensions, reflecting the demands and opportunities offered by the respective environment. On the one hand, the model represents the idea that people search for environments that fit their interests and, on the other hand, the idea that environments reinforce people's interests and values (Holland, 1997).

Regarding the structure of the six interest dimensions, Holland (1997) proposed that they could be placed in a hexagon, where the distances between the angles represent the similarities between the interest dimensions (see Figure 1a). Adjacent interest dimensions are postulated to be more strongly related than nonadjacent dimensions, and opposite interests are postulated to be weakly or even negatively related.

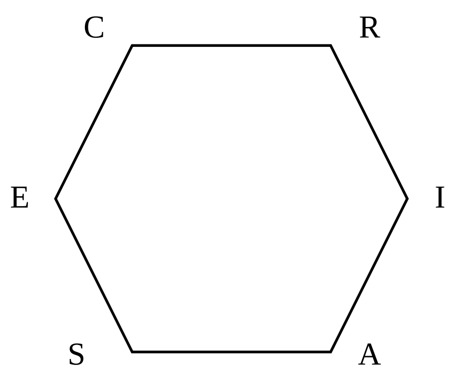


*Figure 1a.* RIASEC model as a hexagon.

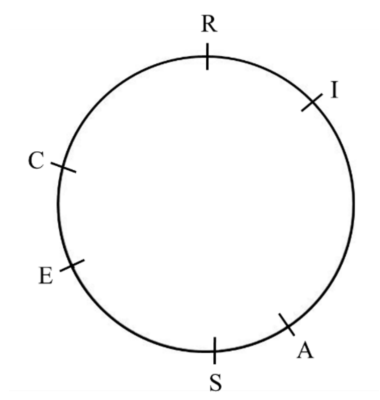


*Figure 1b.* RIASEC model as a circumplex without equal distances between interests (example demonstration).

Although empirical research has shown the postulated ordering of the dimensions (R-I-A-S-E-C), the assumption of equal distances between the angles has not always been supported (e.g., Darcy & Tracey, 2007). Therefore, current research has proposed and found support for a circular model (see Figure 1b) to better represent the RIASEC interest structure (Armstrong, Hubert, & Rounds, 2003; Darcy & Tracey, 2007).

The circular structure of vocational interests has largely been confirmed (Tracey & Rounds, 1993). However, most studies that have supported the circular RIASEC model were conducted in the US, and findings from other countries have been mixed in terms of the structural validity of the circular model (e.g., Fouad & Dancer, 1992; Glidden-Tracey & Parraga, 1996; Lent, Tracey, Brown, Soresi, & Nota, 2006). Two studies that investigated the structure of vocational interests in German samples found support for the circular representation, although their findings are limited to older students because they only examined samples of high school or university students (Nagy, Trautwein, & Lüdtke, 2010; Volodina, Nagy, & Retelsdorf, 2015).

## Development of the Circular RIASEC Structure: Interest Differentiation

Vocational interests as preferences for objects or activities are proposed to be relatively broad in early childhood and later become more specific and differentiated, especially from the beginning of middle school (Tracey, 2002). Holland (1997) introduced the construct of the differentiation of a person’s interests, which can be shown in an interest profile that has rather clear peaks in some interest dimensions compared with others. This assumption has gained empirical support (Tracey, 2002; Tracey & Ward, 1998). The differentiation of vocational interests resembles a process involving the continuous elimination of interests that do not fit one’s self-concept or personal identity (Todt, 1990).

The differentiation process is manifested not only in a pronounced interest profile but also in the RIASEC interests’ circular structure, which develops over time. The circular representation is based on the pattern of associations between the six interest dimensions, with the strongest associations between dimensions that are located next to each other going around the circle (e.g., R and I) and the weakest associations between dimensions that are across from each other (e.g., R and S; Holland, 1997; Volodina et al., 2015). Along with his colleagues, Tracey (Darcy & Tracey, 2007; Tracey, 2002; Tracey & Ward, 1998; Xu & Tracey, 2016) was able to show that the representation of the

RIASEC circle improved with age. Whereas in elementary school, the circumplex model was not a good representation of the data, the fit of the model improved in middle school and remained stable in high school. Thus, Darcy and Tracey (2007) concluded that the circular interest structure is formed by the time students are in the eighth grade, that is, around the age of 14. However, most research on the structural validity of the RIASEC circle has investigated samples of participants who were in late adolescence or early adulthood (e.g., Darcy & Tracey, 2007; Lent et al., 2006; Nagy et al., 2010), and not much is known about how the circular structure develops in early adolescence.

**Subject Interests: Individual Interests in the School Context**

In the school context, individual interests are defined as relatively enduring predispositions to re-engage with particular content (Hidi, 2006). This content can be a specific object, topic, or subject area (Schiefele, 2009). That is, rather than being globally interested in school, a student's interests become related to specific school subjects and evolve from repeated experience with the subjects (Hidi, 2006; Hidi, Renninger, & Krapp, 2004). Thus, subject specificity is an important characteristic of interests.

There is ample evidence that subject interests positively influence many learning outcomes, such as students' attention, deep-level learning, course choices, and achievement in the respective subject (Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008; Köller et al., 2001; McDaniel, Waddill, Finstad, & Bourg, 2000; for a literature review, see Hidi & Renninger, 2006). In many of these studies, interests were measured with respect to one subject, which emphasizes the domain specificity of interests also stated in theory (Hidi et al., 2004).

**Development of Associations between Subject Interests: Interest Differentiation**

As proposed by Marsh and Shavelson (1985), academic subjects can be placed along a continuum ranging from math to verbal domains, where math is located on the mathematical end of the continuum, and languages, such as German and English, are located on the verbal end of the continuum. The similarities in subjects become apparent, for example, through students' perceptions of the subjects, such as interests or self-concepts, that are differently related between the subjects (Guo, Marsh, Parker, Morin, & Dicke, 2017; Schurtz, Pfost, Nagengast, & Artelt, 2014). According to the subject's position on the continuum, students' interests in two verbal subjects have been found to be moderately associated, whereas the associations between interests in verbal subjects and math interests have been found to be weaker (in a sample of fifth and sixth graders; Schurtz et al., 2014) or even zero (in a sample of students in Grades 5 to 12; Gaspard et al., 2018).

How do these domain-specific interests develop over time? Students typically have relatively high interests in many subjects when they enter school, but as the years go by, their interests become more differentiated (Schurtz et al., 2014; Wigfield & Cambria, 2010). During adolescence, researchers have found an overall decline in interests in most subjects (e.g., Gottfried, Fleming, & Gottfried, 2001; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002), which entails a further differentiation of interests, similar to the differentiation of vocational interests. This self-differentiation is proposed to result from students' growing experiences with various subjects as well as more differentiated self-perceptions (Marsh & Ayotte, 2003) that allow students to realize that their interests differ between subjects. However, as Wigfield and Cambria (2010) outlined, students are already beginning to differentiate between subjects in primary school. Thus, if students have already developed differentiated subject interests during their earlier school careers, their subject interests might not change much in adolescence.

### Similarities between Vocational Interests and Subject Interests

Vocational and subject interests have been conceptualized in different contexts. Despite their different conceptualizations, they also have some important commonalities. First, they are both motivational variables that dispose individuals to engage in particular behavior. Vocational interests lead people to engage in specific career-related activities (Holland, 1997), whereas subject interests lead students to engage in learning in the specific subject (Hidi, 2006). Thus, both types of interests are context- and subject-specific, always referring to a particular object of interest.

Second, vocational as well as subject interests are viewed as maintained and enduring interests. In a meta-analysis, Low et al. (2005) showed that vocational interests are extremely stable during adolescence, with stabilities further increasing toward adulthood. Subject interests refer to the subject as a whole and represent relatively stable dispositions (Hidi & Renninger, 2006).

Third, and most important for the present investigation, the two types of interests exhibit similar development. Vocational interests (Holland, 1997; Stoll & Trautwein, 2017) and subject interests (Silvia, 2001; Wigfield & Cambria, 2010) develop in an interaction with a person's environment and repeated experiences with the object of interest. Additionally, during adolescence, most interests decline on average (see, e.g., Jacobs et al., 2002, for subject interests; Tracey, 2002, for vocational interests). This decline is associated with a differentiation process such that vocational interests (Tracey et al., 2005) and subject interests (Krapp, 2002; Wigfield & Cambria, 2010) are proposed to become more differentiated over time. Thus, the phase of adolescence seems to be crucial for the development of both interest constructs (Krapp, 2002; Tracey et al., 2005).

**Joint Development and Differentiation of Vocational Interests and Subject Interests**

Vocational interests and subject interests have been conceptualized from different theoretical perspectives and have rarely been investigated together in one study. However, several researchers have recently called for insights from research on vocational interests and subject interests to be brought together because studying their interrelations might help extend the understanding of the development of interests and abilities, both of which are important for students' educational outcomes (Hidi & Ainley, 2002; Su, 2018). Hidi and Ainley (2002) highlighted the idea that subject interests in childhood are important for the development of vocational interests in adolescence and early adulthood.

Although the two interest constructs refer to different objects—vocational activities and school subjects—they can be assumed to overlap to some extent. For example, adolescents might engage in activities in the school context that refer not only to specific subjects but also to certain occupations or fields of study. Because they spend much of their time in school, they might experience the school context as an important environment that affects their subject interests as well as their vocational interests. This means that vocational interests and subject interests are probably influenced by similar environmental factors during adolescence. In addition, the differentiation process, which occurs for both interest constructs, might have similar roots, such as a larger number of experiences and growing knowledge about one's own preferences (Tracey et al., 2005; Wigfield & Cambria, 2010), as well as similar effects, such as greater maturation with respect to one's own vocational future and higher career-choice readiness (Hirschi & Läge, 2007). It is thus safe to assume that the processes of interest differentiation regarding vocational activities and school subjects inform each other.

When thinking about content-related overlaps between vocational and subject interests, the RIASEC interests are more similar to some school subjects than to others. For instance, realistic and investigative interests are most closely related to math and science, whereas artistic interests include interests in languages and are therefore more similar to verbal subjects (Holland, 1997). There is also empirical support for the proximities of the RIASEC interests to certain school subjects (Volodina & Nagy, 2016).

Until today, only a few studies have examined vocational interests in the educational context, focusing on their predictive power for course choices. In a review of studies on Australian students, Elsworth et al. (1999) found that the school subjects students chose in their final years of secondary school were positively associated with one or two dimensions of the RIASEC interests (e.g., math and physics were associated with investigative interest). They concluded that students' subject choices occur along dimensions that are congruent with the RIASEC interests. However, not much is known about associations between the RIASEC interests and interests related to school subjects.

**The Present Study**

In the present study, we jointly investigated vocational interests and subject interests in early adolescence. We examined the structural development of these interests with regard to interest differentiation. In addition, we were interested in the interrelations between the two constructs as well as in the development of these relations. To this end, we investigated a large sample of German students from lower and middle track schools whose interests were assessed each year from Grade 5 to Grade 8. We had three main research questions: First, will we find the postulated structure of vocational interests and subject interests in early adolescence? Relying on previous findings (e.g., Darcy & Tracey, 2007), we expected to find the circular structure of vocational interests in eighth grade at the latest; we expected the circular structure to be less clear or even undetectable in earlier grades. Clear predictions regarding the correlational pattern of the RIASEC interests could be made (see also Tracey & Rounds, 1993). First, correlations between the six adjacent dimensions (RI, IA, AS, SE, EC, and CR) were expected to be higher than correlations between the six alternating dimensions (RA, IS, AE, SC, ER, and CI), resulting in 36 order predictions. Second, correlations between alternating dimensions were expected to be higher than correlations between the three opposite dimensions (RS, IE, and AC), resulting in 18 additional order predictions. Third, and consequently, correlations between adjacent dimensions were expected to be higher than correlations between opposite dimensions, resulting in 18 final order predictions. These 72 predictions for the circular structure of the RIASEC interests are displayed in Table 1. Regarding subject interests, we expected to find the postulated structure in terms of proximity on the math-verbal domain continuum (Marsh & Shavelson, 1985), with higher associations between verbal subjects and lower associations between math and verbal subjects.

Table 1

*Order Predictions of the Magnitudes of the Correlations from Holland's Circular Model (Tracey & Rounds, 1993)*

| | RI | RA | RS | RE | RC | IA | IS | IE | IC | AS | AE | AC | SE | SC | EC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RI | — | | | | | | | | | | | | | | |
| RA | < | — | | | | | | | | | | | | | |
| RS | < | < | — | | | | | | | | | | | | |
| RE | < | = | > | — | | | | | | | | | | | |
| RC | = | > | > | > | — | | | | | | | | | | |
| IA | = | > | > | > | = | — | | | | | | | | | |
| IS | < | = | > | = | < | < | — | | | | | | | | |
| IE | < | < | = | < | < | < | < | — | | | | | | | |
| IC | < | = | > | = | < | < | = | > | — | | | | | | |
| AS | = | > | > | > | = | = | > | > | > | — | | | | | |
| AE | < | = | > | = | < | < | = | > | = | < | — | | | | |
| AC | < | < | = | < | < | < | < | = | < | < | < | — | | | |
| SE | = | > | > | > | = | = | > | > | > | = | > | > | — | | |
| SC | < | = | > | = | < | < | = | > | = | < | = | > | < | — | |
| EC | = | > | > | > | = | = | > | > | > | = | > | > | = | > | — |

*Note*. The cells show the expected relation for the row correlation compared with the column correlation. Row values are the first values, that is, > indicates that the row value is greater than the column value (e.g., the > cell for row RE and column RS means that the correlation between R and E is expected to be higher than the correlation between R and S).

Second, do vocational interests and subject interests become more differentiated during early adolescence? We hypothesized that vocational interests would become more differentiated over time, showing stronger associations with adjacent interest dimensions and weaker associations with other dimensions. For subject interests, we also expected to find differentiation over time but to a smaller extent because the differentiation process usually begins as early as primary school for subject interests (Wigfield & Cambria, 2010).

Third, how are vocational interests related to subject interests and how do these associations develop over time? We expected to find stronger associations between interests that are similar in terms of their content, such as between interests in verbal subjects and artistic interests and between math interests and realistic and investigative interests. Over time, we hypothesized that these relations would become stronger, whereas relations between interests that are not similar in content would become weaker.

## Method

### Sample and Procedure

We used data from the Tradition and Innovation in School Systems study (TRAIN study; Jonkmann, Rose, & Trautwein, 2013) conducted in lower and middle track schools in two German federal states. This is a longitudinal large-scale assessment investigating the development of students' achievement, motivation, personality, and well-being in early adolescence. Our sample (Cohort 1 of the TRAIN study) comprised 3,473 students (55.0% male students) from 143 classrooms across 105 schools. From the total sample of 3,880 students, 407 students were excluded because they did not provide any information on the relevant scales (i.e., interests) because they were absent when the data were collected or they did not respond to the items. Students attended three different school types: the *Hauptschule* track, which is the lowest track (41.7%), the *Realschule* track, which is the intermediate track between the lowest and academic tracks (24.7%), and the *Mittelschule* track, which is a combination of *Hauptschule* and *Realschule* (33.6%). Students were surveyed at the beginning of Grade 5 (T1), Grade 6 (T2), Grade 7 (T3), and Grade 8 (T4) beginning in the 2008/2009 school year. Grade 5 is the first year of secondary school after the transition from primary school. Students' mean age was 11.1 years ($SD$ = 0.55) at the first measurement point. Regarding their family background, 27.2% of the students had a migration background (these families were predominantly from Turkey and the former Soviet Union), and 14.0% of mothers as well as 16.4% of fathers held qualifications for college education. Parents had to provide written consent for their children to participate in the study, and trained research assistants administered the questionnaires during regular class times.

## Measures

Interest constructs were measured with identical scales at the different time points. All items can be found in the Appendix (Table A1).

**Vocational interests.** Students' vocational interests were measured with 36 items that represented Holland's (1997) RIASEC model. They were taken from a well-established German instrument (AIST; Bergmann & Eder, 2005) and from a German translation of the Inventory of Children's Activities (ICA; Tracey & Ward, 1998). Additionally, some items were self-developed. Usually, vocational interest scales, such as the AIST, are developed for older adolescents and adults. Thus, the items used here were chosen to adapt the scales so that they would be appropriate for children and young adolescents with respect to language and content (e.g., they included leisure time activities that are connected to later job activities). Each RIASEC dimension was assessed with six items. The initial question ("How much are you interested in the following things?") was followed by the respective activities regarding the six dimensions (e.g., "working with machines or technical equipment" for realistic interests; "nursing or caring for other people" for social interests), which were presented in a mixed order. Students were asked to answer the items on a 5-point Likert-type scale ranging from 1 (*not at all*) to 5 (*very much*). The internal consistencies of the scales were good for all interest dimensions and all time points (R: $\alpha$ = .85-.89; I: $\alpha$ = .81-.82; A: $\alpha$ = .79-.81; S: $\alpha$ = .84-.86; E: $\alpha$ = .78-.81; C: $\alpha$ = .81-.83).

**Subject interests.** Students' subject-specific interests in math, German, and English were assessed with three items each. An established scale (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005) that was originally developed on the basis of Krapp's (2000) interest theory was adapted for this study. The items measuring interests in the different subjects were parallel in wording except for the respective subject (e.g., "Doing exercises in math [German; English] is fun for me"). The 4-point Likert-type scales, ranging from 1 (*completely disagree*) to 4 (*completely agree*), showed acceptable internal consistencies for all subjects and at all time points (math: $\alpha$ = .69-.75; German: $\alpha$ = .64-.72; English: $\alpha$ = .70-.74).

## Statistical Analyses

**Correlational patterns among constructs.** To examine whether vocational interests and subject interests showed the postulated structure, we inspected their correlational patterns separately. To this end, we calculated manifest correlations between all interest scales in Mplus 7.31 (Muthén & Muthén, 1998-2012). The model included correlations between the six RIASEC interests as well as the three subject interests at all time points. The clustering of the data, in which students were nested in classes, was accounted for with the design-based correction of standard errors (McNeish, Stapleton, & Silverman, 2017).

Regarding the structure of the RIASEC interests, we tested the order predictions of correlations listed in Table 1. The rows and columns represent the 15 possible correlations between the RIASEC dimensions, and the cells represent their relations according to the circular model.[1] To evaluate the circular RIASEC structure, for every prediction displayed in Table 1, we tested whether one correlation was significantly higher than the other correlation according to the prediction, and afterwards, we counted the predictions that were met (Tracey & Rounds, 1993). Regarding the structure of subject interests, we expected German and English interests to show stronger correlations than math and German interests and math and English interests. To evaluate these predictions, we tested for whether the correlations between verbal interests were significantly higher than the correlations between verbal and math interests.

To examine whether vocational and subject interests became more differentiated over time, we first tested for whether the correlations differed between neighboring time points overall (i.e., T1-T2, T2-T3, and T3-T4). Afterwards, we tested all the correlations separately (e.g., we tested for whether the correlation between R and I at T1 differed from the same correlation at T2). In addition, we counted the specific predictions regarding the correlations within the vocational and subject interests that were met at every time point and compared the numbers of predictions that were met across time points. A large number of the assumptions that were met indicated that many of the relations between the correlations were as expected, which in turn indicated that the circular model represented the data well. Thus, an increasing number of assumptions that were met across time

[1] In addition to the 72 order predictions, the table also shows 33 equality predictions drawn from Holland’s (1997) original circumplex model, where the distances between the types are assumed to be equal. However, because we examined a less rigorous model here, we ignored these predictions and did not test them.

indicated that the circular structure represented the data with increasing accuracy in the higher grades.

**Circular unidimensional scaling.** To complement the testing of correlations with a graphical method, we used circular unidimensional scaling (CUS), which is a direct and parsimonious approach for investigating variables that are supposed to have a circular structure (Armstrong et al., 2003; Hubert, Arabie, & Meulman, 1997). CUS tests the specific assumptions regarding intercorrelations between the dimensions of the construct and is thus based on their correlational pattern. It can be used to test the circular structure of objects, such as the RIASEC interests, by assessing the ordering as well as spacing of the objects on a circle. The graphical representation of distances between interests is helpful to get an idea of their circular structure and its development over time. The technique provides an easily interpreted measure of model fit, the Variance Accounted For (VAF), which is supposed to be above the critical value of .60 in order to represent a good fit (Armstrong et al., 2003).

Because we were interested in the ordering as well as the spacing of vocational interests around the circle in Grades 5 through 8, we specified a CUS model for each time point where the ordering of the RIASEC interests and their distances were freely arranged. Additionally, we used CUS for the subject interests to display their proximity and distances around the circle. When three objects are placed on a circle, every object is adjacent to the two other objects, always resulting in the same order (either clockwise or counterclockwise). Thus, because we used only three subject interests (math, German, English), we restricted their order to be the same at every time point to provide an easier interpretation (M-G-E).[2] Again, the distances between subject interests were allowed to be unequal. The CUS analyses were performed with the MATLAB program[3] (for more details about the technique and application of CUS, see Armstrong et al., 2003; Hubert et al., 1997).

**Correlational patterns between constructs.** To examine how vocational interests and subject interests are related to each other and how these associations develop over time, we inspected the correlations between vocational and subject interests from

[2] As a robustness check, we also tested models where we allowed the ordering to be free. This resulted in the order M-G-E in Grades 6 and 8 and in the order M-E-G in Grades 5 and 7, although the distances between the respective subjects were identical to those in the restricted models. The fit was the same as in the restricted models.

[3] The files necessary to run the CUS analyses described here are available at http://cda.psych.uiuc.edu/unidimensionalscaling_mfiles.

the model that included all interest variables at the four time points. Again, we tested whether the correlations differed significantly between the time points.

**Missing data.** In the majority of longitudinal studies, missing values are often the result of attrition or the absence of participants at single time points. Because we included all students who provided information at a minimum of one time point, our variables showed rates of missing data of 30.3% to 47.0% for vocational interests and 28.2% to 33.5% for subject interests. To deal with these non-negligible proportions of missing values, we used the full information maximum likelihood approach implemented in Mplus, which takes all available information into account to estimate the model parameters (Schafer & Graham, 2002).

## Results

### Structure of Vocational Interests

The correlations between all interest constructs are displayed in Table 2 (Grades 5 and 6) and Table 3 (Grades 7 and 8). We will first report the correlational patterns for the vocational interests and their development before we present the results of the CUS analyses.

For the RIASEC interests, we expected to find the circular structure represented by the order predictions for the magnitudes of the correlations. Across time points, we found that on average, 48 of the 72 predictions were met. That is, a considerable number of correlations between the specific RIASEC dimensions showed the hypothesized pattern. When comparing correlations between specific dimensions, it appeared that there were differences between RIASEC types. For example, in line with our expectations, for realistic interests, we found the strongest correlations with the adjacent dimensions investigative ($.61 \leq r \leq .67$) and conventional interests ($.51 \leq r \leq .56$) and the weakest correlations with artistic ($.12 \leq r \leq .30$) and the opposite social interests ($.03 \leq r \leq .34$). Similarly, social interests were found to be most strongly correlated with the neighboring dimension artistic ($.59 \leq r \leq .68$) and most weakly correlated with realistic interests. However, we also found some associations that went contrary to the expected pattern. For example, investigative interests were strongly related to the opposite enterprising interests ($.45 \leq r \leq .54$), and artistic interests had strong correlations with the opposite conventional interests ($.45 \leq r \leq .59$).

Table 2

*Manifest Correlations of Vocational and Subject Interests in Grade 5 (above the diagonal) and Grade 6 (below the diagonal)*

| | | Vocational interests | | | | | | Subject interests | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variables | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| *Vocational interests* | | | | | | | | | | |
| 1 | Realistic | | .67 | .30 | .34 | .49 | .56 | .23 | .10 | .10 |
| 2 | Investigative | .67 | | .57 | .55 | .54 | .58 | .21 | .22 | .17 |
| 3 | Artistic | .28 | .54 | | .68 | .56 | .59 | .17 | .35 | .28 |
| 4 | Social | .29 | .50 | .68 | | .61 | .61 | .15 | .29 | .22 |
| 5 | Enterprising | .49 | .54 | .56 | .63 | | .63 | .20 | .22 | .20 |
| 6 | Conventional | .54 | .61 | .58 | .60 | .62 | | .37 | .32 | .28 |
| *Subject interests* | | | | | | | | | | |
| 7 | Math | .24 | .25 | .18 | .19 | .18 | .39 | | .39 | .38 |
| 8 | German | .14 | .27 | .34 | .35 | .25 | .35 | .41 | | .52 |
| 9 | English | .11 | .23 | .30 | .28 | .20 | .30 | .38 | .54 | |

*Note.* All correlations were significant at $p \leq .001$.

Table 3

*Manifest Correlations of Vocational and Subject Interests in Grade 7 (above the diagonal) and Grade 8 (below the diagonal)*

| | | Vocational interests | | | | | Subject interests | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variables | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| *Vocational interests* | | | | | | | | | | |
| 1 | Realistic | | .65 | .21 | .19 | .45 | .54 | 31 | 15 | .14 |
| 2 | Investigative | .61 | | .50 | .41 | .51 | .59 | .31 | .26 | .24 |
| 3 | Artistic | .12 | .48 | | .64 | .52 | .54 | .18 | .33 | .29 |
| 4 | Social | .03 [a)] | .28 | .59 | | .59 | .55 | .20 | .32 | .30 |
| 5 | Enterprising | .40 | .45 | .46 | .49 | | .62 | .18 | .23 | .21 |
| 6 | Conventional | .51 | .57 | .47 | .43 | .62 | | .41 | .36 | .29 |
| *Subject interests* | | | | | | | | | | |
| 7 | Math | .30 | .26 | .11 | .13 | .16 | .39 | | .45 | .43 |
| 8 | German | .08 | .19 | .26 | .27 | .19 | .29 | .45 | | .56 |
| 9 | English | .07 [b)] | .21 | .23 | .24 | .17 | .22 | .36 | .59 | |

*Note.* All correlations were significant at $p \leq .001$, except [a)] $p = .232$ and [b)] $p = .002$.

When examining the development of the correlations, we expected to find a differentiation over time with a clearer correlational structure represented by an increasing number of order predictions that were met. First, the test of the model revealed no difference between the correlations in Grades 5 and 6 ($\chi^2 = 49.18$, $df = 36$, $p = .071$) but a significant difference between the correlations in Grades 6 and 7 ($\chi^2 = 55.05$, $df = 36$, $p = .022$) and an even larger difference from Grade 7 to Grade 8 ($\chi^2 = 124.76$, $df = 36$, $p < .001$). Second, regarding the 72 order predictions of the correlations, we found that the number of predictions that were met increased over time (Grade 5: 44, Grade 6: 47, Grade 7: 50, and Grade 8: 52). That is, the circular structure of the RIASEC interests represented by the correlational pattern became clearer over time. We found relatively strong correlations in Grades 5 and 6 overall without much differentiation between the dimensions (e.g., I interests were correlated .50 or higher with all other dimensions). From Grade 6 to Grade 7, only a few correlations significantly decreased (R and A: $\Delta r = .07$, $p = .024$; R and S: $\Delta r = .10$, $p < .001$; I and S: $\Delta r = .10$, $p = .001$). That is, most of the correlations remained moderate in size and comparably undifferentiated for some dimensions (e.g., C interests: $.54 \leq r \leq .62$). We found the greatest changes from Grade 7 to Grade 8, where the correlational pattern became more differentiated. Especially R interests showed a pattern that was in accordance with our expectations because they were weakly correlated with A interests ($\Delta r = .09$, $p = .006$) and even uncorrelated with S interests ($\Delta r = .16$, $p < .001$), whereas the correlations with I and C interests were high. Moreover, the I (with S: $\Delta r = .12$, $p < .001$; with E: $\Delta r = .06$, $p = .040$), A (with E: $\Delta r = .07$, $p = .040$; with C: $\Delta r = .08$, $p = .030$), and S interests (with C: $\Delta r = .12$, $p < .001$) showed decreases in the correlations in line with the expected patterns. Still, the correlations for the E and C interests remained relatively high. Taken together, the development of the RIASEC correlations showed a clear differentiation over time, although there were differences between the dimensions, and not all of the order predictions were supported.

To further examine the circular structure of vocational interests, we applied CUS as a graphical representation of the associations between the interest dimensions. Because the models were based on correlations, we expected to find a partially fitting circular model for the RIASEC interests, with improvement in higher grades. Visual representations of the circular structures at all time points are shown in Figure 2. The numbers within the graphics indicate the proportions of the circle represented by the distance between two adjacent dimensions. Model fits of the CUS analyses in terms of VAF are displayed in Table 4.

Table 4

*VAF as Fit Indices for CUS Models from Grade 5 to Grade 8*

| | Vocational interests | Subject interests |
|---|---|---|
| Grade 5 | 0.68 | 1.00 |
| Grade 6 | 0.70 | 1.00 |
| Grade 7 | 0.72 | 1.00 |
| Grade 8 | 0.71 | 1.00 |

*Note.* VAF = variance accounted for; CUS = circular unidimensional scaling.

The VAF of the vocational interest models ranged from .68 to .72 and increased slightly over time. Thus, although not perfect, the fit was above the critical value of .60 at all time points. The ordering, which was allowed to be free, turned out to be R-I-A-S-E-C at all time points, indicating that as early as in Grade 5, the optimal order was the order specified by Holland’s theory.

Regarding the circular arrangements of the RIASEC dimensions, they spanned the entire circle but showed large differences in their distances. In Grade 5, the pattern was somewhat different from the others with a relatively large distance between the R and I interests. From Grade 6 onwards, the interests split up into pairs (R-I, A-S, and E-C). Whereas in Grade 6, the A and S interests could not be separated but were part of one dimension on the circle, the two dimensions became more distinct over time. Thus, in Grades 7 and 8, the six RIASEC interests were well distinguished, although they showed a clear grouping.

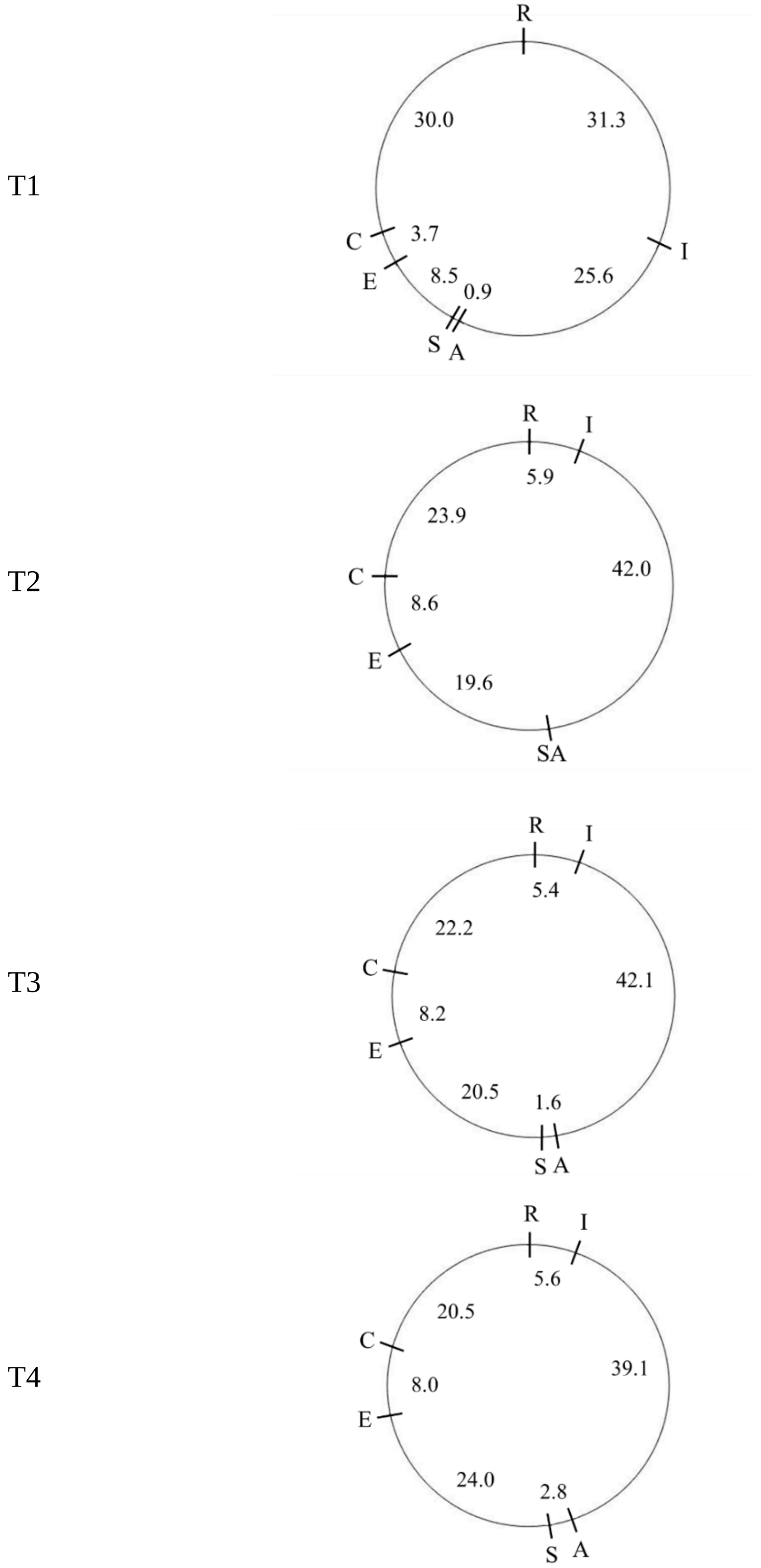


*Figure 2.* CUS of vocational interests at all time points.

**Structure of Subject Interests**

The correlations between the subject interests can be found in Tables 2 and 3. Again, we will first report the correlational patterns and their development before we present the results of the CUS analyses.

We expected to find stronger associations between interests in the two verbal subjects than between interests in the verbal and math subjects. We found that the correlations between German and English interests ($.52 \leq r \leq .59$) were significantly higher than the correlations between German and math interests ($.39 \leq r \leq .45$) or English and math interests ($.36 \leq r \leq .43$). Thus, all predictions regarding the correlational pattern were met.

When we looked at development over time, we found only a few differences between the grades. The order predictions regarding correlations were met at all time points; that is, the correlations already showed the expected pattern in Grade 5. The association between interests in German and English seemed to become stronger over time, although we found no significant changes between grades. We also tested whether the correlation in Grade 5 differed from the one in Grade 8 and found a significant increase ($\Delta r = .07$, $p = .041$) but no changes in between. The association between interests in math and English decreased slightly between Grades 7 and 8 ($\Delta r = .07$, $p = .049$), whereas the association between interests in math and German did not change meaningfully over time. Overall, comparing the correlational patterns between Grades 5 and 8, we found a slightly more differentiated pattern in Grade 8, although the correlations between math and languages as the more distant subjects remained relatively high.

Visual representations of the CUS analyses at all time points are shown in Figure 3. We expected a stable pattern without much change over time. The VAF for the subject interest models was 1.00 at all time points. German and English interests were located closer to each other on the circle, indicating greater similarity between the two subjects than between languages and math. The distances between math, German, and English interests hardly changed from Grade 5 to Grade 8, representing the stable correlational pattern. However, in Grade 8, the distance between math and English interests increased, whereas the distance between German and English interests decreased. These findings highlight the slightly greater differentiation between math and verbal subject interests in Grade 8.

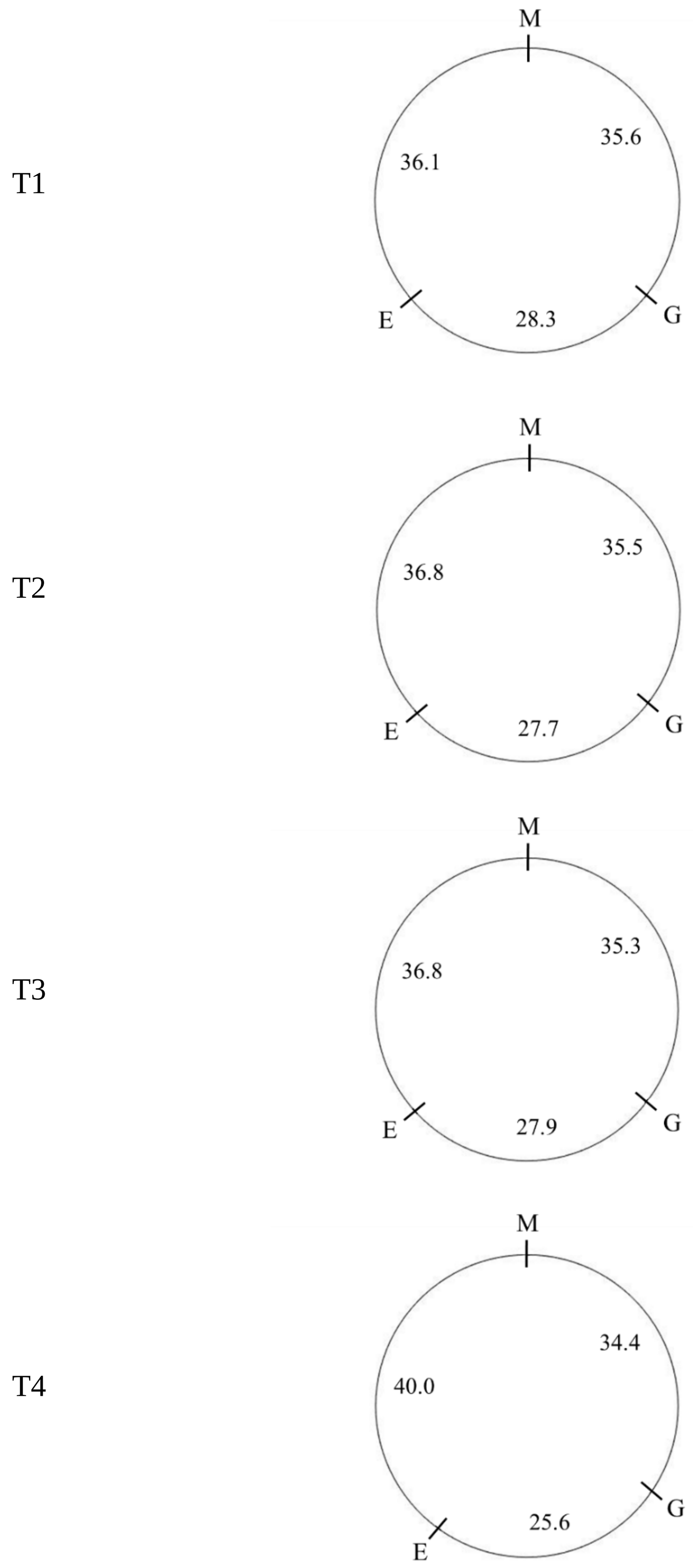


*Figure 3.* CUS of subject interests at all time points.

**Correlations between Vocational Interests and Subject Interests**

Because we were interested in associations between the vocational and subject interests, we examined the correlations between the two interest constructs. We expected to find stronger associations between interest dimensions that were similar in content and to find increases in these correlations as well as decreases in correlations between dissimilar dimensions, indicating a differentiation. Overall, we found weaker correlations when we correlated the vocational and subject interests with each other than within themselves. Math interests had the highest correlations with C interests ($.37 \leq r \leq .41$) and the lowest with A ($.11 \leq r \leq .18$) and S interests ($.13 \leq r \leq .20$). German and English interests had the strongest associations with A (German: $.26 \leq r \leq .35$; English: $.23 \leq r \leq .30$), S (German: $.27 \leq r \leq .35$; English: $22 \leq r \leq .30$), and C interests (German: $.29 \leq r \leq .36$; English: $.22 \leq r \leq .30$) and the weakest with R interests (German: $.08 \leq r \leq .15$; English: $.07 \leq r \leq .14$). Comparing the correlations across time, we found an increase in the correlation between English interests and I interests from Grade 5 to Grade 6 ($\Delta r = .06$, $p = .039$) and an increase between math interests and R interests from Grade 6 to Grade 7 ($\Delta r = .08$, $p = .004$).

From Grade 7 to Grade 8, the correlations between German interests and all RIASEC interests except E significantly decreased, showing no differential changes in the different dimensions and going against our expectations. Similarly, the correlations between English interests and all RIASEC interests except I decreased significantly. Only math interests showed differential changes such that the correlations with the dissimilar A ($\Delta r = .06$, $p = .034$) and S interests ($\Delta r = .07$, $p = .009$) decreased. Taken together, we found strong and weak associations between vocational and subject interests to some extent as expected and only a slight differentiation in interests across time, particularly for math interests.

## Discussion

This study was one of the first to investigate vocational interests and subject interests together with the aim of providing a better understanding of how interests become differentiated in early adolescence. To extend previous research, we chose a sample that was younger than most participants of previous vocational interest studies. We examined German students from nonacademic track schools who have not been in the focus of previous studies. We investigated the structural development of the RIASEC interests and subject interests in math, German, and English from Grade 5 to Grade 8 separately as well as the development of their interrelations. We found relatively strong associations among the RIASEC interests, especially in the lower grades. As expected, some of the associations decreased with age, especially between Grades 7 and 8, and showed a relatively clear pattern in Grade 8, which was also supported by the increasing number of order predictions that were met. Accordingly, the circular model represented the data better in Grades 7 and 8, although the interest dimensions showed clear groupings of R and I, A and S, and E and C interests. By contrast, associations among the subject interests were relatively stable, with somewhat higher associations between German and English in comparison with math. The associations between vocational and subject interests were as expected to some extent, with some subject interests showing strong correlations with the RIASEC dimensions that were similar in content, but we also found some unexpected associations. Overall, vocational interests showed a differentiation across time, and most of the predictions were met in Grade 8, whereas the subject interests hardly changed, and only math interests showed differential changes that were in line with our expectations.

### Differentiation of Vocational Interests

Our results indicated that vocational interests showed quite a differentiated pattern in Grade 8. Most of the RIASEC dimensions showed higher associations with adjacent interests and lower associations with other interests. This was in accordance with the order predictions, which increased in number over time. Correspondingly, the circular structure of the RIASEC interests became clearer over time, indicating that the six interest dimensions were distinguishable and well distributed across the circle. In addition, the six RIASEC interests were in the correct order at all time points, and the fit of the model increased slightly as the years went by.

These results are in line with previous research, for instance, by Tracey (2002) as well as Darcy and Tracey (2007), who also found that the circular structure of interests improved with age and was formed by eighth grade. Our findings showed the largest changes between Grades 7 and 8, thus suggesting that adolescents at the age of 14 change their perceptions of different work-related activities and improve their skills of differentiating between several activities as well as how much they like and dislike these activities. This result can be evaluated positively because being aware of one’s interests and showing a differentiated interest profile is seen as helpful for a career decision as well as an indicator of career-choice readiness (Hirschi & Läge, 2007; Holland, 1997). This especially applies to our sample, which consisted of students from low and middle track schools. In Germany, these students usually leave school after Grade 9 or 10 and either continue with secondary school or start vocational training. That is, they have to make an important career-related decision relatively early in the immediate future, which is why they might benefit from a differentiated interest profile. Most likely, during their final school years, they intensify their engagement in occupational decisions, such as exploring possible career options (Kracke, 1997), which might lead to an increase in knowledge about career decisions and their own vocational preferences.

However, our results indicated that not all RIASEC interests were differentiated to the same degree. Whereas some dimensions (e.g., R) showed differential correlations with other dimensions according to the expected pattern, others (e.g., E) showed moderate correlations overall, even in Grade 8. This suggests that, at least for this group of students, the distinctions between some interest dimensions made by Holland (1997) were not as prominent as the distinctions between others. Adolescents might have different associations for the different interest dimensions and the related activities. For instance, they might find it easier to imagine activities describing realistic interests and might differentiate them from other activities compared with activities that describe enterprising interests, which might be more abstract and harder to connect to a specific job or career.

The CUS analyses revealed that the circular model indeed represented the data quite well, with VAF values that were similar in range to the values from other studies in which CUS was used to examine the structure of the RIASEC interests, although participants of these studies attended high school or were even employed adults (Armstrong et al., 2003; Darcy & Tracey, 2007). Nonetheless, the graphs also showed a clear grouping such that R and I, A and S, and E and C were located closer to each other on the circle. This grouping was proposed before in an alternative hierarchical model of the RIASEC interests such that each of two interest dimensions (R-I, A-S, and E-C) were grouped together to build a second order factor (Gati, 1991). This indicates that every two interest dimensions seem to be more similar to each other than to the remaining dimensions. Other empirical studies have shown similar CUS patterns, such as the study by Armstrong et al. (2003), who found that R and I interests were closely tied across several racial-ethnic samples in the US, and Nagy et al. (2010), whose German participants' interests were grouped the same way as ours. Thus, our results support the idea that the circular model can represent adolescents' RIASEC interests with increasing precision but that this circle is somewhat far from building a hexagon with equal distances between interest dimensions, as originally postulated by Holland (1997).

**Differentiation of Subject Interests**

In contrast to vocational interests, the correlations between the subject interests showed much less change and a small differentiation across time. As expected, we found medium-sized correlations between German and English interests, which increased slightly over time. However, the associations between math interests and interests in verbal subjects were only a little smaller, and we only found a meaningful decrease in the association between math and English interests from Grade 7 to Grade 8. We had expected to find less differentiation in subject interests compared with vocational interests because the process of interest differentiation takes place earlier in the school context (Wigfield & Cambria, 2010). Because students become familiar with their subjects beginning in the early school grades, they are already able to rank their subject preferences soon after starting school, which led us to expect that their profile of subject interests might already be relatively differentiated in fifth grade. However, the correlational pattern in fifth grade was not well differentiated and remained quite uniform up to eighth grade.

Only a few previous studies looked at associations between interests in several subjects, and they revealed mixed results. On the one hand, Schurtz et al. (2014) found a medium-sized correlation of $r$ = .24 between math and English interests in sixth grade students, a finding that is a little lower than our values. On the other hand, Gaspard et al. (2018) found a medium-sized correlation of $r$ = .30 between German and English as well as zero correlations between math and verbal subjects. Whereas our correlations between verbal subjects fell in a range similar to the correlation they found, the strong associations we found between verbal subjects and math were unexpected and went contrary to their results. However, Gaspard et al. did not directly assess students' interests, but rather assessed their intrinsic value as conceptualized in expectancy-value theory (Eccles et al., 1983), which is conceptually related but distinct from subject interests. In addition, their sample consisted of students from academic track schools from Grades 5 to 12. Thus, because we know that students' age and maturation play a role in interest differentiation, the different samples might be a reason for the diverse findings.

**Associations between Vocational Interests and Subject Interests**

To our knowledge, our study was the first to examine associations between vocational interests and subject interests directly. Given the call to bring together the two constructs and the two research traditions (Hidi & Ainley, 2002; Su, 2018) on the one hand and the relatedness of some RIASEC interests with the content and activities of specific school subjects on the other hand, we were surprised that there were no such studies. The understanding of the formation of interests during adolescence could benefit from insights into the associations between different interest types because the development of one might be influenced by the development of the other. The current findings provide the first indications of similarities between interest dimensions that refer to different but related activities and contents.

Our results met our expectations to some extent with respect to proximities and distances between interests. For example, we found strong associations between A interests and interests in verbal subjects as well as weak associations with math interests, findings that correspond to Volodina and Nagy's (2016) previous findings. Although they focused on subject-specific variables other than interests (e.g., self-concepts and achievement in various school domains), their results indicated systematic relationships between the RIASEC dimensions and school subjects. Next to the proximity of verbal subjects and A interests, they found relations between math affinity and R interests that were not supported by our data. We found that math interests showed the strongest correlations with C interests, which probably stemmed from the scale measuring C interests. It captured activities similar to those performed during math classes (e.g., comparing prices or adding numbers), which is why students scoring high on math interests probably also scored high on C interests.

Although the associations between subject and vocational interests in our study were medium-sized and only partly confirmed the expected pattern, we found some relations between the specific interest dimensions from the vocational and educational context. This emphasizes the need to integrate the different types of interests into individuals' interest profiles, which has also been suggested by Volodina and Nagy (2016). Such integrations might help us further grasp the categories of which students' interests are comprised. In turn, this might add to the understanding of how adolescents make their vocational choices and might provide indications for how and when specific interests can be fostered. Thus, due to our mixed results, more evidence on the relations between vocational and subject interests is needed, especially with respect to understanding the process of interest development and differentiation during adolescence.

**Limitations and Future Research**

When interpreting the results of our study, some limitations should be taken into account. First, our sample was limited to students from low and middle track schools in Germany. We purposely chose this sample because these students have not been the focus of previous research on the structure of interests, and there have been calls to examine non-college-bound populations (e.g., Nagy et al., 2010). However, the sample used in this study is not representative of all German students. This group of students usually has a lower educational and socioeconomic family background than students from academic track schools who were more often investigated in previous studies. These background characteristics might influence their interests as well as their understanding of the activities described in the questionnaires. Additionally, they tend to opt for different vocational sectors and specific occupations after school because of their educational qualifications. Therefore, these students might differ from other samples in their vocational interests such that they have higher interests related to specific occupations they often take up later (e.g., R interest). This indicates that our results cannot be generalized to all German students. Future research should thus examine vocational and subject interests in other samples to broaden the understanding of their interrelations.

Second, the scales we used to assess vocational interests used a combination of items that were adapted from other questionnaires and self-developed items. This was necessary because most of the previously available instruments had been developed for adults. Thus, we did not use a validated instrument. An instrument that was designed to systematically assesses the vocational interests of children and young adolescents in Germany, such as the German version of the ICA (von Maurice, 2006), should be used in future studies. However, the reliabilities of the scales used in our study were acceptable.

Third, we only examined subject interests in the three main school subjects. Other subject areas might also be related to activities captured by vocational interests, such as science and technology, which might be close to the R and I interests, or economics, which is probably related to E interests. Thus, a broader range of subjects should be considered, and their associations with vocational interests should be examined. This might help in capturing the different dimensions or categories of which students' interests are built and might shed more light on the process of interest differentiation.

## Conclusion

The present study was aimed at taking a closer look at the structural development and differentiation of interests in early adolescence. To this end, we examined vocational interests and subject interests in a large sample of German students from Grade 5 to Grade 8. Our results showed that this period is important for the differentiation of interests, especially for vocational interests, and that there are differences between single interest dimensions regarding their differentiated nature. To replicate these findings, future research should further investigate how and why interest dimensions develop differently. Moreover, considering vocational and subject interests together should be the focus of future studies in order to fully account for the development and differentiation of adolescents' interests.

**References**

Armstrong, P. I., Hubert, L., & Rounds, J. (2003). Circular unidimensional scaling: A new look at group differences in interest structure. *Journal of Counseling Psychology*, *50*(3), 297–308. https://doi.org/10.1037/0022-0167.50.3.297

Bergmann, C., & Eder, F. (2005). *Allgemeiner Interessen-Struktur-Test mit Umwelt-Struktur-Test (AIST-R/ UST-R) [General interest structure test]*. Göttingen: Beltz Test.

Darcy, M. U. A., & Tracey, T. J. G. (2007). Circumplex structure of Holland's RIASEC interests across gender and time. *Journal of Counseling Psychology*, *54*(1), 17–31. https://doi.org/10.1037/0022-0167.54.1.17

Eccles, J. S., Adler, T., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 74–146). New York, NY: Freeman.

Elsworth, G. R., Harvey-Beavis, A., Ainley, J., & Fabris, S. (1999). Generic interests and school subject choice. *Educational Research and Evaluation*, *5*, 290–318. https://doi.org/10.1076/edre.5.3.290.3882

Fouad, N. A., & Dancer, L. S. (1992). Cross-cultural structure of interests: Mexico and the United States. *Journal of Vocational Behavior*, *40*(2), 129–143. https://doi.org/10.1016/0001-8791(92)90061-4

Gaspard, H., Wigfield, A., Jiang, Y., Nagengast, B., Trautwein, U., & Marsh, H. W. (2018). Dimensional comparisons: How academic track students' achievements are related to their expectancy and value beliefs across multiple domains. *Contemporary Educational Psychology*, *52*, 1–14. https://doi.org/10.1016/j.cedpsych.2017.10.003

Gati, I. (1991). The structure of vocational interests. *Psychological Bulletin*, *109*, 309–332. https://doi.org/10.1037/0033-2909.109.2.309

Glidden-Tracey, C. E., & Parraga, M. I. (1996). Assessing the structure of vocational interests among Bolivian University students. *Journal of Vocational Behavior*, *48*(1), 96–106. https://doi.org/10.1006/jvbe.1996.0010

Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. *Journal of Educational Psychology*, *93*(1), 3–13. https://doi.org/10.1037/0022-0663.93.1.3

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J. S., & Dicke, T. (2017). Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional comparison processes and expectancy-by-value interactions. *Learning and Instruction*, *49*, 81–91. https://doi.org/10.1016/j.learninstruc.2016.12.007

Harackiewicz, J. M., Durik, A. M., Barron, K. E., Linnenbrink-Garcia, L., & Tauer, J. M. (2008). The role of achievement goals in the development of interest: Reciprocal relations between achievement goals, interest, and performance. *Journal of Educational Psychology*, *100*(1), 105–122. https://doi.org/10.1037/0022-0663.100.1.105

Hidi, S. (2001). Interest, reading, and learning: Theoretical and practical considerations. *Educational Psychology Review*, *13*(3), 191–210. https://doi.org/10.1023/A:1016667621114

Hidi, S. (2006). Interest: A unique motivational variable. *Educational Research Review*, *1*(2), 69–82. https://doi.org/10.1016/j.edurev.2006.09.001

Hidi, S., & Ainley, M. (2002). Interest and adolescence. In F. Pajares & T. Urdan (Eds.), *Academic Motivation of Adolescents* (pp. 247–275). Greenwich: Information Age Publishing.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hidi, S., Renninger, K. A., & Krapp, A. (2004). Interest, a motivational variable that combines affective and cognitive functioning. In D. Y. Dai & R. J. Sternberg (Eds.), *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development* (pp. 89–115). Mahwah, NJ: Lawrence Erlbaum Associates, Inc. https://doi.org/10.4324/9781410610515

Hirschi, A., & Läge, D. (2007). Holland’s secondary constructs of vocational interests and career choice readiness of secondary students: Measures for related but different constructs. *Journal of Individual Differences*, *28*(4), 205–218. https://doi.org/10.1027/1614-0001.28.4.205

Holland, J. L. (1959). A theory of vocational choice. *Journal of Counseling Psychology*, *6*, 35–45. https://doi.org/10.1037/h0040767

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources.

https://doi.org/10.1016/0022-4405(74)90056-9

Hubert, L., Arabie, P., & Meulman, J. (1997). Linear and circular unidimensional scaling for symmetric proximity matrices. *British Journal of Mathematical and Statistical Psychology*, *50*, 253–284. https://doi.org/10.1111/j.2044-8317.1997.tb01145.x

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development*, *73*(2), 509–527. https://doi.org/10.1111/1467-8624.00421

Jonkmann, K., Rose, N., & Trautwein, U. (2013). *Tradition und Innovation: Entwicklungsverläufe an Haupt- und Realschulen in Baden-Württemberg und Mittelschulen in Sachen [Tradition and innovation - Developmental trends at lower and middle track schools in Baden-Württemberg and Saxony]*. Tübingen: Projektbericht an die Kultusministerien der Länder.

Köller, O., Baumert, J., & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education*, *32*(5), 448–470. https://doi.org/10.2307/749801

Kracke, B. (1997). Parental behaviors and adolescents' career exploration. *Career Development Quarterly*, *45*(4), 341–350. https://doi.org/10.1002/j.2161-0045.1997.tb00538.x

Krapp, A. (2000). Interest and human development during adolescence: An educational-psychological approach. In J. Heckhausen (Ed.), *Advances in Psychology, 131. Motivational psychology of human development: Developing motivation and motivating development* (pp. 109–129). New York, NY: Elsevier Science. https://doi.org/10.1016/S0166-4115(00)80008-4

Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and Instruction*, *12*, 383–409. https://doi.org/10.1016/S0959-4752(01)00011-1

Lent, R. W., Tracey, T. J. G., Brown, S. D., Soresi, S., & Nota, L. (2006). Development of interests and competency beliefs in Italian adolescents: An exploration of circumplex structure and bidirectional relationships. *Journal of Counseling Psychology*, *53*(2), 181–191. https://doi.org/10.1037/0022-0167.53.2.181

Low, K. S. D., Yoon, M., Roberts, B. W., & Rounds, J. (2005). The stability of vocational interests from early adolescence to middle adulthood: A quantitative review of longitudinal studies. *Psychological Bulletin*, *131*(5), 713–737. https://doi.org/10.1037/0033-2909.131.5.713

Marsh, H. W., & Ayotte, V. (2003). Do multiple dimensions of self-concept become more differentiated with age? The differential distinctiveness hypothesis. *Journal of Educational Psychology*, *95*(4), 687–706. https://doi.org/10.1037/0022-0663.95.4.687

Marsh, H. W., & Shavelson, R. (1985). Self-concept: Its multifaceted, hierarchical structure. *Educational Psychologist*, *20*(3), 107–123.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standarized test scores. Reciprocal effects models of causal ordering. *Child Development*, *76*(2), 397–416. https://doi.org/0009-3920/2005/7602-0007

McDaniel, M. A., Waddill, P. J., Finstad, K., & Bourg, T. (2000). The effects of text-based interest on attention and recall. *Journal of Educational Psychology*, *92*(3), 492–502. https://doi.org/10.1037/0022-0663.92.3.492

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods*, *22*(1), 114–140. https://doi.org/10.1037/met0000078

Muthén, L. K., & Muthén, B. O. (1998-2012). *Mplus user's guide. Seventh edition.* Los Angeles, CA: Muthén & Muthén.

Nagy, G., Trautwein, U., & Lüdtke, O. (2010). The structure of vocational interests in Germany: Different methodologies, different conclusions. *Journal of Vocational Behavior*, *76*, 153–169. https://doi.org/10.1016/j.jvb.2007.07.002

Rounds, J., & Su, R. (2014). The nature and power of interests. *Current Directions in Psychological Science*, *23*(2), 98–103. https://doi.org/10.1177/0963721414522812

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, *7*(2), 147–177. https://doi.org/10.1037/1082-989X.7.2.147

Schiefele, U. (2009). Situational and individual interest. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 197–222). New York: Routledge.

Schurtz, I. M., Pfost, M., Nagengast, B., & Artelt, C. (2014). Impact of social and dimensional comparisons on student's mathematical and English subject-interest at the beginning of secondary school. *Learning and Instruction*, *34*, 32–41. https://doi.org/10.1016/j.learninstruc.2014.08.001

Silvia, P. J. (2001). Interest and interests: The psychology of constructive capriciousness. *Review of General Psychology*, *5*(3), 270–290. https://doi.org/10.1037/1089-2680.5.3.270

Stoll, G., & Trautwein, U. (2017). Vocational interests as personality traits: Characteristics, development, and significance in educational and organizational environments. In J. Specht (Ed.), *Personality Development Across the Lifespan* (pp. 401–417). London: Academic Press. https://doi.org/10.1016/B978-0-12-804674-6.00025-9

Su, R. (2018). The three faces of interests: An integrative review of interest research in vocational, organizational, and educational psychology. *Journal of Vocational Behavior*. Advance online publication. https://doi.org/10.1016/j.jvb.2018.10.016

Todt, E. (1990). Development of interest. In H. Hetzer (Ed.), *Applied developmental psychology of children and youth*. Wiesbaden: Quelle & Meyer.

Tracey, T. J. G. (2002). Development of interests and competency beliefs: A 1-year longitudinal study of fifth- to eighth-grade students using the ICA-R and structural equation modeling. *Journal of Counseling Psychology*, *49*(2), 148–163. https://doi.org/10.1037/0022-0167.49.2.148

Tracey, T. J. G., Robbins, S. B., & Hofsess, C. D. (2005). Stability and change in interests: A longitudinal study of adolescents from grades 8 through 12. *Journal of Vocational Behavior*, *66*, 1–25. https://doi.org/10.1016/j.jvb.2003.11.002

Tracey, T. J. G., & Rounds, J. (1993). Evaluating Holland’s and Gati’s vocational-interest models: A structural meta-analysis. *Psychological Bulletin*, *113*, 229–246. https://doi.org/10.1037/0033-2909.113.2.229

Tracey, T. J. G., & Ward, C. C. (1998). The structure of children’s interests and competence perceptions. *Journal of Counseling Psychology*, *45*(3), 290–303. https://doi.org/10.1037/0022-0167.45.3.290

Volodina, A., & Nagy, G. (2016). Vocational choices in adolescence: The role of gender, school achievement, self-concepts, and vocational interests. *Journal of Vocational Behavior*, *95–96*, 58–73. https://doi.org/10.1016/j.jvb.2016.07.005

Volodina, A., Nagy, G., & Retelsdorf, J. (2015). Berufliche Interessen und der Übergang in die gymnasiale Profiloberstufe: Ihre Struktur und Vorhersagekraft für das individuelle Wahlverhalten [Vocational interests and the transition to upper secondary school: Their structure and predictive power for choices]. *Zeitschrift für*

*Pädagogische Psychologie*, *29*(2), 89–100. https://doi.org/10.1024/1010-0652/a000154

von Maurice, J. (2006). *ICA-D. Deutschsprachige Version des [German version of the] Inventory of Children's Activities - Revised (ICA-R, Tracey & Ward, 1998).* Unveröffentlichtes Forschungsinstrument. Bamberg: Otto-Friedrich-Universität.

Wigfield, A., & Cambria, J. (2010). Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Developmental Review*, *30*, 1–35. https://doi.org/10.1016/j.dr.2009.12.001

Xu, H., & Tracey, T. J. G. (2016). Stability and change in interests: A longitudinal examination of grades 7 through college. *Journal of Vocational Behavior*, *93*, 129–138. https://doi.org/10.1016/j.jvb.2016.02.002

## Appendix

Table A1

*All Items Measuring Vocational Interests and Subject Interests*

| | How much are you interested in the following things? |
|---|---|
| Realistic interests | Building something or putting something together |
| | Driving nails in with a hammer |
| | Watching construction work |
| | Producing something out of wood or metal |
| | Watching an electrical device (e.g., a television) being repaired |
| | Working with machines or technical equipment |
| Investigative interests | Conducting experiments in a laboratory |
| | Investigating the behavior of animals or plants |
| | Watching a scientific broadcast |
| | Observing something through a microscope |
| | Mixing different liquids and seeing what happens |
| | Reading newspaper articles on scientific topics |
| Artistic interests | Drawing pictures |
| | Making things beautiful (decorating and adorning) |
| | Inventing a story |
| | Designing clothing |
| | Reading poems |
| | Doing things that require imagination and creativity |
| Social interests | Listening to other people's problems |
| | Advising other people |
| | Helping others feel comfortable |
| | Helping sick people |
| | Taking care of small children |
| | Nursing or caring for other people |

| | |
|---|---|
| Enterprising interests | Selling something to others |
| | Leading a group |
| | Telling others what to do |
| | Planning games for others |
| | Being the speaker of a group |
| | Organizing an event (e.g., a class party) |
| Conventional interests | Adding numbers |
| | Putting things in order |
| | Counting and sorting things |
| | Listing things |
| | Cleaning up a cupboard |
| | Comparing prices |
| Math interests | Doing exercises in math is fun for me. |
| | It is important for me to be good at math. |
| | I am willing to sacrifice my leisure time for math. |
| German interests | Doing exercises in German is fun for me. |
| | It is important for me to be good in German. |
| | I am willing to sacrifice my leisure time for German. |
| English interests | Doing exercises in English is fun for me. |
| | It is important for me to be good in English. |
| | I am willing to sacrifice my leisure time for English. |

# 3 Study 2: Helping Parents Support Adolescents' Career Orientation: Effects of a Parent-Based Utility-Value Intervention

Piesch, H., Häfner, I., Gaspard, H., Flunger, B., Nagengast, B., & Harackiewicz, J. M. (2019). Helping parents support adolescents' career orientation: Effects of a parent-based utility-value intervention. *Unterrichtswissenschaft*, *47*(3), 271–293. doi: 10.1007/s42010-018-0024-x

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**Abstract**

Adolescents' motivation is crucial for their transition from school to further education. Parents are known to have a substantial influence on their children's motivational beliefs through their own beliefs and behaviors. In this study, we tested whether a parent-based utility-value intervention could promote parents' and students' motivational beliefs and career orientation behavior. Twenty eighth-grade classrooms from German middle-track schools were randomly assigned to the intervention or to a waitlist control condition. Data from 357 students and their parents were obtained via separate questionnaires at pretest and posttest. The intervention was operationalized through a website where parents and students could find information about the usefulness of different school subjects for future careers. The website was designed to help parents support their children during the career orientation process. To examine the effects of the intervention on parents' and students' motivational beliefs and career orientation behavior, Intention-to-treat and Complier Average Causal Effect analyses were calculated. The results showed negative intervention effects on parental career support and perceived importance of career support. No intervention effects were found on the other parental outcomes or on student outcomes. We discuss reasons for these results. The study shows that intervention material needs to be carefully designed and implemented.



*Keywords*: motivation, intervention, parents, career orientation, expectancy-value

**Realschule und dann? Effekte einer Nützlichkeitsintervention zur Unterstützung von Eltern und Jugendlichen bei der Berufsorientierung**

## Zusammenfassung

Die Lernmotivation hängt eng mit beruflichen Entscheidungen am Übergang von der Schule in die weitere Ausbildung zusammen. Eltern können die motivationalen Überzeugungen ihrer Kinder durch ihre eigenen Überzeugungen und ihr Verhalten in hohem Maße beeinflussen. In der vorliegenden Studie wurde untersucht, ob eine elternbasierte Nützlichkeitsintervention die Berufsorientierung und die motivationalen Überzeugungen von Eltern und Jugendlichen fördern kann. In einem experimentellen Prätest-Posttest-Design wurden 20 Realschul-Klassen mit insgesamt 357 Schülerinnen und Schülern der 8. Jahrgangsstufe zufällig der Interventions- oder Warte-Kontrollgruppe zugewiesen. Die Intervention wurde mithilfe einer Webseite umgesetzt, die Informationen zur Nützlichkeit von mehreren Schulfächern für verschiedenen Berufe enthielt. Die Webseite sollte Eltern darin unterstützen, ihren Kindern bei der Berufsorientierung zu helfen. Die Interventionseffekte auf die Motivation und die Berufsorientierung von Jugendlichen und Eltern wurden mithilfe von Intention-to-treat- sowie Complier Average Causal Effect-Analysen untersucht. Es zeigten sich negative Interventionseffekte auf die elterliche Unterstützung bei der Berufsorientierung sowie auf deren wahrgenommene Wichtigkeit. Für weitere elterlichen Variablen sowie auf Seiten der Schülerinnen und Schüler fanden sich keine Interventionseffekte. Mögliche Gründe für die fehlenden bzw. unerwarteten Effekte werden diskutiert. Die Ergebnisse verdeutlichen, dass Nützlichkeitsinterventionen sorgfältig entwickelt und implementiert werden sollten.

*Schlüsselwörter*: Motivation, Nützlichkeitsintervention, Eltern, Berufsorientierung, Erwartungs-Wert-Theorie

**Helping Parents Support Adolescents' Career Orientation: Effects of a Parent-Based Utility-Value Intervention**

The transition from school to vocational education is often a crucial period in adolescents' lives. They are faced with decisions and choices that can substantially impact their future (for a review, see Dietrich, Parker, & Salmela-Aro, 2012). Thus, preparing for this transition is an important task for adolescents and socializers. Previous research has indicated that parents can play an essential role in their children's career decision process (Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001; Noack, Kracke, Gniewosz, & Dietrich, 2010). Adolescents listed their parents as important supporters of career-related decisions when asked about potential sources of support in their transition process (Tynkkynen, Nurmi, & Salmela-Aro, 2010). Providing parents with assistance and information about career-related topics appears to be a promising way to help adolescents make these important choices.

Harackiewicz, Rozek, Hulleman, and Hyde (2012) developed a parent-based intervention that was aimed at supporting parents and students in their career preparation. The intervention focused on parents' and students' value beliefs in math and the sciences by providing parents with information about the importance of these subjects for their children's future careers. This intervention promoted students' course taking and motivation in math and the sciences and had long-term indirect effects on career goals and course-taking at university (Rozek, Svoboda, Harackiewicz, Hulleman, & Hyde, 2017).

Relying on Harackiewicz et al.'s (2012) results, in the present study, we examined whether a similar parent-based utility-value intervention could help parents and students place more value on school subjects and support students' career orientation process. The intervention was based on expectancy-value theory (Eccles et al., 1983) and focused on the value students attach to different school subjects, which in turn influences their later educational choices (Eccles, 2005). We expected the intervention to promote parents' and students' value beliefs and foster their communication about students' career plans, which, in turn, can have a positive impact on their career orientation process.

First, we wanted to conceptually replicate the findings of the abovementioned parent-based intervention study (Harackiewicz et al., 2012) by investigating the generalizability of such intervention effects in a different setting, that is, in German middle-track schools. In this setting, the transition from school to job occurs at an earlier age, and the intervention was thus aimed at helping adolescents prepare for this transition. Second, our study was aimed at extending the intervention from focusing only on school subjects to focusing on transitions from school to vocational education. We examined intervention effects on many outcomes, including parents' and students' value beliefs about different domains, parents' career-supporting behavior, and students' career orientation behavior. Here, we especially considered students' active engagement in career exploration and career decision processes, which are important prerequisites for a successful transition (Noack et al., 2010; Savickas, 2002).

## Expectancy-Value Theory

A common framework for explaining students' achievement motivation is Eccles' expectancy-value theory (EVT; Eccles et al., 1983). According to EVT, students' expectancy of success in a specific task and their task value (i.e., their reasons for engaging in the task) predict their achievement-related behaviors and choices (e.g., career aspirations and decisions; Eccles & Wigfield, 2002). Eccles (2005) proposed four value components: intrinsic value (enjoyment of a task), attainment value (the importance one attaches to the task), utility value (the usefulness of the task for one's life or future), and cost (negative emotions or effort required when doing the task). Many studies have shown that expectancy and value beliefs have a substantial impact on achievement-related behaviors and on course and career choices (Simpkins, Davis-Kean, & Eccles, 2006; for a review, see Wigfield, Tonks, & Klauda, 2016). Subject- and school-related utility value may be especially important for students' career aspirations, given that utility information highlights how specific subjects can facilitate the achievement of future goals (Battle & Wigfield, 2003). Thus, we developed an intervention based on EVT emphasizing the value of different school subjects for the transition from school to work. Our intervention targets both value beliefs and career orientation behavior, both of which are important for this transition. Moreover, it focuses on parents as they can have a substantial influence on their children's value beliefs and career choices.

## The Role of Parental Beliefs and Behavior in Students' Motivation and Career Orientation

Parents' expectations and beliefs can shape their children's motivation, achievement, and career orientation through multiple ways of involvement (Eccles, 2005;

Häfner et al., 2017; Jodl et al., 2001). For example, parents express their expectations and values when they communicate with their children about school and future careers (Jodl et al., 2001). However, previous research has shown that not only the amount and frequency (i.e., the quantity) of parental involvement are important for students' academic and career outcomes but also the quality (Grolnick, Friendly, & Bellas, 2009). More specifically, too much parental involvement can even have negative effects on students' motivation: Older students in particular might feel controlled and not supported in their autonomy, which in turn can even undermine their intrinsic motivation (Pomerantz, Grolnick, & Price, 2005). Self-determination theory (Ryan & Deci, 2009) postulates that parental involvement supporting children's need for autonomy is important for their motivation, personal growth and social development, which has been supported by many empirical studies (Fan & Chen, 2001; Grolnick et al., 2009). With regard to their career orientation, adolescents consider their parents' autonomy supportive behavior to promote their career orientation process (Phillips, Blustein, Jobin-Davis, & White, 2002). Accordingly, autonomy supportive behavior seems to be particularly important during transitions (e.g., the transition from school to work; Grolnick, Kurowski, Dunlap, & Hevey, 2000) as adolescents could benefit from the autonomy to develop their own ideas about their future career (i.e., career autonomy). Thus, intervening in the context of parental autonomy supportive behavior and beliefs could help students develop and maintain motivation and engage in career orientation behavior.

## Student- and Parent-Based Utility-Value Interventions

Given the great influence students' and parents' beliefs can have on adolescents' achievement and career orientation processes, researchers have developed and implemented interventions to promote students' and parents' beliefs (for a review, see Lazowski & Hulleman, 2016). The approaches that were based on EVT typically address subject-specific motivational beliefs and focus on the utility value component. In contrast to intrinsic and attainment value, utility value, as a more extrinsic part of motivational beliefs (Eccles & Wigfield, 2002), can be influenced more easily from the outside. These interventions are designed to help students perceive academic subjects as relevant to their own lives. They typically involve tasks in which students reflect on and generate examples of the personal usefulness of the subject for their own future (Hulleman & Harackiewicz, 2009). Another effective way to promote perceived utility value is to present quotations of former students about the usefulness of the subject in question (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015; Harackiewicz et al., 2012). Such interventions have been successful at enhancing students' utility value beliefs, self-concept, effort, and achievement in different school subjects (Brisson et al., 2017; Gaspard, Dicke, Flunger, Brisson, et al., 2015; Hulleman & Harackiewicz, 2009; for reviews, see Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016).

In recent years, researchers have investigated whether interventions that target parents can also promote students' value beliefs. In a randomized field trial with ninth-grade students that was part of a longitudinal study (Wisconsin Study of Families and Work; for more details, see Hyde, Klein, Essex, & Clark, 1995), Harackiewicz et al. (2012) tested a parent-based intervention for promoting parents' and students' value beliefs about STEM subjects (science, technology, engineering, and math). Parents were provided with information about possible STEM careers for their children and the usefulness of math and science for these careers. The researchers found that parents showed higher utility value beliefs about STEM courses for their children after the intervention. Furthermore, students took more STEM courses, and this in turn was associated with students' STEM beliefs and career aspirations five years later (Harackiewicz et al., 2012; Rozek et al., 2017). Later analyses of Rozek et al. (2015) revealed, though, that the success of the intervention depended on previous achievement and gender and that low-achieving girls even seemed to experience negative intervention effects.

Harackiewicz et al.'s (2012) study showed the potential of parent-based utility-value interventions. However, they examined only a small number of parent behaviors and beliefs. Specifically, students' subsequent career orientation behavior (e.g., exploration of career options) might have been impacted as well because it was addressed in the intervention material.

## Students' and Parents' Career Orientation Behavior

In their career orientation process, youths need to investigate their own interests and expectations concerning their future careers as well as job characteristics and labor market conditions (Noack et al., 2010). This information-gathering process is known as career exploration, which is an important prerequisite for the actual transition (Noack et al., 2010; Savickas, 2002) and a satisfactory career choice (Kracke, 1997). It requires a long-term orientation process that begins during the last years of school (Kracke, 1997) and usually increases as the transition approaches.

Other constructs that are relevant for adolescents' career orientation include the importance they attach to engaging in their career decision (Kaak, Kracke, Driesel-Lange, & Hany, 2013) and their career decidedness, which refers to adolescents' ability and preparedness for choosing a specific occupation (Super & Kidd, 1979). Hirschi and Läge (2008) showed that students with higher career decidedness felt less stressed about their career decision-making, were more actively engaged in applying for an apprenticeship, and were more successful in finding one.

There is evidence that parental career support and promotion of career exploration are positively associated with children's career exploration (Dietrich & Kracke, 2009; Kracke, 1997). Child-centered parenting that includes support and reciprocal communication is supposed to foster adolescents' maturity and self-initiative (Kracke, 2002), both of which are important aspects of career orientation behavior. Kracke and Schmitt-Rodermund (2001) found that parental openness and supportive behavior concerning their children's ideas positively predicted children's career exploration. Teaching parents how to support their children's career orientation and how to interact with their children can therefore be a promising way to support adolescents' career orientation process.

## The Present Study

In a cluster-randomized study, we evaluated the effects of a parent-based utility-value intervention on parents and students. Our aim was to replicate Harackiewicz et al.'s (2012) parent intervention study on a conceptual level and to expand it by investigating the effects on parents' and students' career orientation. As previous parent-based utility-value intervention studies have been conducted in only the U.S. school system, we adapted Harackiewicz et al.'s intervention to the German educational system and specifically to a sample of eighth-grade students from middle-track schools. These students usually graduate after 10$^{th}$ grade and afterwards choose either to attend a vocationally oriented academic track school or to begin a vocational training. We chose to intervene in this specific context because these students have to make their first career-related decision in the immediate future. During their final school years, students normally intensify their occupational preparation and discuss career-related issues at school. However, many students have trouble making a decision that will match their individual interests and abilities (Oechsle, Knauf, Maschetzke, & Rosowski, 2009).

The intervention was implemented via a website that contained information for parents and students about the usefulness of school and different careers options. In the intervention material, we addressed math, German, and English as the main subjects that play roles in the transition from school to job. Similar to Harackiewicz et al. (2012), we also guided parents in how to successfully communicate with their children. In addition, we placed emphasis on a detailed assessment of students' and parents' career orientation behavior that involved various scales and the perspectives of both students and parents. Thus, we tried to transfer Harackiewicz et al.'s (2012) results, which showed surprisingly promising effects of a simple intervention, to the context of motivation for the transition from school to vocational education.

We propose a working model of our study illustrating the mechanisms through which the intervention was assumed to influence the outcomes (Figure 1). The first part of the intervention, the utility information about different subjects and information about careers, was hypothesized to promote parents' and students' utility value beliefs concerning the different subjects. The other part, the communication support for parents, was hypothesized to foster and support interactions between parents and their children about the usefulness of school and about career-related topics. We expected both parts of the intervention to promote students' engagement in their career orientation. By providing information about different careers and about the utility of different subjects for these careers, we sought to encourage students to reflect on possible careers and the perceived utility of school. Additionally, we expected parents to convey their value beliefs to their children and to support them within their career orientation by jointly reflecting about the usefulness of school and about possible career paths. We paid special attention to how we advised parents to support their children by emphasizing the importance of autonomy.

Our specific research questions were as follows: First, can parents' and students' utility value beliefs be promoted through the intervention? We hypothesized that the intervention would increase parents' utility value beliefs regarding their children as well as students' utility value beliefs in the targeted subjects. Second, can the intervention affect parents' career supportive behaviors and beliefs (i.e., school and career communication, career autonomy, career support, and importance of career support)? We expected that parents would show more career supportive behavior and communication with their children after the intervention because parents were taught how to communicate with their children. Third, can the intervention affect students' career orientation behavior (i.e., career decision, career exploration, and career involvement) and discussions with their parents about career-related issues? Again, we expected to find an increase in students' engagement in career orientation behavior and in their communication with their parents.

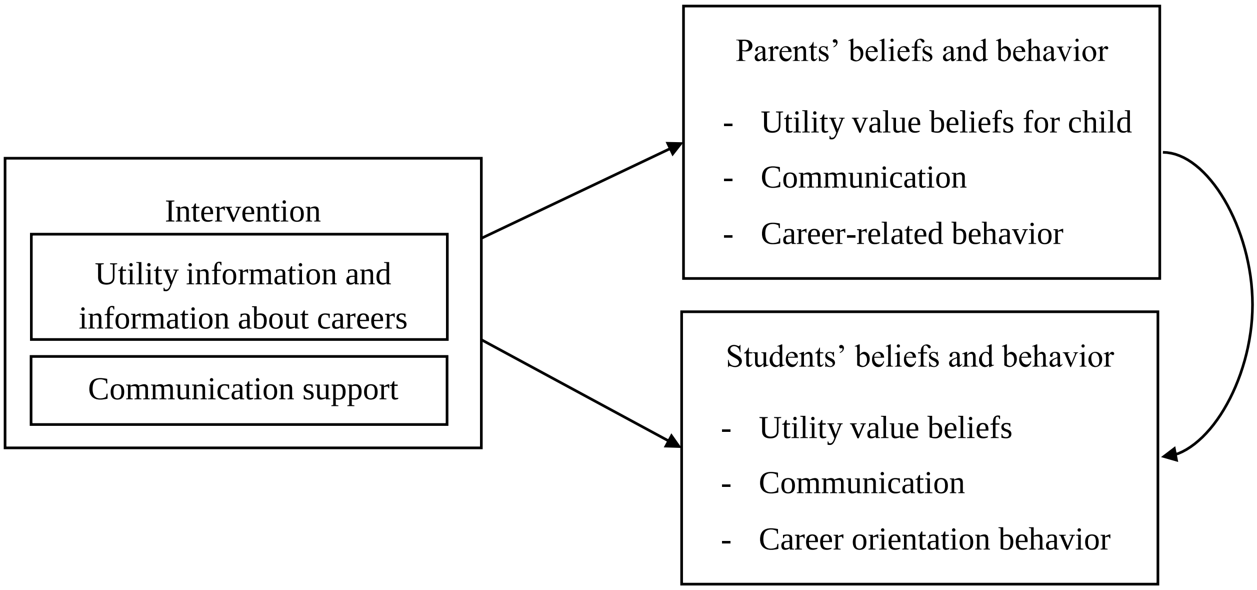


*Figure 1.* Theoretical model illustrating how the intervention components are supposed to affect parent and student variables.

## Method

### Sample and Procedure

Our sample consisted of 20 classes of eighth graders from seven middle-track schools (one to five classes per school) in the German state of Baden-Württemberg. Overall, 357 students participated (51.5% female; age at pretest: $M = 14.11$). Participation was voluntary, and students and parents had to give written consent to participate. Parents of 326 families (91.3%) filled out at least one questionnaire at pretest or posttest. Regarding family background, 23.8% of mothers and 31.4% of fathers held qualifications for college education (Abitur). As for immigration status, one parent was born outside of Germany in 12.5% of the families, and both parents were born outside of Germany in 18.6% of them (predominantly in Turkey). Before the pretest, classes were randomly assigned to the intervention or control condition within each school. Thus, there were 10 classes in each condition ($n_{\text{intervention}}$ = 169, $n_{\text{control}}$ = 188). Data collection took place before the intervention in February 2016 (pretest = T1) and approximately six weeks later in March 2016 (posttest = T2). Trained research assistants administered the questionnaires to the students and handed out envelopes containing the parent questionnaires, which parents were requested to fill out at home.

**Intervention**

Two weeks after the pretest, we sent letters to the parents in the intervention classes containing a link to the password-protected website and a personal login code. The letter invited parents to explore the website on their own or along with their child. The original website is available at www.realschule-und-dann.de. An outline of the topics presented on the website can be found in Appendix A. We presented information for parents and students about the usefulness of math, German, and English for specific vocational trainings and careers as well as for students' daily lives and futures in general. Drawing on previous intervention studies (Gaspard, Dicke, Flunger, Brisson, et al., 2015; Harackiewicz et al., 2012), we used quotations of former students and adults who talked about how they had applied what they learned in the abovementioned subjects to their job or daily life. To help parents and students reflect on possible connections from school to future jobs, we included examples and small communication tasks. Moreover, the website included information about possible future careers in several areas that were typical for graduates of middle-track schools. We also presented research results on the roles that students' effort and self-concept play for school achievement in order to counteract any potential negative intervention effects for students who might not feel competent in the targeted subjects (Durik, Hulleman, & Harackiewicz, 2014). In addition, we included an online questionnaire in which parents could evaluate the website and provide feedback. Because we used a waitlist control group design, we opened the website to the public after we administered the posttest and invited the participants in the control condition to visit the website as well.

**Compliance Measure**

Although we invited all families in the intervention classes to visit our website, these visits were voluntary. To assess whether participants in the intervention condition were compliant with our intervention (i.e., whether they actually visited the website), we asked parents and students at posttest whether they looked at the website. We asked parents this question in the online questionnaire, too. In addition, we tried to track the website logins to get information about families' frequency and duration of visits, but this was possible for only a small proportion of our sample (seven families) due to computer safety settings. However, the data we were able to track were consistent with the data we received through the questionnaires.

Table 1

*Descriptive Statistics for Compliance Status in the Intervention Condition*

| | Visited website | | Did not visit website | | Missing | |
|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % |
| Students | 92 | 54.4 | 62 | 36.7 | 15 | 8.9 |
| Parents | 92 | 54.4 | 29 | 17.2 | 48 | 28.4 |
| Students and parents | 79 | 46.7 | 38 | 22.5 | 52 | 30.8 |
| Students and/or parents | 105 | 62.1 | 49 | 29.0 | 15 | 8.9 |

*Note*. $N$ = 169.

The descriptive statistics for compliance status (i.e., a measure of the website visits) are displayed in Table 1. In 62.1% of the families in the intervention condition, the student, the parent, or both visited the website. By contrast, 29.0% reported that they did not visit the website, and we received no clear information about the website visits of 8.9% of the participating families. To form the compliance measure, we combined the student and parent measures from all data sources (student and parent questionnaires, online questionnaire) into one compliance measure per family. The family was coded as compliant if either the child or the parent or both reported that they had visited the website at least once. If the child and the parent stated that they did not visit the website, the family was coded as noncompliant. In addition, if one person (e.g., the child) reported that he or she did not take a look at the website and the other person (the parent) did not answer the question, the compliance measure was coded as noncompliant. The families that did not report whether they visited the website as well as all participants in the control group were coded as missing values. To test the robustness of our results, we also used an alternative coding scheme in which the families with one negative answer (e.g., the child did not visit the website) and one missing answer (no answer from the parent) were coded as missing values instead of noncompliers. Because the different ways of coding did not produce substantially different results, we report only the results of the first, more conservative coding strategy here. The results of the other coding scheme can be found in the Supplemental Material (Tables S1 and S2).

### Instruments of Parent Questionnaire

Appendix B includes sample items and scale reliabilities for all constructs. We ran confirmatory factor analyses to test the measurement properties of the adapted and self-developed scales, all of which revealed an acceptable model fit (see Supplemental Material, Table S3). Regarding validity, these scales showed high and low correlations with scales measuring conceptually similar and different scales, respectively, supporting their convergent and discriminant validity (see Table 2).

**Utility value beliefs.** Parents were asked to rate the extent to which they perceived school in general, math, German, and English to be useful for their child. This *utility value for child* scale was measured with three items for each subject with parallel wording (Häfner et al., 2017) and with four items for school in general (slightly adapted from Harackiewicz et al., 2012). All items were rated on a 5-point Likert-type scale ranging from 1 (*not at all useful*) to 5 (*very useful*).

**Communication.** Communicating about school and career-related topics with the child were both measured with four items on a 4-point Likert-type scale ranging from 1 (*never*) to 4 (*very often*). For *school communication*, a scale from the Trends in Mathematics and Science Study (TIMSS) 2007 was used (Bos, Bonsen, Kummer, Lintorf, & Frey, 2009). The items for assessing *career communication* were self-developed.

**Career supportive behavior and beliefs.** The *career autonomy* parents granted to their children was measured with five self-developed items. Parental *career support* was assessed with a scale by Dietrich and Kracke (2009) consisting of five items. Parents' perceived *importance of career support* was measured with four items (adapted to the career context from Walker, Wilkins, Dallaire, Sandler, & Hoover-Dempsey, 2005). All items were measured on a 4-point Likert-type scale ranging from 1 (*disagree*) to 4 (*agree*).

## Instruments of Student Questionnaire

**Utility value beliefs.** Students' perceived *utility value* for school in general, math, German, and English was assessed with a questionnaire developed and validated in previous studies (Gaspard, Dicke, Flunger, Schreier, et al., 2015; Gaspard, Häfner, Parrisius, Trautwein, & Nagengast, 2017). For our study, we chose two subscales that best covered the constructs that we addressed in our intervention, namely, the subfacets tapping utility for daily life (three items) and utility for job (four items). These seven items were combined into one utility value scale for school and for the three subjects, respectively. They were answered on a 4-point Likert-type scale ranging from 1 (*completely disagree*) to 4 (*completely agree*).

**Parental career supportive behavior.** Students' perception of their *career communication* with their parents and their parents' *career autonomy* and *career support* were assessed with items that were parallel to the parent questionnaire.

**Students' career orientation behavior.** To assess how deeply students were involved in their career decision and the extent to which they sought information about possible careers, we measured their *career decision*, *career exploration*, and *career involvement*. For their career decision, we used a 12-item scale by Seifert and Stangl (1986). Students' career exploration was measured with seven items (Kracke, 1997), and the importance they attached to career involvement was measured with eight items (Kaak et al., 2013). All items were assessed on a 4-point Likert-type scale ranging from 1 (*completely disagree*) to 4 (*completely agree*).

## Statistical Analyses

All statistical analyses were conducted in Mplus 7.31 (Muthén & Muthén, 1998-2012). The clustered data structure in which students were nested in classes[4] was accounted for with the design-based correction of standard errors (see McNeish, Stapleton, & Silverman, 2017, for a justification of this approach).

[4] Intra-class correlation coefficients on the class as well as the school level at pretest were very small for all outcomes (.00 ≤ ICC ≤ .04 on the school level, .01 ≤ ICC ≤ .04 on the class level; see Supplemental Material, Table S4). Therefore, dependencies at the school level could be disregarded. Only the class level was considered.

**Intention-to-treat analyses.** The approach that is traditionally used to analyze intervention effects in randomized studies is the Intention-to-treat (ITT) analysis (Sagarin et al., 2014). In this approach, the groups that are compared are formed only by the condition that participants were randomly assigned to. In order to estimate the ITT effects, we specified separate multiple regression models for all outcome variables for parents and students. Each model contained an indicator of the intervention condition as a predictor. Testing for pretest differences between the intervention and control groups revealed that only two out of 19 tests were significant (parental career support, $d = 0.32$, and importance of career support, $d = 0.22$). All results on pretest differences can be found in the Supplemental Material (Table S5). Nevertheless, in order to obtain more precise estimates of intervention effects, as suggested by Raudenbush (1997), pretest scores on the respective variables were included as covariates in the models. To facilitate the interpretation of the results, all variables were standardized beforehand. Thereby, the regression coefficients for the dichotomous indicator of the intervention group can be directly interpreted as effect sizes.

**Complier Average Causal Effect analyses.** In randomized intervention studies, conventional ITT analyses can generate misleading results if participants are not responsive to the treatment (Hirano, Imbens, Rubin, & Zhou, 2000). In such cases, Complier Average Causal Effect (CACE) analyses are an appropriate way to take into account information about participants' compliance with the treatment (Sagarin et al. 2014; for an example of a CACE analysis applied in an intervention study, see Nagengast et al., 2018). CACEs represent the treatment effect on intervention-group participants who were actually compliant with the treatment (i.e., who embraced the treatment as intended; Sagarin et al., 2014). Typically, compliance is assumed to be a dichotomous measure. However, as information about the compliance status of participants in the control group was missing because they could not be compliant with an intervention they were not allowed to access, two further assumptions are required to identify CACEs. First, the *Exclusion Restriction* (Angrist, Imbens, & Rubin, 1996) is typically applied. This implies that assignment to the treatment condition does not have an effect on the outcome other than through compliance with the intervention (Sagarin et al., 2014). If the *Exclusion Restriction* holds, the potential outcome of a participant who was assigned to the intervention group but did not use the treatment (i.e., a noncomplier) is the same as it would be if the person had been assigned to the control group. In our study, we would not expect any changes in the outcome variables for the noncompliers who were assigned to the intervention group but did not visit the website. Thus, the *Exclusion Restriction* seemed to be plausible in the current study.

The second assumption is the *Monotonicity Assumption*, which implies that there are no so-called defiers, that is, participants who would refuse to take the treatment when assigned to the intervention condition and would take the treatment when assigned to the control condition (Angrist et al., 1996). This hypothetical group of participants would always act against their treatment assignment, which seems to be very unlikely. In our study, the assumption that there were no defiers was plausible.

To consider the compliance status, we conducted CACE analyses that included families' compliance with the intervention. To this end, we specified separate multivariate mixture models for all outcome variables of parents and students. The dichotomous compliance status variable served to define the latent classes of compliers and noncompliers (Jo & Muthén, 2001). In both latent classes, the intervention condition served as the predictor in the model. Again, pretest scales were included as covariates, and all continuous variables were standardized.

**Missing data.** Apart from the compliance measure, the percentage of missing data ranged from 14.6% to 26.1% for parent variables and from 5.3% to 19.6% for student variables (pretest and posttest). In all analyses, we used the full information maximum likelihood approach implemented in Mplus to deal with missing data. This approach takes all available information into account to estimate the model parameters (Schafer & Graham, 2002).

## Results

### Descriptive Statistics and Correlations

Descriptive statistics for the outcome variables at pre- and posttest are displayed in Table 3 separately for the intervention and control groups. Correlations for parent and student variables at pretest can be found in Table 2.

Regarding the mean levels on the parent variables at pretest, there was some indication for ceiling effects for the utility and career scales in both the intervention and control groups (e.g., school utility for child: $M$ = 4.39/4.47, scale 1-5; career support: $M$ = 3.54/3.34, scale 1-4). Students' own utility values at pretest were at a medium level except for English, which had exceptionally high ratings ($M$ = 3.30/3.25, scale 1-4). Other tendencies toward ceiling effects were found for students' perceptions of their parents' career autonomy (*M* = 3.18/3.27, scale 1-4) and career involvement (*M* = 3.38/3.43, scale 1-4).

The correlation pattern reveals that students and parents seem to perceive their interactions differently to some extent. For example, regarding career communication, autonomy, and support, we found low to zero correlations between parents' and students' perceptions ($-.01 \leq r \leq .26$). Regarding correlations among parent and student variables, parents' utility perceptions for their child for the different subjects correlated relatively highly ($.44 \leq r \leq .74$), whereas the correlations between students' own utility perceptions were only small to medium ($.13 \leq r \leq .46$). As expected, the measures for parents' career-related behavior were positively interrelated from both the parents' ($.17 \leq r \leq .67$) and students' perspectives ($.23 \leq r \leq .52$). Students' career-related behaviors were positively related to their perception of their parents' behavior ($.20 \leq r \leq .40$).

Table 2

*Correlations for Parent and Student Variables at Pretest*

| | Parent variables | | | | | | | | | Student variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| *Parent variables* | | | | | | | | | | | | | | | | | | |
| 1 School utility for child | | | | | | | | | | | | | | | | | | |
| 2 Math utility for child | .49*** | | | | | | | | | | | | | | | | | |
| 3 German utility for child | .46*** | .57*** | | | | | | | | | | | | | | | | |
| 4 English utility for child | .44*** | .61*** | .74*** | | | | | | | | | | | | | | | |
| 5 Career communication | .13 | .13 | .16 | .15 | | | | | | | | | | | | | | |
| 6 Career autonomy | .04 | .05 | .18*** | .09 | .17*** | | | | | | | | | | | | | |
| 7 Career support | .17* | .18** | .24* | .20* | .36*** | .23*** | | | | | | | | | | | | |
| 8 Importance career support | .21* | .19* | .29* | .24* | .37*** | .22*** | .67*** | | | | | | | | | | | |
| 9 School communication | .14* | .13* | .17** | .13* | .36*** | .05 | .16* | .13 | | | | | | | | | | |
| *Student variables* | | | | | | | | | | | | | | | | | | |
| 10 School utility | .13 | .14*** | .11* | .11 | -.02 | .00 | .06 | -.01 | -.02 | | | | | | | | | |
| 11 Math utility | .07 | .26*** | .02 | .04 | -.10 | -.02 | .05 | -.02 | -.10* | .46*** | | | | | | | | |
| 12 German utility | .13 | -.02 | .13** | .13* | .11 | -.02 | -.09 | -.04 | .10* | .36*** | .13* | | | | | | | |
| 13 English utility | .06 | -.05 | .10 | .19** | .07 | .01 | -.07 | .01 | -.07 | .21* | .13* | .31*** | | | | | | |
| 14 Career communication | .05 | -.05 | .01 | -.01 | .26*** | .03 | .10 | .15** | .18* | .13* | .06 | .17** | .10 | | | | | |
| 15 Career autonomy | .02 | -.02 | -.03 | .02 | .00 | .09 | -.01 | .03 | .05 | .24*** | .17** | .12* | .17*** | .23** | | | | |
| 16 Career support | -.07 | -.05 | -.05 | -.03 | .12 | .00 | .05 | .01 | .08 | .22*** | .16* | .18** | .11* | .52*** | .41*** | | | |
| 17 Career decision | -.02 | .01 | .01 | .00 | .03 | .07 | .13* | .02 | .04 | .03 | .04 | -.07 | -.07 | .21*** | .10 | .10 | | |
| 18 Career exploration | -.05 | -.12 | -.04 | -.02 | .05 | .02 | -.05 | .00 | .04 | .18** | .10 | .20*** | .15* | .32*** | .20* | .40*** | .05 | |
| 19 Career involvement | .01 | -.02 | .00 | .02 | .06 | .03 | -.06 | -.01 | -.09 | .31*** | .10 | .25*** | .19* | .26*** | .31*** | .36*** | -.03 | .43*** |

*Note*. The pattern of correlations at posttest were comparable. *$p$ < .05. **$p$ < .01. ***$p$< .001.

Table 3

*Descriptive Statistics for Parent and Student Variables at Pre- and Posttest*

| | Intervention group | | | | Control group | | | |
|---|---|---|---|---|---|---|---|---|
| | Pretest | | Posttest | | Pretest | | Posttest | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| *Parent variables* | | | | | | | | |
| School utility for child | 4.39 | 0.77 | 4.35 | 0.79 | 4.47 | 0.60 | 4.35 | 0.72 |
| Math utility for child | 4.14 | 0.84 | 4.24 | 0.82 | 4.12 | 0.72 | 4.14 | 0.85 |
| German utility for child | 4.44 | 0.65 | 4.46 | 0.69 | 4.40 | 0.56 | 4.37 | 0.67 |
| English utility for child | 4.32 | 0.71 | 4.37 | 0.69 | 4.31 | 0.64 | 4.30 | 0.71 |
| Career communication | 2.78 | 0.52 | 2.74 | 0.56 | 2.72 | 0.58 | 2.75 | 0.61 |
| Career autonomy | 3.36 | 0.43 | 3.34 | 0.50 | 3.40 | 0.45 | 3.38 | 0.47 |
| Career support | 3.54 | 0.59 | 3.31 | 0.63 | 3.34 | 0.65 | 3.41 | 0.59 |
| Importance career support | 3.66 | 0.51 | 3.44 | 0.58 | 3.55 | 0.48 | 3.51 | 0.52 |
| School communication | 2.90 | 0.55 | 2.88 | 0.58 | 2.83 | 0.53 | 2.78 | 0.51 |
| *Student variables* | | | | | | | | |
| School utility | 2.97 | 0.45 | 2.95 | 0.48 | 3.01 | 0.45 | 2.96 | 0.49 |
| Math utility | 2.87 | 0.70 | 2.86 | 0.62 | 2.86 | 0.69 | 2.88 | 0.63 |
| German utility | 2.93 | 0.67 | 2.94 | 0.69 | 2.86 | 0.72 | 2.88 | 0.72 |
| English utility | 3.30 | 0.61 | 3.21 | 0.62 | 3.25 | 0.60 | 3.24 | 0.56 |
| Career communication | 2.74 | 0.63 | 2.67 | 0.60 | 2.69 | 0.63 | 2.60 | 0.60 |
| Career autonomy | 3.18 | 0.57 | 3.18 | 0.59 | 3.27 | 0.53 | 3.17 | 0.58 |
| Career support | 3.06 | 0.62 | 3.00 | 0.66 | 3.02 | 0.58 | 2.94 | 0.69 |
| Career decision | 2.67 | 0.62 | 2.69 | 0.59 | 2.61 | 0.60 | 2.71 | 0.60 |
| Career exploration | 2.68 | 0.57 | 2.69 | 0.47 | 2.73 | 0.45 | 2.65 | 0.59 |
| Career involvement | 3.38 | 0.51 | 3.32 | 0.59 | 3.43 | 0.46 | 3.36 | 0.56 |

*Note.* The utility for child scales were measured on a scale ranging from 1 to 5. All other scales were measured on a scale ranging from 1 to 4.

**Intervention Effects on Parent and Student Variables**

The results of the ITT and CACE analyses for testing the intervention effects looked very similar. Overall, we found only a few intervention effects at posttest (Table 4).

In the ITT analysis for parents, we found a negative intervention effect on career support for their children (β = -0.30, $p$ = .002). There was also a tendency toward a negative effect on the importance parents attached to their career support, but it missed significance (β = -0.24, $p$ = .054). There were no effects on parents' utility perceptions for their children that were statistically significant. The regression coefficients for parents' career communication, career autonomy and school communication were small and nonsignificant, too.

Table 4

*Intervention Effects on Parent and Student Variables at Posttest*

| | ITT | | | CACE | | |
|---|---|---|---|---|---|---|
| Outcome variable | β | SE | *p* | β | SE | *p* |
| *Parent variables* | | | | | | |
| School utility for child | 0.02 | 0.14 | .911 | -0.06 | 0.12 | .659 |
| Math utility for child | 0.04 | 0.08 | .655 | -0.10 | 0.10 | .301 |
| German utility for child | 0.11 | 0.10 | .270 | 0.02 | 0.13 | .898 |
| English utility for child | 0.07 | 0.10 | .445 | -0.06 | 0.14 | .688 |
| Career communication | -0.10 | 0.09 | .287 | -0.28 | 0.17 | .100 |
| Career autonomy | -0.07 | 0.09 | .444 | -0.17 | 0.11 | .106 |
| Career support | -0.30 | 0.10 | .002 | -0.44 | 0.13 | .001 |
| Importance career support | -0.24 | 0.12 | .054 | -0.36 | 0.14 | .008 |
| School communication | 0.10 | 0.08 | .207 | 0.09 | 0.14 | .505 |
| *Student variables* | | | | | | |
| School utility | 0.10 | 0.11 | .388 | 0.08 | 0.14 | .588 |
| Math utility | -0.01 | 0.12 | .933 | 0.02 | 0.16 | .905 |
| German utility | 0.13 | 0.10 | .194 | 0.12 | 0.18 | .492 |
| English utility | 0.01 | 0.07 | .902 | 0.01 | 0.14 | .928 |
| Career communication | 0.09 | 0.11 | .396 | 0.14 | 0.16 | .402 |
| Career autonomy | 0.12 | 0.12 | .291 | 0.15 | 0.16 | .358 |
| Career support | 0.12 | 0.16 | .452 | -0.03 | 0.15 | .854 |
| Career decision | -0.18 | 0.10 | .066 | -0.10 | 0.13 | .460 |
| Career exploration | 0.12 | 0.13 | .358 | 0.22 | 0.14 | .100 |
| Career involvement | 0.05 | 0.17 | .780 | -0.05 | 0.13 | .721 |

The results of the CACE analyses showed a similar pattern. Again, we found negative intervention effects on parents' career support (β = -0.44, $p$ = .001) and its perceived importance (β = -0.36, $p$ = .008). The effects were a little larger than in the ITT analysis. In the CACE analyses, the regression coefficients for other constructs (e.g., career communication and career autonomy) were larger but still not significant. Again, we did not find an effect on parents' perceived utility of the subjects for their children or on school communication.

For students, there were no significant intervention effects in the ITT analyses or the CACE analyses. In the ITT analyses, there was a tendency for students' career decision ratings to decline (β = -0.18, $p$ = .066), but this effect was not significant. In the CACE analyses, the largest but still nonsignificant coefficient was found for career exploration, for which students reported higher values after the intervention (β = 0.22, $p$ = .100). All other coefficients for students' utility value beliefs and career orientation as well as for their parents' career supportive behavior were relatively small.

## Discussion

In a cluster-randomized study, we investigated the effects of a parent-based utility-value intervention on parents' and students' utility values and career orientation. We aimed to conceptually replicate Harackiewicz et al.'s (2012) findings and also to expand the focus to include the transition from school to work. Unfortunately, we found only that the parents in the intervention condition reported less career support for their children afterwards and that they perceived their career support to be less important. No intervention effects were found for other parent or student outcomes.

### Decline in Parental Career Support

Our findings indicate that the parents in the intervention condition reported less support for their children's career orientation. As our intention was to get parents and children to focus more on students' future careers, the intervention did not work as expected. However, it is important to keep in mind that we did not observe parents' actual behavior but asked them about their perception of their own behavior. It might therefore be possible that parents did not really support their children less, but perhaps the intervention caused them to recalibrate how much support they gave at posttest. Self-perceptions are influenced by comparisons with a certain frame of reference (Bong &

Skaalvik 2003), which might have changed. After parents learned about the many other people or institutions that might be involved in their children's career orientation, they may have perceived their own support as less in quantity and as less important. In addition, we did not find these negative effects on the same scales from the students' perspective, and this finding is in line with the idea that parents did not actually change their support.

If parents really reduced their career support, one explanation could be that they perceived themselves as less competent in supporting their children after realizing how many career options their children have. In addition, after learning that there are many other sources of support their children can seek out, they may consequently leave this task to others. Previous studies have also reported that parents sometimes offer less career support if they perceive their own lack of competence (Dietrich & Kracke 2009).

Regarding research on parental involvement in general, our finding of less parental support does not have to be solely negative. As reported by Pomerantz et al. (2005), too much parental involvement can even have a negative effect on students' intrinsic motivation. Thus, the right amount of parental autonomy support is crucial for students' sense of autonomy (Grolnick et al. 2009). Especially regarding career orientation, when adolescents discover their own interests and gain the experience of making choices with far-reaching effects, they should experience autonomy and personal responsibility. On our website, we tried to highlight the importance of parents' autonomy support for their children. Perhaps some parents had been engaging in more active and intrusive career supportive behavior, but after exploring the website, they realized they should reduce their (intrusive) career support. From this perspective, the potential decline in parents' career support might represent a positive impact.

### Absent Intervention Effects and Failed Replication

We did not achieve our aim of replicating the findings from Harackiewicz et al. (2012) who had successfully promoted participants' utility value beliefs and career choices with a simple intervention. Although their intervention was successful, later analyses revealed that girls with low previous achievement did not benefit from the intervention due to low success expectancies, which seemed to negate the positive intervention effect (Harackiewicz et al. 2012; Rozek et al. 2015).

In our study, there are several potential reasons for the failure to find intervention effects. First, our intervention might not have been designed and implemented appropriately for the target group. Perhaps if we had repeatedly invited the families to visit the website, this would have been more effective. In contrast to Harackiewicz et al.'s longitudinal study, in which families were sent informational brochures in addition to an invitation to visit the website and thus received more exposure to the intervention, we sent the website link only once. It might also be the case that the parents in that study visited the website more often or examined it more closely than the parents in our study because they were used to complying with what was expected of them. Furthermore, the social backgrounds of the samples were different. About one third of our families had an immigration background, which probably made it more difficult to reach them (e.g., due to language problems). Moreover, it is possible that the content of our website, which focused on information about the utility of subjects and career possibilities, did not meet participants' needs. Although we intended to help parents connect with their children, parents might not have used the information as expected or might have needed more advice on how to handle certain topics (e.g., uncertainty in the stage of career orientation). It is also possible that fostering parents' and students' utility value for career orientation behavior itself, instead of their utility value for school, would have been more effective, as the former is more closely connected to the activities that the intervention was supposed to change.

Second, parents and students showed relatively high mean levels at pretest on several utility value scales. These ceiling effects might indicate that there was perhaps no great need to intervene, and that, for example, parents may have already been convinced of the utility of school for their child. Maybe it is not the usefulness of school that needed to be fostered but rather other autonomy supportive aspects, such as providing choices to children (Grolnick et al. 2009). Furthermore, in our study, students and parents showed rather low levels of career communication. Thus, further intervention studies could target career communication and career autonomy more systematically.

**Limitations and Future Research**

For the interpretation of our results, some limitations should be kept in mind. First, our sample was limited to eighth graders from German middle-track schools. We deliberately chose this school type and specifically developed the website for our participants. Thus, future research should adapt the intervention to test whether the results look different for other school types. Second, we only assessed perceptions and no actual career orientation behavior. We found low correlations between parents' and students' ratings of parental career supportive behavior, indicating that they differ in their perceptions of their behavior to some extent. Thus, it would be interesting to further investigate what actually happens when parents and students talk about the website content at home. This could help to better illuminate the processes of information transfer between parents and students as well as the role parents play in influencing their children's career orientation. Third, we did not succeed in tracking data on the length of parents' and students' website visits. If participants spent only a few minutes visiting the website, we might not expect a change in their beliefs or behaviors. Our intervention may have been too weak regarding active engagement, relative to previous intervention programs that used a combination of parent and teacher support (Mayhack 2011) or were designed as career workshops (e.g., Hirschi & Läge 2008; Koivisto et al. 2010). In future studies, it will be important to measure the duration of time spent actively engaged with the intervention material, to evaluate how long and how intensive the intervention needs to be to work optimally. Finally, it is possible that the intervention setting at home made it difficult for students to link the website content to their school subjects and curricula. A classroom-based intervention might have been more effective in fostering students' utility value beliefs.

In general, although we put effort into designing an appropriate intervention, we may not have met the needs of our specific sample or they might not have used the intervention as intended. Parents in this context might need more specific information on how to handle difficulties within the career orientation process or a stronger encouragement to actively support their children in an autonomy supportive way. Students in this context might need an intervention that affords more active engagement and allows them to directly connect to their subjects. Our study points to the fact that utility-value interventions are sometimes not as easy to implement as they seem, as many parameters influence the success of such interventions. Thus, researchers should consider the specific context and participants' needs and should incorporate suitable and reliable measures when developing and implementing such interventions.

## References

Angrist, J. D., Imbens, G. W., & Rubin, D. B. (1996). Identification of causal effects using instrumental variables. *Journal of the American Statistical Association*, *91*(434), 444–455. https://doi.org/10.2307/2291629

Battle, A., & Wigfield, A. (2003). College women's value orientations toward family, career, and graduate school. *Journal of Vocational Behavior*, *62*(1), 56–75. https://doi.org/10.1016/S0001-8791(02)00037-4

Bong, M., & Skaalvik, E.M. (2003). Academic self-concept and self-efficacy: how different are they really? *Educational Psychology Review*. https://doi.org/10.1023/A:1021302408382.

Bos, W., Bonsen, M., Kummer, N., Lintorf, K., & Frey, K. (2009). *TIMSS 2007 – Dokumentation der Erhebungsinstrumente zur [Scale documentation of] „Trends in International Mathematics and Science Study“*. Münster: Waxmann.

Brisson, B. M., Dicke, A.-L., Gaspard, H., Häfner, I., Flunger, B., Nagengast, B., & Trautwein, U. (2017). Short intervention, sustained effects: Promoting students' math competence beliefs, effort, and achievement. *American Educational Research Journal*, *54*(6), 1048–1078. https://doi.org/10.3102/0002831217716084

Dietrich, J., & Kracke, B. (2009). Career-specific parental behaviors in adolescents' development. *Journal of Vocational Behavior*, *75*(2), 109–119. https://doi.org/10.1016/j.jvb.2009.03.005

Dietrich, J., Parker, P., & Salmela-Aro, K. (2012). Phase-adequate engagement at the post-school transition. *Developmental Psychology*, *48*(6), 1575–1593. https://doi.org/10.1037/a0030188

Durik, A. M., Hulleman, C. S., & Harackiewicz, J. M. (2014). One size fits some: Instructional enhancements to promote interest. In K. A. Renninger & M. Nieswandt (Eds.), *Interest, the Self, and K-16 Mathematics and Science Learning*. Washington, D.C.: American Educational Research Association.

Eccles, J. S. (2005). Subjective task values and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York, NY: Guilford.

Eccles, J. S., Adler, T., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological* *approaches* (pp. 74–146). New York, NY: Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*, 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review*, *13*(1), 1–22. https://doi.org/10.1023/A:1009048817385

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. *Developmental Psychology*, *51*(9), 1226–1240. https://doi.org/10.1037/dev0000028

Gaspard, H., Dicke, A.-L., Flunger, B., Schreier, B. M., Häfner, I., Trautwein, U., & Nagengast, B. (2015). More value through greater differentiation: Gender differences in value beliefs about math. *Journal of Educational Psychology*, *107*(3), 663–677. https://doi.org/10.1037/edu0000003

Gaspard, H., Häfner, I., Parrisius, C., Trautwein, U., & Nagengast, B. (2017). Assessing task values in five subjects during secondary school: Measurement structure and mean level differences across grade level, gender, and academic subject. *Contemporary Educational Psychology*, *48*, 67–84. https://doi.org/10.1016/j.cedpsych.2016.09.003

Grolnick, W. S., Friendly, R. W., & Bellas, V. M. (2009). Parenting and children's motivation at school. In K. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 279–300). New York, NY: Routledge.

Grolnick, W. S., Kurowski, C. O., Dunlap, K. G., & Hevey, C. (2000). Parental resources and the transition to junior high. *Journal of Research on Adolescence*, *10*(4), 465–488. https://doi.org/10.1207/SJRA1004_05

Häfner, I., Flunger, B., Dicke, A.-L., Gaspard, H., Brisson, B. M., Nagengast, B., & Trautwein, U. (2017). The role of family characteristics for students' academic outcomes: A person-centered approach. *Child Development*. Advance online publication. https://doi.org/10.1111/cdev.12809

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899–906.

https://doi.org/10.1177/0956797611435530

Hirano, K., Imbens, G. W., Rubin, D. B., & Zhou, X.-H. (2000). Assessing the effects of influenza vaccine in an encouragement design. *Biostatistics*, *1*, 69–88. https://doi.org/10.1093/biostatistics/1.1.69

Hirschi, A., & Läge, D. (2008). Increasing the career choice readiness of young adolescents: An evaluation study. *International Journal for Educational and Vocational Guidance*, *8*(2), 95–110. https://doi.org/10.1007/s10775-008-9139-7

Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science*, *326*(5958), 1410–1412. https://doi.org/10.1126/science.1177067

Hyde, J. S., Klein, M. H., Essex, M. J., & Clark, R. (1995). Maternity leave and women's health. *Psychology of Women Quarterly*, *19*(2), 257–285. https://doi.org/10.1111/j.1471-6402.1995.tb00291.x

Jo, B., & Muthén, B. O. (2001). Modeling of intervention effects with noncompliance: A latent variable approach for randomized trials. In G. A. Marcoulides & R. E. Schumacker (Eds.), *New Developments and Techniques in Structural Equation Modeling* (pp. 57–87). Mahwah, NJ: Lawrence Erlbaum Associates, Inc. Publishers.

Jodl, K. M., Michael, A., Malanchuk, O., Eccles, J. S., & Sameroff, A. (2001). Parents' roles in shaping early adolescents' occupational aspirations. *Child Development*, *72*(4), 1247–1265. https://doi.org/10.1111/1467-8624.00345

Kaak, S., Kracke, B., Driesel-Lange, K., & Hany, E. (2013). Diagnostik und Förderung der Berufswahlkompetenz Jugendlicher [Diagnosis and promotion of adolescents' career choice competencies]. In K. Driesel-Lange & B. Dreer (Eds.), *bwp@ Spezial 6 – Hochschultage Berufliche Bildung 2013 [bwp@ special 6 – University congress on vocational education], Workshop 14* (pp. 1–13).

Koivisto, P., Vuori, J., & Vinokur, A.D. (2010). Transition to work: effects of preparedness and goal construction on employment and depressive symptoms. *Journal of Research on Adolescence*, *20*(4), 869–892. https://doi.org/10.1111/j.1532-7795.2010.00667.x.

Kracke, B. (1997). Parental behaviors and adolescents' career exploration. *Career Development Quarterly*, *45*(4), 341–350. https://doi.org/10.1002/j.2161-0045.1997.tb00538.x

Kracke, B. (2002). The role of personality, parents and peers in adolescents career exploration. *Journal of Adolescence*, *25*(1), 19–30. https://doi.org/10.1006/jado.2001.0446

Kracke, B., & Schmitt-Rodermund, E. (2001). Adolescents' career exploration in the context of educational and occupational transitions. In J.-E. Nurmi (Ed.), *Navigating through adolescence: European perspectives*. New York, NY: Falmer Press.

Lazowski, R. A., & Hulleman, C. S. (2016). Motivation interventions in education: A meta-analytic review. *Review of Educational Research*, *86*(2), 602–640. https://doi.org/10.3102/0034654315617832

Mayhack, K. (2011). *Gemeinsam auf dem Weg zum Beruf. Intervention zur Förderung berufswahlrelevanter Kompetenzen von Schülern durch den Elterneinbezug in die Schule [Together towards a career. An intervention to promote students' career-related competencies by involving parents in school]* (Dissertation). Retrieved from https://d-nb.info/1017972362/34.

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods*, *22*(1), 114–140. https://doi.org/10.1037/met0000078

Muthén, L. K., & Muthén, B. O. (1998-2012). *Mplus user's guide. Seventh edition.* Los Angeles, CA: Muthén & Muthén.

Nagengast, B., Brisson, B. M., Hulleman, C. S., Gaspard, H., Häfner, I., & Trautwein, U. (2018). Learning more from educational intervention studies: Estimating Complier Average Causal Effects in a relevance intervention. *Journal of Experimental Education*, *86*(1), 105–123. https://doi.org/10.1080/00220973.2017.1289359

Noack, P., Kracke, B., Gniewosz, B., & Dietrich, J. (2010). Parental and school effects on students' occupational exploration: A longitudinal and multilevel analysis. *Journal of Vocational Behavior*, *77*(1), 50–57. https://doi.org/10.1016/j.jvb.2010.02.006

Oechsle, M., Knauf, H., Maschetzke, C., & Rosowski, E. (2009). *Abitur und was dann? Berufsorientierung und Lebensplanung junger Frauen und Männer und der Einfluss von Schule und Eltern [Abitur and then? Vocational orientation and future plans of young people and the influence of school and parents]*. *Geschlecht und Gesellschaft 34*. Wiesbaden: VS: Verlag für Sozialwissenschaften.

Phillips, S. D., Blustein, D. L., Jobin-Davis, K., & White, S. F. (2002). Preparation for the school-to-work transition: The views of high school students. *Journal of*

*Vocational Behavior*, *61*(2), 202–216. https://doi.org/10.1006/jvbe.2001.1853

Pomerantz, E. M., Grolnick, W. S., & Price, C. E. (2005). The role of parents in how children approach school: a dynamic process perspective. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 259–278). New York, NY: Guilford.

Raudenbush, S. W. (1997). Statistical analysis and optimal design for cluster randomized trials. *Psychological Methods*, *2*(2), 173–185. https://doi.org/10.1037/1082-989X.2.2.173

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist*, *51*(2), 146–163. https://doi.org/10.1080/00461520.2016.1154792

Rozek, C. S., Hyde, J. S., Svoboda, R. C., Hulleman, C. S., & Harackiewicz, J. M. (2015). Gender differences in the effects of a utility-value intervention to help parents motivate adolescents in mathematics and science. *Journal of Educational Psychology*, *107*(1), 195–206. https://doi.org/10.1037/a0036981

Rozek, C. S., Svoboda, R. C., Harackiewicz, J. M., Hulleman, C. S., & Hyde, J. S. (2017). Utility-value intervention with parents increases students’ STEM preparation and career pursuit. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(5), 909–914. https://doi.org/10.1073/pnas.1607386114

Ryan, R. M., & Deci, E. L. (2009). Promoting self-determined school engagement: Motivation, learning, and well-being. In *Handbook of motivation at school* (pp. 171–195).

Sagarin, B. J., West, S. G., Ratnikov, A., Homan, W. K., Ritchie, T. D., & Hansen, E. J. (2014). Treatment noncompliance in randomized experiments: Statistical approaches and design issues. *Psychological Methods*, *19*(3), 317–333. https://doi.org/10.1037/met0000013

Savickas, M. L. (2002). Career construction: A developmental theory of vocational behavior. In D. Brown (Ed.), *Career choice and development* (pp. 149–205). San Francisco, CA: Jossey-Bass.

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, *7*(2), 147–177. https://doi.org/10.1037/1082-989X.7.2.147

Seifert, K. H., & Stangl, W. (1986). Der Fragebogen Einstellungen zur Berufswahl und beruflichen Arbeit [Questionnaire about attitudes towards career choice and work].

*Diagnostica*, *32*(2), 153–164.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, *42*(1), 70–83. https://doi.org/10.1037/0012-1649.42.1.70

Super, D. E., & Kidd, J. M. (1979). Vocational maturity in adulthood: Toward turning a model into a measure. *Journal of Vocational Behavior*, *14*(3), 255–270. https://doi.org/10.1016/0001-8791(79)90054-X

Tynkkynen, L., Nurmi, J.-E., & Salmela-Aro, K. (2010). Career goal-related social ties during two educational transitions: Antecedents and consequences. *Journal of Vocational Behavior*, *76*(3), 448–457. https://doi.org/10.1016/j.jvb.2009.12.001

Walker, J. M. T., Wilkins, A. S., Dallaire, J. R., Sandler, H. M., & Hoover-Dempsey, K. V. (2005). Parental involvement: Model revision through scale development. *The Elementary School Journal*, *106*(2), 85–104. https://doi.org/10.1086/499193

Wigfield, A., Tonks, S., & Klauda, S. L. (2016). Expectancy-value theory. In K. R. Wentzel & D. B. Miele (Eds.), *Handbook of motivation at school* (pp. 55–74). New York, NY: Routledge.

## Appendix A

Website content and structure

1. Information for parents on how to support their children's career choice and school achievement; communication tasks to connect with the child regarding the usefulness of school and the child's future career
2. Information for students, invitation to explore the website
3. Usefulness of school in general and of math, German, and English for students' future career and daily life
4. Information on different career possibilities; self-assessment tests for career choice
5. Information on how to continue going to school after completing middle-track school after $10^{th}$ grade
6. Information on the roles that self-concept and effort play in school achievement
7. Additional informational sources and links

## Appendix B

*Sample Items and Scale Reliabilities for Student and Parent Variables*

| Construct | Sample item | $\alpha_{T1}$ |
|---|---|---|
| *Parent variables* | | |
| School utility for child | How useful will a school education be for your child in general? | .94 |
| Math/German/English utility for child | How useful will … be for your child's future career? | .88/.85/ .83 |
| Career communication | How often do you talk to your child about the career opportunities he/she will have after finishing middle-track school? | .84 |
| Career autonomy | I leave it to my child what he/she will do after finishing school (vocational training, high school …) | .68 |
| Career support | I help my child search for an appropriate field of study or vocational training. | .90 |
| Importance career support | It is important to me to encourage my child to think about his/her future career. | .88 |
| School communication | How often do you talk to your child about things he/she has learned at school? | .80 |
| *Student variables* | | |
| School utility | What we learn in school is directly applicable to my everyday life. | .77 |
| Math/German/English utility | Good grades in … will bring many advantages for my job and my career. | .91/.91/ .88 |
| Career communication | How often do you talk to your parents about your career aspirations? | .81 |
| Career autonomy | My parents are open to my career aspirations. | .84 |
| Career support | My parents call my attention to different possible careers. | .86 |
| Career decision | I already know quite well what requirements my favorite career has. | .89 |
| Career exploration | I talk to as many people as possible about jobs I am interested in. | .76 |
| Career involvement | It is important to me to clarify what jobs I am qualified for. | .88 |

*Note.* $\alpha_{T2}$ were comparable.

## Supplemental Material

Table S1

*Descriptive Statistics for Compliance Status in the Intervention Condition – Alternative Compliance Coding*

| | Visited website | | Did not visit website | | Missing | |
|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % |
| Students | 92 | 54.4 | 62 | 36.7 | 15 | 8.9 |
| Parents | 92 | 54.4 | 29 | 17.2 | 48 | 28.4 |
| Students and parents | 79 | 46.7 | 38 | 22.5 | 52 | 30.8 |
| Students and/or parents | 105 | 62.1 | 23 | 13.6 | 41 | 24.3 |

*Note.* *N* = 169.

Table S2

*Intervention Effects on Parent and Student Variables at Posttest – Alternative Compliance Coding*

| | CACE | | |
|---|---|---|---|
| Outcome variable | β | SE | *p* |
| *Parent variables* | | | |
| School utility for child | -0.01 | 0.12 | .914 |
| Math utility for child | -0.06 | 0.09 | .464 |
| German utility for child | 0.05 | 0.12 | .658 |
| English utility for child | 0.03 | 0.11 | .817 |
| Career communication | -0.11 | 0.11 | .317 |
| Career autonomy | -0.14 | 0.11 | .194 |
| Career support | -0.37 | 0.13 | .003 |
| Importance career support | -0.31 | 0.13 | .015 |
| School communication | 0.13 | 0.10 | .220 |
| *Student variables* | | | |
| School utility | 0.05 | 0.13 | .715 |
| Math utility | 0.00 | 0.13 | .986 |
| German utility | 0.10 | 0.13 | .443 |
| English utility | -0.07 | 0.07 | .325 |
| Career communication | 0.12 | 0.14 | .400 |
| Career autonomy | 0.12 | 0.13 | .338 |
| Career support | 0.15 | 0.18 | .393 |
| Career decision | -0.15 | 0.14 | .275 |
| Career exploration | 0.17 | 0.13 | .177 |
| Career involvement | -0.05 | 0.13 | .692 |

Table S3

*Fit Indices of Confirmatory Factor Analyses of Adapted and Self-developed Scales*

| | chi² | df | CFI/TLI | RMSEA | SRMR |
|---|---|---|---|---|---|
| School utility for child | 18.26 | 15 | .99/.99 | .03 | .02 |
| Career communication | 29.15 | 15 | .98/.97 | .05 | .03 |
| Career autonomy | 63.02 | 29 | .93/.89 | .06 | .06 |
| Importance career support | 27.27 | 15 | .98/.97 | .05 | .03 |

*Note.* df=degrees of freedom, CFI=Comparative fit index, TLI=Tucker-Lewis index, RMSEA=Root mean square error of approximation, SRMR=Standardized root mean square residual.

Table S4

*Intra-Class-Correlation Coefficients (ICCs) of Parent and Student Variables at Pretest*

| | ICC L2 | ICC L3 |
|---|---|---|
| *Parent variables* | | |
| School utility for child | 0.03 | 0.03 |
| Math utility for child | 0.01 | 0.02 |
| German utility for child | 0.01 | 0.01 |
| English utility for child | 0.01 | 0.02 |
| Career communication | 0.01 | 0.02 |
| Career autonomy | 0.01 | 0.03 |
| Career support | 0.03 | 0.00 |
| Importance career support | 0.02 | 0.00 |
| School communication | 0.01 | 0.00 |
| *Student variables* | | |
| School utility | 0.01 | 0.02 |
| Math utility | 0.02 | 0.02 |
| German utility | 0.02 | 0.03 |
| English utility | 0.02 | 0.01 |
| Career communication | 0.04 | 0.03 |
| Career autonomy | 0.03 | 0.02 |
| Career support | 0.03 | 0.02 |
| Career decision | 0.03 | 0.02 |
| Career exploration | 0.02 | 0.04 |
| Career involvement | 0.01 | 0.02 |

*Note.* L2=Class level, L3=School level.

Table S5

*Mean Level Differences between Intervention and Control Groups at Pretest*

| | $\Delta M$ | *p* | *d* |
|---|---|---|---|
| *Parent variables* | | | |
| School utility for child | -0.08 | .368 | -0.12 |
| Math utility for child | 0.02 | .831 | 0.03 |
| German utility for child | 0.05 | .489 | 0.07 |
| English utility for child | 0.01 | .885 | 0.01 |
| Career communication | 0.06 | .371 | 0.11 |
| Career autonomy | -0.03 | .576 | -0.09 |
| Career support | 0.20 | .001 | 0.32 |
| Importance career support | 0.12 | .021 | 0.23 |
| School communication | 0.07 | .223 | 0.13 |
| *Student variables* | | | |
| School utility | -0.03 | .484 | -0.09 |
| Math utility | 0.01 | .915 | 0.01 |
| German utility | 0.07 | .459 | 0.10 |
| English utility | 0.04 | .464 | 0.08 |
| Career communication | 0.05 | .555 | 0.08 |
| Career autonomy | -0.09 | .251 | -0.16 |
| Career support | 0.05 | .551 | 0.07 |
| Career decision | 0.06 | .392 | 0.10 |
| Career exploration | -0.06 | .453 | -0.10 |
| Career involvement | -0.05 | .299 | -0.10 |

# 4 Study 3: How Can a Relevance Intervention in Math Support Students' Career Choices?

Piesch, H., Gaspard, H., Parrisius, C., Wille, E., Nagengast, B., & Trautwein, U. (submitted). How can a relevance intervention in math support students' career choices? *Journal of Applied Developmental Psychology*.

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**Abstract**

Career choice is an important challenge in adolescence. Relevance interventions may be an option for promoting career choices because students reflect on the usefulness of the learning content for their future careers. We investigated whether a relevance intervention focusing on the usefulness of math for students' lives and careers could promote several precursors of their career choices. Seventy-eight classrooms were randomly assigned to one of two intervention conditions or to a control condition (*N*=1,744). Multilevel regression analyses revealed that the intervention fostered students' perceptions of the importance of math and physics for their career aspirations. Positive effects on investigative interest and negative effects on realistic and enterprising interests were found. No effects were found on students' career orientation or career aspirations in STEM. Findings point to the potential of relevance interventions for supporting students' career choices, although a comprehensive fostering of career choice may be difficult to achieve.

*Keywords*: career choice, relevance intervention, STEM, cluster-randomized trial, expectancy-value theory

**How Can a Relevance Intervention in Math Support Students' Career Choices?**

"Which career should I choose?" Many students ask themselves this question when they think about the opportunities they will have to embrace certain careers after they finish school. And the answer is not simple: In Western societies, the number of occupational choices has increased considerably in recent decades (OECD, 2004a), and adolescents are provided with multiple options regarding their future careers. This makes career choice a complex process for many students (Praskova, Creed, & Hood, 2015). Still, career choices represent important developmental challenges and can substantially impact adolescents' lives (for a review, see Dietrich, Parker, & Salmela-Aro, 2012), which is why it is important to support adolescents during this process.

Research grounded in expectancy-value theory (EVT) by Eccles and colleagues (1983) has shown that students' value beliefs (e.g., the perceived importance and usefulness of a subject) are crucial for choices of courses and careers (for an overview, see Wigfield, Tonks, & Klauda, 2009). Based on this framework, a number of interventions focusing on the relevance of a subject for students' lives have been successfully developed to foster students' motivational beliefs (for reviews, see Harackiewicz, Tibbetts, Canning, & Hyde, 2014; Rosenzweig & Wigfield, 2016). Most of them have been implemented in the area of science, technology, engineering, and math (STEM). As part of these relevance interventions, students are encouraged to reflect on the usefulness of math and science for their own future lives and careers (e.g., Durik, Schwartz, Schmidt, & Shumow, 2018; Gaspard et al., 2015; Hulleman & Harackiewicz, 2009). Thereby, they are dealing with questions about their career plans, for which it seems reasonable that relevance interventions might offer a promising way to support adolescents' career choices. In fact, results from two empirical studies have pointed toward the positive effects that relevance interventions in math and science can have on students' course choices, career pursuit, and persistence in the STEM field (Canning et al., 2018; Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Hecht et al., 2019; Rozek, Svoboda, Harackiewicz, Hulleman, & Hyde, 2017). However, most studies that have tested the effectiveness of relevance interventions have focused on proximal outcomes (e.g., motivational beliefs in math), and not much is known about possible effects on career-related variables.

In the present study, we examined whether a relevance intervention in math implemented in ninth-grade classrooms could support students' career choices by influencing different precursors of these choices. During the intervention, students received information about the relevance of math for their future lives and careers. In a cluster-randomized study with 78 classes, this relevance intervention had been shown to successfully promote students' utility value in math (Gaspard et al., 2019). In the current study, we tested the intervention's potential to support students in the process of making decisions about their future careers.

**The Process of Making Career Decisions for Adolescents**

During adolescence, students usually develop ideas about their future, and they formulate their career options (Beal & Crockett, 2013). The choice of a future career represents an important decision that can substantially affect adolescents' lives (Dietrich et al., 2012), for example, their future educational plans or future income. The decision to choose a specific career represents a complex challenge for the majority of adolescents (Praskova et al., 2015), requiring careful preparation. Central to this preparation is the exploration of career options, which refers to an information-gathering process in which students investigate their interests and expectations about potential future careers as well as characteristics of the job and the labor market (Noack, Kracke, Gniewosz, & Dietrich, 2010; Savickas, 2002). This long-term orientation process, which usually begins during school has been shown to be important for a satisfactory career choice (Kracke, 1997). At best, the successful exploration of a career leads to greater career decidedness, which refers to students' ability and preparedness to choose a specific career (Super & Kidd, 1979). Hirschi and Läge (2008) demonstrated that higher career decidedness was associated with more successful transitions from school to work. For simplicity, we will subsume the two constructs of career exploration and career decidedness under the expression of career orientation.

In addition to adolescents' engagement in career orientation in general, their personal preferences (e.g., interests) influence their career choices. Holland's (1997) theory of vocational personalities and work environments is a prominent approach for describing and explaining career choices through interests. Holland postulated six types of vocational interests (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional, or RIASEC) that represent relatively broad preferences for certain activities. Empirical studies have supported their power to predict the career aspirations and choices of adolescents and young adults (e.g., Päßler & Hell, 2012; Volodina & Nagy, 2016; for an overview, see also Stoll & Trautwein, 2017). There is also evidence that vocational interests can change during adolescence (e.g., Xu & Tracey, 2016). Regarding careers in STEM, realistic interests (i.e., interest in working with machines or with one's hands) and investigative interests (i.e., interest in scientific activities, such as conducting experiments or working on abstract problems) are most closely related to the fields of math and science, as proposed in theory (Holland, 1997) and as shown by empirical research (e.g., Volodina & Nagy, 2016).

A number of interventions have been developed to support students in preparing to make a career choice. Such career preparation programs have been shown to foster important career-related outcomes, such as students' career exploration, career decidedness, and successful employment (e.g., Hirschi & Läge, 2008; Koivisto, Vuori, & Nykyri, 2007). However, such programs are often time-consuming and require additional resources, for example, special learning settings. Interventions focusing on the relevance of a school subject for students' later lives and careers tend to be relatively brief and can easily be implemented in the regular school context. Although they are designed to foster students' motivational beliefs in the first place (Harackiewicz et al., 2014), they usually address questions about students' career choices as well and could therefore be promising for promoting the process of making sound career decisions.

## Relevance Interventions—Making Connections to One's Life and Career

Interventions that target students' value beliefs are based on expectancy-value theory (Eccles et al., 1983), which is a widely used and well-supported framework on the role that motivational beliefs play in academic outcomes. According to EVT, students' achievement, persistence, and choices (e.g., career choices) are influenced by their expectancies of success and their value beliefs regarding a specific task or subject (Eccles & Wigfield, 2002). The model distinguishes between four value components: intrinsic value (enjoyment of a task), attainment value (personal importance of the task and importance of doing well on it), utility value (usefulness of the task for one's future plans and goals), and cost (negative consequences, e.g., the effort required or negative emotions that are associated with the task; Eccles, 2005; Eccles & Wigfield, 2002). Many empirical studies have shown that success expectancies and value beliefs are important predictors of students’ achievement-related behavior in various school subjects and for their course and career choices (e.g., Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Simpkins, Davis-Kean, & Eccles, 2006; for a review, see Wigfield et al., 2009).

Interventions developed to foster students’ value beliefs usually focus on the utility component because utility value is more extrinsic in nature compared with intrinsic or attainment value (Eccles & Wigfield, 2002) and therefore seems to be more easily influenced by external interventions (Harackiewicz et al., 2014). These interventions highlight the usefulness of the course contents for students’ future lives and try to help them perceive the course contents as personally relevant. Such relevance interventions have usually been implemented in math and science and have been shown to successfully promote students’ value beliefs, interest, and achievement (for reviews, see Lazowski & Hulleman, 2016; Rosenzweig & Wigfield, 2016). A study of college students even found that a relevance intervention implemented in an introductory biology course could enhance students’ chances of enrolling in the follow-up course and remaining in their STEM major, even up to 2 years later (Canning et al., 2018; Hecht et al., 2019). In addition, Harackiewicz and colleagues (Harackiewicz et al., 2012; Rozek et al., 2017) found that a parent-based relevance intervention promoted students’ STEM course choices in high school and their pursuit of a STEM career 5 years later. In a similar study, Piesch and colleagues (2019) found no effects of a parent-based intervention on students’ career orientation. Thus, although these studies did not reveal a clear pattern of effects, they provided initial indications that relevance interventions can serve to address important variables within the process of making career decisions for students. More research is therefore needed to examine effects of interventions on these distal outcome variables.

**Promoting Students’ Career-Related Outcomes with a Relevance Intervention**

Through the tasks and the information students receive during relevance interventions, they are encouraged to make connections from the material to their own lives and future careers (e.g., Hulleman & Harackiewicz, 2009; for a review, see Harackiewicz et al., 2014). More specifically, they should realize the practical relevance of the subject for various jobs (e.g., the specific career they aspire to) and reflect on the educational and occupational pathways they will pursue after school. Therefore, it seems plausible that relevance interventions may influence students' career-related outcomes on a broader level.

As part of relevance interventions, students reflect on typical questions about career orientation (e.g., "Which job am I interested in?"; "What are the career options that match my abilities and expectations?") and gather new information about possible careers. Thus, these interventions could have a positive impact on their career orientation. However, students may eventually also receive conflicting information that does not match their previous idea of their favorite career. Therefore, students might also reevaluate their current career plans and might experience negative effects (e.g., on their career decidedness).

To date, relevance interventions have been shown to promote interest in math and science (Harackiewicz et al., 2014), but, to our knowledge, vocational interests have not been examined as outcomes of such interventions. Cognate research focusing on self-efficacy regarding occupational activities has shown that students' math- and science-related career interest and self-efficacy were enhanced through interventions (Betz & Schifano, 2000; Luzzo, Hasper, Albert, Bibby, & Martinelli Jr., 1999). When students learn about the importance and usefulness of a subject for a career and think about activities related to this career, as occurs in relevance interventions, they might find that not only does their interest in a subject increase but also their vocational interests related to the career (for more details on the relation between values and science interests, see Weisgram & Bigler, 2006).

If students reflect on their career options during relevance interventions, this may also affect the actual career they aspire to. Students' career aspirations are often used as a proxy for students' later career choices (e.g., Chow & Salmela-Aro, 2011; Parker, Nagy, Trautwein, & Lüdtke, 2014). However, career aspirations are not fixed and can be influenced, for example, by the information students receive or by changes in their interests (Van Tuijl & Van der Molen, 2016), which implies that career aspirations may be affected by relevance interventions.

Taken together, relevance interventions address important questions about career choice and its preparation. Thus, they might offer a promising way to support students in the process of making decisions about their future careers, which, however, has rarely been investigated so far.

**The *Motivation in Mathematics* (MoMa) Relevance Intervention**

In the present study, we focused on one particular relevance intervention, the so-called *Motivation in Mathematics* (MoMa) intervention, which is a 90-min classroom-based intervention targeting students' perceptions of the relevance of math and which has been implemented in two large field trials. In the first trial (MoMa 1; see Brisson et al., 2017; Gaspard et al., 2015) involving 82 ninth-grade classes, students in two intervention conditions experienced a lesson on the relevance of math, which was implemented by researchers. In both conditions, students first saw a presentation on the usefulness of math for various careers before they worked on relevance-inducing tasks that varied between the two intervention conditions. They either wrote an essay on the relevance of math or evaluated quoted statements that came from interviews with previous students on the usefulness of math for one's daily life and job. The relatively brief intervention was shown to foster students' value beliefs, self-concept, effort, and achievement in math up to 5 months later, whereas the quotations condition was more successful.

In a follow-up trial (MoMa 2), the former quotations condition was optimized and implemented by regular math teachers or trained master's students in a study involving 78 ninth-grade classrooms. The study, which was aimed at testing intervention effects under these more real-life conditions, showed that the intervention successfully promoted students' utility value in both intervention conditions (Gaspard et al., 2019). This study provided the data to which we applied the current analyses. Whereas Gaspard and colleagues (2019) focused on motivational beliefs as outcomes, in the present study, we examined effects of the intervention on career-related outcomes.

The MoMa intervention included three main characteristics that might have helped to support students' career-related decisions. First, students were encouraged to reflect on their future career options through examples of the usefulness of math in the presentation as well as in the quotations. Thus, they were offered several ways to connect to the relevance arguments, which maximized the stimulation of the process of making decisions about their future careers. Second, when working on the quotations, students could have learned from other people they identified with, as stated in possible-selves theory (Markus & Nurius, 1986) or identity-based motivation (Oyserman & Destin, 2010). The personal and authentic examples of potential role models might have helped students imagine a possible future identity and find connections from their current situation to this future identity. Third, the quotations task especially considered students' autonomy in learning because—inspired by the given examples—they could develop their own ideas about their future careers. This has been shown to be important for positive learning results, particularly regarding the transition from school to work (Grolnick, Kurowski, Dunlap, & Hevey, 2000; for a study that explicitly tested the role of autonomy and choice during relevance interventions, see Rosenzweig et al., 2018). Therefore, the MoMa intervention seems to be suitable for supporting students in their career choices and in preparing to make this decision.

**The Present Study**

Given the importance of math for many careers on the one hand and the focus of relevance interventions on careers on the other hand, we investigated the potential of an existing relevance intervention for supporting students' career choices. We examined the effects of a relevance intervention in math on different precursors of students' career choices that were related to the contents of the intervention, namely, students' perceptions of the importance of math and physics for their career aspirations, their career orientation, vocational interests, and career aspirations in STEM. Thereby, we wanted to investigate whether students' career choices could be supported by a brief relevance intervention in math. To address this research question, we used data from a cluster-randomized trial with ninth-grade students from academic track schools who were assigned to one of two relevance intervention conditions or to a waitlist control group. In the two intervention conditions, the students received the same intervention that was implemented by different instructors (i.e., the regular math teacher or a master's student), which did not have much impact on its effectiveness (Gaspard et al., 2019).

During the MoMa 2 relevance intervention, one key aspect involved students making personal connections from the course material in math to their own career aspirations. Therefore, we expected that the intervention would promote students' perceptions of the importance of math for their career aspirations. We also examined intervention effects on the perceived importance of physics for students' career aspirations because the subjects are closely related, and the careers in which math and physics are important often overlap. As students reflect on typical questions in their career orientation, we expected that the intervention would enhance students' career orientation, namely, their career exploration and career decidedness. Moreover, we expected that the intervention would promote students' vocational interests in relation to math, namely, their realistic and investigative interests, because students become deeply engaged in the relevance of the subject, which might influence their interests as well. In addition, because adolescents may reconsider their career aspirations and options during the intervention, we examined whether the intervention would influence students' career aspirations. We expected that it would enhance their career aspirations in the STEM field.

## Method

### Sample and Procedures

The Ministry of Education in Baden-Württemberg (7.26.2017) as well as an institutional review board at [Institution; blinded for reviewer purposes] (8.1.2017) approved the study and the collection of the data with respect to ethical and data security matters.

To answer our research question, we used data from the MoMa 2 study, which had been conducted during the 2017-2018 school year. Our sample consisted of 1,744 students from 78 ninth-grade classrooms from 28 academic track schools in the German state of Baden-Württemberg (one to five classes per school). Students' mean age was 14.63 years ($SD$ = 0.48) at the beginning of the study, and 53.6% of the students were female adolescents. Schools were contacted and asked if they were willing to take part in the study. Participation was voluntary, and parents as well as students had to give written consent to participate. The actual sample of 1,744 students represents a participation rate of 88.7%. The study consisted of three waves of data collection. Students were administered questionnaires by trained research assistants before the intervention (pretest, T1), an average of 4 weeks after the intervention (posttest, T2), and an average of 3 months after the intervention (follow-up, T3).

Before the first round of data collection, math teachers and their classes were randomly assigned to one of two intervention conditions or a waitlist control condition within each school. The randomization resulted in 25 classes allocated to the intervention condition "teacher" ($n_1$ = 569 students), 28 classes allocated to the intervention condition "master's student" ($n_2$ = 629 students), and 25 classes allocated to the control condition ($n_3$ = 546 students). The randomization process resulted in slightly unequal numbers of classes within conditions because the classes of several teachers who participated with two classes each had been allocated to the same condition, respectively.

The sample size was determined by a power analysis with Optimal Design (Spybrook et al., 2011) for a multisite cluster randomized trial where the treatment is implemented at Level 2. To obtain realistic estimates of the parameters, the analysis was based on data from the previous MoMa 1 study (Gaspard et al., 2015). The power analysis, which was computed for the effect of the intervention on utility value as the primary outcome of the MoMa 2 study, revealed that a power of .79 to detect intervention effects of $\delta = .20$ (comparing each of the intervention conditions with the control condition) would be achieved with a total sample of 25 schools (with one class per experimental condition and $n = 25$ students per class). This effect size was chosen to be able to also detect relatively small intervention effects (for typical effect sizes from relevance interventions and a discussion of factors that influence these effect sizes, see Hulleman & Cordray, 2009; Lazowski & Hulleman, 2016).

The study design and the planned analyses were preregistered in the Open Science Framework (link: https://osf.io/d4vp9/?view_only=bcf08d5118f449d49ae2b0572089ddd5) when the intervention phase had just started. Only the hypotheses and analyses for the primary outcomes (expectancy and value beliefs, effort, and achievement in math), as reported in Gaspard et al. (2019), were registered. Secondary outcomes, which the present study focused on, were not included in the preregistration due to a lack of previous findings on intervention effects on these variables. However, we conducted a set of analyses that were parallel to those of the primary outcome and thereby stuck to the procedure described in the preregistration.

## The MoMa 2 Relevance Intervention

The relevance intervention was implemented either by the regular math teachers or by trained master's students. For preparation and to ensure that the intervention would be conducted in a standardized way, teachers were provided with 3 hr of training in the implementation of the intervention. A total of 23 math teachers (12 women, 11 men) were trained and implemented the intervention in their own class (one of the teachers had two classes). One teacher who was assigned to the teacher intervention condition and was supposed to be trained was not able to attend the training session and did not implement the intervention in his class. Thus, one class from the teacher intervention condition did not receive the intervention. Because we followed the Intention-to-treat approach (Hollis & Campbell, 1999) in our analyses, this class was still considered to be in the intervention condition. As a robustness check, we also ran the analyses without this class, and the results were nearly identical. They are reported in the Supplement (Tables S1 to S4). Master's students were trained as part of a two-semester course on motivation interventions and received intensive practical training on how to implement the intervention. There were six master's students (five women, one man) who conducted four to five interventions each.

In both intervention conditions, the relevance intervention comprised the same intervention components and intervention material. It was a 90-min session on the relevance of math that included a psychoeducational presentation for the whole class and relevance-inducing tasks that students worked on individually. The psychoeducational presentation had two main components. First, research results on the importance of self-concept and effort for math achievement were presented, and the role of social comparisons (i.e., frame-of-reference effects) within the classroom were discussed. Second, students were provided with various examples of the usefulness of math for their future educational plans, career opportunities, and daily life activities. Most examples focused on students' future educational plans and careers, such as how various study majors or work activities are related to math. After the presentation, students worked on individual relevance-inducing tasks. They were asked to evaluate six quotes from interviews with young adults describing situations in which they have used math skills in their jobs and daily lives. Students were encouraged to draw connections from these examples to their own future careers.

Two observers attended each intervention and rated the quality of the implementation of the intervention. Overall, the intervention was implemented as planned in both conditions, with the observers noting only a few deviations from the standardized procedure. More specifically, the intervention consisted of 15 phases that were predefined in advance. All of them were implemented in all classes, except three classes, where the teachers skipped one phase, and one class, where the teacher skipped two phases. Regarding adherence to the intervention script, the observers reported that both the teachers and the master's students followed the script closely (teachers: $M = 7.29$, $SD = 1.34$; master's students: $M = 9.05$, $SD = 0.55$, on a scale from 1 = *the instructor did not follow the script at all* to 10 = *the instructor followed the script almost word-for-word*).

## Measures

If not stated otherwise, the variables were assessed via identical questionnaires at pretest, posttest, and follow-up. All items are documented in the Appendix (Table A1).

**Importance of math and physics for career aspirations.** After students stated their current career aspirations, they were asked about their perceptions of the *importance of math* and *importance of physics* for their specific career with two items (e.g., "How important is math for this career?"). Students were asked to separately indicate the importance of the subjects on a 4-point Likert-type scale ranging from 1 (*not at all important*) to 4 (*very important*). The importance of physics was only assessed at pre- and posttest.

**Career orientation**. Students' career orientation, that is, how deeply they were involved in the process of making a decision about their future career, were assessed with two scales. Students' *career exploration* (e.g., "I talk to as many people as possible about careers I am interested in") was measured with seven items taken from Kracke (1997). For *career decidedness* (e.g., "I already know pretty well which jobs I am best suited for"), six items from a 12-item scale developed by Seifert and Stangl (1986) were used, which were chosen on the basis of a reliability analysis from a prior study (Piesch et al., 2019). This scale was only measured at pre- and posttest. All items were assessed on a 4-point Likert-type scale ranging from 1 (*completely disagree*) to 4 (*completely agree*). Both scales showed good internal consistencies (career exploration: $\alpha_{T1} = .79$, $\alpha_{T2} = .83$, $\alpha_{T3} = .82$; career decidedness: $\alpha_{T1} = .90$, $\alpha_{T2} = .89$).

**Vocational interests.** To assess students' *vocational interests* according to the RIASEC model, a short scale developed by Bergmann (2003) was used that measures each interest dimension with one item. Each item includes a list of typical activities that represent the respective dimension (e.g., "How do you rate your interest in the following six areas of activity: "realistic" activities, e.g., working with machines or technical equipment; working with wood, metal, or other materials; repairing engines or machines, …; "investigative" activities, e.g., conducting experiments, reading scientific literature, working on abstract problems, developing new ideas, closely observing and analyzing, …"). Students were asked to indicate their interest in these activities on a 9-point Likert-type scale ranging from 1 (*I am not interested at all, I dislike doing this*) to 9 (*I am very interested*, *I like doing this a lot*).

**Career aspirations.** Two open questions were used to ask students about their *career aspirations* ("Which career or occupational field would you like to work in later?") as well as their *educational aspirations* ("What further educational plans (e.g., which field of study or what kind of vocational training) will you engage in after school?"; Köller, Watermann, Trautwein, & Lüdtke, 2004). Their answers were coded according to the International Standard Classification of Occupations (ISCO-08) and afterwards divided into STEM and non-STEM careers (more details below). Two research assistants who had been trained for this purpose carried out the coding for the pretest, and their decisions were discussed with the first author after every step. Before they started their coding, students' answers were put in alphabetical order and divided into two parts. Both research assistants coded half of the answers with 100 overlapping cases that were coded by both of them. Their codings were highly consistent (interrater reliability $r$ = .89). One of the research assistants carried out the coding for the posttest and follow-up on the basis of the pretest coding.

We followed a five-step approach for the coding. In a first step, all career aspirations that could be assigned one specific ISCO code were coded ($n_{T1}$ = 794; $n_{T2}$ = 863; $n_{T3}$ = 868). Many students gave vague answers, indicated a field of work instead of a specific career or mentioned more than one career, and therefore, their answers could not be assigned an ISCO code ($n_{T1}$ = 607; $n_{T2}$ = 471; $n_{T3}$ = 365). In a second step, their educational aspirations were inspected. If this answer fit one of the careers mentioned in the career aspiration item or helped to make this answer more specific, the student was given the respective ISCO code. For example, if a student's career aspiration was "science" (too unspecific), but his or her educational aspiration was "biology" the students' answer was assigned the ISCO code for biology. Thereby, the answers involving additional career aspirations were codable ($n_{T1}$ = 131; $n_{T2}$ = 124; $n_{T3}$ = 104). In a third step, career aspirations were coded for students who did not answer the career aspiration item but answered the educational aspiration item if the answer was specific enough to be coded. Thus, some more students ($n_{T1}$ = 39; $n_{T2}$ = 33; $n_{T3}$ = 56) could be assigned a code, resulting in a total of $n_{T1}$ = 964, $n_{T2}$ = 1,020, and $n_{T3}$ = 1,028 students with an ISCO code.

Table 1

*Students' STEM Career Aspirations in the Three Conditions at all Time Points*

| | Teacher condition | | Master's student condition | | Control condition | | All | |
|---|---|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % | *n* | % |
| STEM | | | | | | | | |
| T1 | 182 | 32.0 | 215 | 34.2 | 162 | 29.7 | 559 | 32.1 |
| T2 | 156 | 27.4 | 223 | 35.5 | 183 | 33.5 | 562 | 32.2 |
| T3 | 174 | 30.6 | 204 | 32.4 | 178 | 32.6 | 556 | 31.9 |
| non-STEM | | | | | | | | |
| T1 | 229 | 40.2 | 197 | 31.3 | 200 | 36.6 | 626 | 35.8 |
| T2 | 200 | 35.2 | 202 | 32.1 | 200 | 36.7 | 602 | 34.5 |
| T3 | 188 | 33.0 | 191 | 30.4 | 195 | 35.7 | 574 | 32.9 |
| Unspecific Answer | | | | | | | | |
| T1 | 86 | 15.1 | 107 | 17.0 | 105 | 19.2 | 298 | 17.1 |
| T2 | 89 | 15.6 | 96 | 15.3 | 69 | 12.6 | 254 | 14.6 |
| T3 | 92 | 16.2 | 101 | 16.1 | 63 | 11.5 | 256 | 14.7 |
| No Answer | | | | | | | | |
| T1 | 59 | 10.4 | 76 | 12.1 | 62 | 11.4 | 197 | 11.3 |
| T2 | 74 | 13.0 | 65 | 10.3 | 69 | 12.6 | 208 | 11.9 |
| T3 | 66 | 11.6 | 71 | 11.3 | 68 | 12.5 | 205 | 11.8 |
| Absent | | | | | | | | |
| T1 | 13 | 2.3 | 34 | 5.4 | 17 | 3.1 | 64 | 3.7 |
| T2 | 50 | 8.8 | 43 | 6.8 | 25 | 4.6 | 118 | 6.8 |
| T3 | 49 | 8.6 | 62 | 9.9 | 42 | 7.7 | 153 | 8.7 |

The fourth step was the division of these codes into STEM and non-STEM careers. We followed the definition given by Taskinen, Asseburg, and Walter (2008), who categorized all careers related to math, informatics, natural sciences, and technology as STEM careers. This included, for example, mathematicians and employees in the financial sector, computer scientists, physicists, chemists, biologists, physicians, psychologists, architects, engineers, and also nonacademic careers within these fields.

The answers of several students ($n_{T1}$ = 221; $n_{T2}$ = 144; $n_{T3}$ = 102) were not specific enough to assign them a specific ISCO code, but they could be coded as STEM or non-STEM careers (e.g., “physicist or engineer” as a STEM career, “politics/social studies” as a non-STEM career) in Step 5. Altogether, we ended up with $n_{T1}$ = 1,185 (67.9%), $n_{T2}$ = 1,164 (66.7%), and $n_{T3}$ = 1,130 (64.8%) students whose aspirations could be coded as STEM or non-STEM careers. All unspecific answers as well as missing answers were coded as missing values (see the Missing Data section for details on how these missing values were handled). The proportions of coded answers for the three intervention conditions can be found in Table 1.

**Covariates.** In addition to the pretest measures that were included in the models, we used a set of covariates. Teachers provided students’ gender and their math grade at the end of eighth grade. Students’ math abilities at pretest were measured with a 3-min normed speed test that assessed their fluency in solving typical math operations (Schmidt, Ennemoser, & Krajewski, 2013). Additionally, we tested for differences in motivational variables in math between the three conditions at pretest. Following the procedure described in the preregistration, we included such variables as covariates when the difference was larger than $d$ = 0.05. Variables that met this criterion were math intrinsic value (three items), math cost (nine items, both scales from Gaspard, Häfner, Parrisius, Trautwein, & Nagengast, 2017), math self-concept (four items, adapted from previous studies, e.g., Marsh et al., 2005), math self-efficacy (four items, scale from PISA 2003; OECD, 2004b), and math effort (three items, scale from TRAIN; Jonkmann, Rose, & Trautwein, 2013).

### Statistical Analyses

**Multilevel regression analyses.** To examine the effects of the intervention on students’ perceived importance of math and physics for their career aspirations, their career orientation, and vocational interests, we conducted two-level regression analyses with Mplus 7.31 (Muthén & Muthén, 1998-2012). Thus, we accounted for the nesting of students within classes to receive correct estimates of the standard errors for regression coefficients (Raudenbush & Bryk, 2002).

Additionally, we accounted for the nesting of classes within schools by using school as a stratification variable [5] (see McNeish, Stapleton, & Silverman, 2017). To investigate the intervention effects, the separate models for every outcome variable at posttest and follow-up included two dummy variables that indicated the intervention conditions (teacher, master's student) with the control condition as a reference group. In all models, the respective pretest measure of the outcome variable on the individual level as well as on the class level served as a covariate to get a more precise estimate of the intervention effects (Raudenbush, 1997). The other covariates (i.e., gender, previous math grade, math speed test, motivational variables in math at T1) were also included on the individual level and on the class level to account for contextual effects (Korendijk, Hox, Moerbeek, & Maas, 2011). Manifest aggregation was used for the class level variables, and all covariates were group-mean centered (Enders & Tofighi, 2007). To examine the intervention effects on students' STEM career aspirations at posttest and follow-up (coded as 1/0), we computed two-level logistic regression analyses that included the same covariates and model specifications as the models described above.

All continuous variables were standardized before running the analyses. This means that the regression coefficients representing the effects in the intervention conditions compared with the control condition could be interpreted as effect sizes (for effect sizes in multilevel models, see Marsh et al., 2009; Tymms, 2004).

**Missing data.** The percentage of missing data due to students' absence at data collection or nonresponses to single items ranged from 4.4 to 10.1% on all outcome variables, disregarding career aspirations, which had a missing rate of 32.5% (see Table 1). We used multiple imputation (Rubin, 1987) to account for the missing data.[6] We

[5] We first tried to run three-level models with schools as a third level. However, due to having only 28 clusters at the school level and the complexity of the models, these models could not be identified. We therefore decided to account for the school level by using the design-based correction of standard errors (type=complex in Mplus).

[6] The results from the imputed data sets were very similar to the results that were based on the sample without imputation, where we used the full information maximum likelihood approach implemented in Mplus to account for missing data ($N$ = 1146). Before we decided to use multiple imputation, we took a closer look at the group of students with missing values on career aspirations. We also ran multinomial logistic regression analyses, where career aspirations as the outcome variable had three categories. That is, students whose answers were coded as unspecific comprised a separate group, next to those aspiring to embrace STEM- and non-STEM careers. The results were similar to those from the imputed data set, that is, the pattern of effects for the STEM- and non-STEM groups were similar in the model including the unspecific category compared with the model with only two categories. As a robustness check, we also ran the analyses with the subsample of students who actually reported their career aspirations at T1 and T2 ($N$ = 883) or at T1 and T3 ($N$ = 836), respectively. Again, the results were similar, but the sample size was substantially reduced. All results of the additional analyses can be obtained from the corresponding author.

imputed the data from an unrestricted two-level model in Mplus because these models are robust against misspecification (Asparouhov & Muthén, 2010) and included all outcome variables (T1-T3) and covariates (T1) in the imputation model. We imputed 20 data sets separately for each of the three conditions and afterwards matched these data sets. The results shown below represent average results over 20 data sets. All analyses were thus based on the full sample ($N$ = 1,744).

## Results

After testing for pretest differences between the groups, we report findings on intervention effects on all career-related outcomes at posttest and follow-up.

### Descriptive Statistics and Pretest Differences

Descriptive statistics for all continuous variables at all time points are presented in Table 2. We used multigroup models to test for whether there were differences at pretest between the conditions on any outcome variables. The results can be found in the Supplemental Material (Table S5). We used a conservative approach and considered not only significant group differences but all differences that were above the criterion of $d$ = 0.05 reported in the preregistration (24 out of 33 effect sizes). We controlled for all pretest measures of the respective outcome variables in our analyses.

### Effects of the Intervention on Importance of Math and Physics, Career Orientation, Vocational Interests, and STEM Career Aspirations

Effects on the importance of math and physics for career aspirations as well as the effects on career exploration and career decidedness are displayed in Table 3. Table 4 shows intervention effects on vocational interests, and Table 5 presents effects on STEM career aspirations. The results of the full two-level regression models including the coefficients of all covariates at both levels are reported in the Supplement (Tables S6 to S9).

Table 2
*Descriptive Statistics for Outcome Variables in the Three Conditions at all Time Points*

| | Teacher condition | | Master's student condition | | Control condition | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Importance of math for career aspiration | | | | | | |
| T1 | 2.73 | 0.90 | 2.84 | 0.88 | 2.77 | 0.88 |
| T2 | 2.85 | 0.91 | 2.94 | 0.91 | 2.81 | 0.89 |
| T3 | 2.71 | 0.95 | 2.79 | 0.94 | 2.60 | 0.93 |
| Importance of physics for career aspiration | | | | | | |
| T1 | 2.28 | 0.99 | 2.42 | 1.00 | 2.21 | 0.99 |
| T2 | 2.41 | 1.01 | 2.52 | 1.05 | 2.22 | 0.97 |
| Career exploration | | | | | | |
| T1 | 2.62 | 0.56 | 2.62 | 0.55 | 2.66 | 0.54 |
| T2 | 2.64 | 0.61 | 2.64 | 0.59 | 2.62 | 0.55 |
| T3 | 2.76 | 0.56 | 2.70 | 0.60 | 2.72 | 0.54 |
| Career decidedness | | | | | | |
| T1 | 2.63 | 0.82 | 2.71 | 0.79 | 2.64 | 0.83 |
| T2 | 2.66 | 0.76 | 2.73 | 0.78 | 2.69 | 0.78 |
| Realistic | | | | | | |
| T1 | 4.89 | 2.46 | 5.14 | 2.70 | 4.37 | 2.44 |
| T2 | 4.68 | 2.55 | 4.99 | 2.61 | 4.55 | 2.52 |
| T3 | 4.82 | 2.42 | 4.99 | 2.53 | 4.51 | 2.42 |
| Investigative | | | | | | |
| T1 | 4.79 | 2.26 | 5.08 | 2.43 | 4.77 | 2.31 |
| T2 | 4.78 | 2.38 | 4.96 | 2.38 | 4.72 | 2.39 |
| T3 | 4.99 | 2.32 | 5.07 | 2.33 | 4.70 | 2.39 |
| Artistic | | | | | | |
| T1 | 5.24 | 2.70 | 5.26 | 2.60 | 5.42 | 2.61 |
| T2 | 5.13 | 2.65 | 5.16 | 2.62 | 5.44 | 2.56 |
| T3 | 5.21 | 2.62 | 5.22 | 2.62 | 5.33 | 2.61 |
| Social | | | | | | |
| T1 | 5.39 | 2.37 | 5.22 | 2.43 | 5.44 | 2.36 |
| T2 | 5.36 | 2.39 | 5.16 | 2.43 | 5.31 | 2.37 |
| T3 | 5.45 | 2.44 | 5.23 | 2.44 | 5.39 | 2.38 |
| Enterprising | | | | | | |
| T1 | 6.30 | 2.26 | 6.06 | 2.22 | 6.10 | 2.17 |
| T2 | 6.41 | 2.14 | 6.09 | 2.18 | 6.27 | 2.12 |
| T3 | 6.45 | 2.10 | 6.16 | 2.16 | 6.34 | 2.11 |
| Conventional | | | | | | |
| T1 | 4.45 | 2.29 | 4.15 | 2.25 | 4.34 | 2.30 |
| T2 | 4.45 | 2.35 | 4.19 | 2.26 | 4.28 | 2.30 |
| T3 | 4.60 | 2.42 | 4.37 | 2.30 | 4.56 | 2.36 |

*Note.* Importance of math/physics, career exploration, career decidedness: 4-point scale, RIASEC interests: 9-point scale.

First, we found that the intervention showed positive effects on the importance of math and physics for students' career aspirations. That is, students perceived math and physics to be more important for their later careers after they had experienced the intervention. More specifically, at posttest, we found a positive effect—in comparison with the control condition—on the importance of math in the master's student condition ($\beta = 0.12$, $p = .050$). Additionally, we found positive effects on the importance of physics in the teacher condition ($\beta = 0.14$, $p = .018$) as well as in the master's student condition ($\beta = 0.17$, $p < .001$). At follow-up, the effects on the importance of math were not significant.

The analyses for career exploration and career decidedness did not reveal significant effects for either of the two conditions at posttest or follow-up. Thus, the intervention did not have an impact on students' career orientation.

When we tested whether the intervention changed vocational interests, we found a negative effect on realistic interest in the teacher condition at posttest ($\beta = -0.18$, $p = .004$) and an indication of a negative effect in the master's student condition ($\beta = -0.09$, $p = .089$). This means that realistic interest seemed to decrease after the intervention. At follow-up, both effects were not significant anymore. In the master's student condition, we found a negative effect on enterprising interest at posttest ($\beta = -0.11$, $p = .008$), which (in absolute terms) decreased slightly at follow-up ($\beta = -0.09$, $p = .077$). In addition, both the teacher condition ($\beta = 0.15$, $p = .007$) and the master's student condition ($\beta = 0.12$, $p = .033$) showed positive effects on investigative interest at follow-up, indicating that the intervention increased students' investigative interest. Regarding the other vocational interests, namely, artistic, social, and conventional interests, we did not find any effects of the intervention, which was in line with our expectations.

In the logistic regression models, we assessed whether the intervention affected students' STEM career aspirations. We found that the coefficients for both conditions and both time points were nonsignificant. Thus, there was no effect of the intervention on students' STEM career aspirations.

Table 3

*Intervention Effects on Importance of Math and Physics for Career Aspirations, Career Exploration, and Career Decidedness at Posttest and Follow-Up*

| | Importance of math | | | Importance of physics | | | Career exploration | | | Career decidedness | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Posttest* | | | | | | | | | | | | |
| Teacher | 0.10 | .08 | .193 | 0.14 | .06 | .018 | 0.04 | .05 | .385 | -0.06 | .05 | .182 |
| Master's student | 0.12 | .06 | .050 | 0.17 | .05 | <.001 | 0.05 | .05 | .353 | -0.03 | .05 | .472 |
| *Follow-Up* | | | | | | | | | | | | |
| Teacher | 0.11 | .07 | .149 | | | | 0.06 | .08 | .463 | | | |
| Master's student | 0.10 | .06 | .112 | | | | -0.03 | .07 | .645 | | | |

*Note.* Coefficients represent effects on the class level for the intervention conditions compared with the control group. The coefficients were taken from two-level models, and pretest measures and all other covariates were controlled for on both levels.

Table 4

*Intervention Effects on Vocational Interests at Posttest and Follow-Up*

| | Realistic | | | Investigative | | | Artistic | | | Social | | | Enterprising | | | Conventional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Posttest* | | | | | | | | | | | | | | | | | | |
| Teacher | -0.18 | .06 | .004 | 0.06 | .05 | .248 | -0.02 | .05 | .667 | 0.09 | .06 | .146 | -0.06 | .05 | .240 | 0.02 | .06 | .808 |
| Master's student | -0.09 | .05 | .089 | 0.01 | .05 | .904 | -0.06 | .04 | .151 | 0.02 | .06 | .687 | -0.11 | .04 | .008 | -0.03 | .06 | .660 |
| *Follow-Up* | | | | | | | | | | | | | | | | | | |
| Teacher | -0.05 | .06 | .371 | 0.15 | .06 | .007 | 0.05 | .06 | .402 | 0.06 | .05 | .222 | -0.07 | .06 | .264 | -0.08 | .05 | .122 |
| Master's student | -0.04 | .05 | .386 | 0.12 | .06 | .033 | 0.02 | .05 | .748 | -0.02 | .05 | .685 | -0.09 | .05 | .077 | -0.08 | .05 | .138 |

*Note*. Coefficients represent effects on the class level for the intervention conditions compared with the control group. The coefficients were taken from two-level models, and pretest measures and all other covariates were controlled for on both levels.

Table 5

*Intervention Effects on STEM Career Aspirations at Posttest and Follow-Up*

| | STEM career aspirations | | |
|---|---|---|---|
| | β | SE | *p* |
| *Posttest* | | | |
| Teacher | -0.19 | .31 | .543 |
| Master's student | -0.03 | .28 | .905 |
| *Follow-Up* | | | |
| Teacher | -0.01 | .28 | .973 |
| Master's student | -0.26 | .34 | .446 |

*Note*. STEM career aspirations are coded as 1 = STEM and 0 = non-STEM. Coefficients represent effects on the class level for the intervention conditions compared with the control group. The coefficients were taken from two-level models, and pretest measures and all other covariates were controlled for on both levels.

## Discussion

In our study, we investigated whether a relevance intervention in math could support students' career choices by examining intervention effects on a broad range of career-related constructs. We found that the intervention fostered students' perceptions of the importance of math and physics for their career aspirations. In addition, we found positive effects on students' investigative interest and negative effects on their realistic as well as enterprising interest. There were no significant effects on students' career orientation and their career aspirations in STEM. Thus, we partly found support for the positive effects we had expected.

### Effects of the Intervention on the Importance of Math and Physics for Career Aspirations—Pivotal Intervention Success

First, we were able to show that the intervention enhanced students' perceptions of the importance of math and physics for their career aspirations. This suggests that the intended fostering of the perceived relevance of these subjects for students' careers and futures was successful and that students drew personal connections from the relevance arguments to their own career plans. Thus, two essential goals of the intervention were achieved, that is, making students aware of the importance of math for their future careers and involving them personally during the intervention. These results are in line with the findings of Gaspard and colleagues (2019), who found positive effects of the intervention on students' utility value in math. Utility value as the primary outcome of relevance interventions is determined by the perceived benefit of a subject for students' personal future goals, such as career goals (Eccles & Wigfield, 2002), which is very similar to the construct of the importance of math or physics for students' career aspirations, as assessed in this study. Thus, this construct supplements the measurement of utility value by directly linking the relevance of the subject to students' own career plans.

Compared with the effects of the intervention on the importance of math, the effects on physics were even stronger. This suggests that students transferred the arguments for the relevance of math to the importance of physics with respect to their career aspirations. For occupations that require physics, math is usually important as well, indicating that the requirements of math and physics careers are often related. Thus, students might not differentiate between specific math or physics careers or activities in these careers but instead have a broader field of activities in mind (e.g., science or technology) that they link to the contents of the intervention. Overall, these results indicate that it is possible to foster students' motivational beliefs in a subject that is similar to the target subject, representing a positive side effect.

**Effects of the Intervention on Vocational Interests—Mixed Pattern**

In general, RIASEC interests are conceptualized as relatively stable across time, an effect that has been shown in several studies (e.g., Tracey, Robbins, & Hofsess, 2005). However, recent investigations have revealed that interests are more stable in later adolescence and adulthood, whereas interests are still more changeable during childhood and early adolescence (Xu & Tracey, 2016; for a review, see Low, Yoon, Roberts, & Rounds, 2005). This implies that vocational interests can probably be molded by targeted interventions, which our results also showed. The intervention effects we found on vocational interests yielded a mixed pattern. As expected, we found that the intervention successfully fostered students' investigative interest, but this effect occurred only at follow-up. This means students' interest in activities related to scientific work increased, such as conducting experiments or developing new ideas (Bergmann, 2003). This finding is in line with the relation between math and investigative interest postulated by Holland (1997). The time delay might be due to the intervention potentially triggering a chain reaction, such that it first led students to engage more with activities related to math and science, which ultimately affected their investigative interest.

Apart from investigative interest, we found negative effects on realistic interest at posttest. According to Holland (1997), realistic interest is closely related to math, and this is why we assumed the intervention would instead promote realistic interest. However, the negative effect shows that students were less interested in activities such as working with tools or repairing machines. Such activities mostly occur in jobs associated with lower educational and vocational requirements, which were not the focus of the intervention and are probably not seen as jobs that students attending academic track schools would want in the first place.

Prior studies that investigated whether it would be possible to change vocational interests through interventions focused on self-efficacy in a specific area, for example, realistic self-efficacy and also interest (Betz & Schifano, 2000; Luzzo et al., 1999). Thus, our study is the first to examine whether vocational interests can be fostered through relevance interventions in order to support students' career choices. Xu and Tracey (2016) already claimed that interventions regarding vocational interests can help young adolescents with their career choices. On the basis of our mixed results, we believe that further research focusing on these questions should take a closer look at the effects that different types of interventions can have on vocational interests. The 90-min intervention that we tested presumably was not sufficient to foster students' interests sustainably. This might probably require students to actively engage in specific activities related to the interest dimension under investigation.

**No Effects of the Intervention on Career Orientation and STEM Career Aspirations**

We did not find any intervention effects on the career orientation scales. That is, the intervention did not give students enough encouragement to increase their career exploration or enhance their career decidedness. In fact, students were not explicitly asked to engage in career exploration, but we expected them to do so as they reflected on their own career aspirations and on connections with the math course contents. With respect to career decidedness, the intervention might have had diverse effects: Some students might have reconsidered their career plans after learning about the importance of math and thereby became unsure about it, which rather decreased their career decidedness; others might have experienced a strengthening of their career decidedness.

In addition, we found no effects on STEM career aspirations, which means that on average, the number of students who wanted to pursue a STEM career after the intervention did not increase. A lack of effects on STEM career aspirations shows that, even though students' awareness of the importance of math and physics could be enhanced, the intervention was not strong enough to change students' actual career plans.

**Implications of Our Findings**

We had hoped that the intervention would positively influence several precursors of students' career choices that were related to the contents of the intervention. The results of our study were mixed, with some positive but also some unexpected negative effects as well as zero effects on other central variables. Because some effects were only present at one time point or in one condition, it seems that our results were somewhat inconsistent. They have several implications. First, when comparing the MoMa study with other studies that have addressed intervention effects on students' career-related outcomes, it must be noted that students' ages differed. Canning and colleagues (2018) as well as Harackiewicz and colleagues (2012) examined samples of upper high school and college students who were closer to the transition from school to work. Their career choice was probably more important to them, which made it easier for them to connect to career-related topics. Research on students' preparedness to make career-related choices has found differences between students in Grade 9 and higher grade levels (for an overview, see Patton & Creed, 2001), which indicates that the relevance of career-related decisions increases as the transition approaches. This implies that interventions addressing students' career-related outcomes might be more beneficial for older students who are already more aware of their career plans, although the MoMa intervention also yielded some positive effects on students in Grade 9.

Next, regarding the intervention dosage, it is important to consider that the MoMa intervention was a minimal intervention lasting only 90 minutes. When comparing it with others, such as the intervention by Harackiewicz and colleagues (2012) who sent information to their participants over the course of 1 year, it became apparent that their tasks were supposed to actively engage students in the process of making decisions about their future careers for a longer period. Because such processes take time and are influenced by a number of personal and contextual factors, such as individuals' preferences or labor market conditions, career choices represent complex processes (Praskova et al., 2015). Our results indicate that it is possible to foster some student characteristics, but that it is not easy to influence their complex choices with such short relevance interventions and that most likely more time or other tasks are needed to support students better. Although they reflected on their career plans during the intervention, students were not faced with the aim of, for example, enhancing their career decidedness. It is possible that the intervention would have needed to be more activating in terms of engagement in concrete career orientation behavior, such as career workshops focusing on career choice (e.g., Hirschi & Läge, 2008), to not only affect students' beliefs, but also to influence their behavior and to better support them in their decision.

Additionally, the type of career-related outcome seems to matter. In contrast to previous studies that assessed career outcomes that were related to the subject the intervention had addressed, such as choices in STEM (Canning et al., 2018; Harackiewicz et al., 2012), we also examined career-related behavior in general (e.g., students' career orientation) because we expected students to engage in career orientation overall. As we did not find an effect here, one might conclude that these variables are too distant from the contents of the intervention, and it might be more promising to focus on content-related outcomes.

### Limitations and Future Research

When interpreting the results of our study, at least three limitations should be considered. First, our sample only included academic track students in ninth grade. This sample was chosen on purpose because many STEM careers require students to graduate from this type of school. In addition, students start to think about career-related questions around this age. By examining this sample, we followed up on previous studies in which relevance interventions were directed toward adolescents from academic track schools (MoMa 1) or college (e.g., Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Rosenzweig et al., 2018). However, this limited the generalizability of our results because the sample was restricted to highly educated students. Therefore, we do not know how well the intervention works for students from other school types, who probably have different prior knowledge or career ideas and therefore connect differently to the intervention materials. Moreover, we investigated only ninth-graders, which is why we cannot generalize our results to other age groups. In future research, it would be interesting to examine how students respond to the intervention when they get older and probably substantiate their career aspirations. After students intensify their career exploration, which normally happens during the final years in high school (Kracke, 1997), they probably know better what activities and requirements their career aspirations include, and this could change their perception of the intervention. Thus, future research should investigate whether relevance interventions can support older students in their career choices.

Second, the intervention focused only on math, but the outcome measures we looked at had a broader range, capturing career aspirations in STEM and career orientation in general. We purposely chose to examine a math intervention because math is central to STEM subjects and STEM careers. However, given that math is not the only subject relevant to STEM, it would be interesting to examine in future studies how relevance interventions in other subjects (e.g., science) may be connected to students' career choices.

Third, regarding the measurement of vocational interests, the interest dimensions were assessed with only one item each. There are reliable and well-established scales measuring the RIASEC interests (e.g., Bergmann & Eder, 2005, in the German language), which unfortunately could not be used because of limited space in the questionnaires.

## Conclusion

Our study is one of the first to investigate effects of a relevance intervention in math on students' career outcomes in more detail, thereby testing whether this type of intervention can support adolescents in their career choices. Although our results were mixed, we were able to show that relevance interventions are suitable for making students aware of the importance of math and physics for their later careers and to some extent also for affecting their vocational interests. Thus, our study suggests that relevance interventions, when focusing on students' future careers, have some potential to support students as they work through the process of making decisions about their future careers, although more research will be needed to further examine which features of the intervention are most important for supporting students best.

## References


Asparouhov, T., & Muthén, B. O. (2010). *Multiple imputation with Mplus*. Retrieved from Mplus Web Notes, 2010, from www.statmodel.com.

Beal, S. J., & Crockett, L. J. (2013). Adolescents' occupational and educational goals: A test of reciprocal relations. *Journal of Applied Developmental Psychology*, *34*(5), 219–229. https://doi.org/10.1016/j.appdev.2013.04.005

Bergmann, C. (2003). Berufliche Interessentests - Wider die Anwendung geschlechtsspezifischer Normen [Vocational interests inventories - Against the application of gender-sepcific norms]. *Zeitschrift für Personalpsychologie*, *2*(2), 66–77. https://doi.org/10.1026//1617-6391.2.2.66

Bergmann, C., & Eder, F. (2005). *Allgemeiner Interessen-Struktur-Test mit Umwelt-Struktur-Test (AIST-R/ UST-R) [General interest structure test]*. Göttingen: Beltz Test.

Betz, N. E., & Schifano, R. S. (2000). Evaluation of an intervention to increase realistic self-efficacy and interests in college women. *Journal of Vocational Behavior, 56*, 35–52. https://doi.org/10.1006/jvbe.1999.1690

Brisson, B. M., Dicke, A.-L., Gaspard, H., Häfner, I., Flunger, B., Nagengast, B., & Trautwein, U. (2017). Short intervention, sustained effects: Promoting students' math competence beliefs, effort, and achievement. *American Educational Research Journal*, *54*(6), 1048–1078. https://doi.org/10.3102/0002831217716084

Canning, E. A., Harackiewicz, J. M., Priniski, S., Hecht, C. A., Tibbetts, Y., & Hyde, J. S. (2018). Improving performance and retention in introductory biology with a utility-value intervention. *Journal of Educational Psychology*, *110*(6), 834–849. https://doi.org/10.1037/edu0000244

Chow, A., & Salmela-Aro, K. (2011). Task-values across subject domains: A gender comparison using a person-centered approach. *International Journal of Behavioral Development*, *35*(3), 202–209. https://doi.org/10.1177/0165025411398184

Dietrich, J., Parker, P., & Salmela-Aro, K. (2012). Phase-adequate engagement at the post-school transition. *Developmental Psychology*, *48*(6), 1575–1593. https://doi.org/10.1037/a0030188

Durik, A. M., Schwartz, J., Schmidt, J. A., & Shumow, L. (2018). Age differences in effects of self-generated utility among Black and Hispanic adolescents. *Journal of Applied Developmental Psychology, 54*, 60–68.

https://doi.org/10.1016/j.appdev.2017.11.004

Eccles, J. S. (2005). Subjective task values and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York, NY: Guilford.

Eccles, J. S., Adler, T., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 74–146). New York, NY: Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53,* 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*, *12*(2), 121–138. https://doi.org/10.1037/1082-989X.12.2.121

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. *Developmental Psychology*, *51*(9), 1226–1240. https://doi.org/10.1037/dev0000028

Gaspard, H., Häfner, I., Parrisius, C., Trautwein, U., & Nagengast, B. (2017). Assessing task values in five subjects during secondary school: Measurement structure and mean level differences across grade level, gender, and academic subject. *Contemporary Educational Psychology*, *48*, 67–84. https://doi.org/10.1016/j.cedpsych.2016.09.003

Gaspard, H., Parrisius, C., Piesch, H., Wille, E., Nagengast, B., Trautwein, U., & Hulleman, C. S. (2019). The effectiveness of a relevance intervention in math classrooms: A cluster-randomized trial. *Manuscript in preparation*.

Grolnick, W. S., Kurowski, C. O., Dunlap, K. G., & Hevey, C. (2000). Parental resources and the transition to junior high. *Journal of Research on Adolescence*, *10*(4), 465–488. https://doi.org/10.1207/SJRA1004_05

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899–906. https://doi.org/10.1177/0956797611435530

Harackiewicz, J. M., Tibbetts, Y., Canning, E. A., & Hyde, J. S. (2014). Harnessing values to promote motivation in education. In S. A. Karabenick & T. C. Urdan (Eds.), *Motivational Interventions - Advances in Motivation and Achievement (Vol. 18)* (pp. 71–105). Bingley, UK: Emerald Group Publishing Limited. https://doi.org/10.1108/S0749-742320140000018002

Hecht, C. A., Harackiewicz, J. M., Priniski, S. J., Canning, E. A., Tibbetts, Y., & Hyde, J. S. (2019). Promoting persistence in the biological and medical sciences: An expectancy-value approach to intervention. *Journal of Educational Psychology*. Advance online publication. https://doi.org/10.1037/edu0000356

Hirschi, A., & Läge, D. (2008). Increasing the career choice readiness of young adolescents: An evaluation study. *International Journal for Educational and Vocational Guidance*, *8*(2), 95–110. https://doi.org/10.1007/s10775-008-9139-7

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources. https://doi.org/10.1016/0022-4405(74)90056-9

Hollis, S., & Campbell, F. (1999). What is meant by intention to treat analysis? Survey of published randomised controlled trials. *BMJ*, *319*(7211), 670–674. https://doi.org/10.1109/ICIF.2002.1021193

Hulleman, C. S., & Cordray, D. S. (2009). Moving from the lab to the field: The role of fidelity and achieved relative intervention strength. *Journal of Research on Educational Effectiveness*, *2*(1), 88–110. https://doi.org/10.1080/19345740802539325

Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology*, *102*(4), 880–895. https://doi.org/10.1037/a0019506

Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science*, *326*(5958), 1410–1412. https://doi.org/10.1126/science.1177067

Jonkmann, K., Rose, N., & Trautwein, U. (2013). *Tradition und Innovation: Entwicklungsverläufe an Haupt- und Realschulen in Baden-Württemberg und Mittelschulen in Sachen [Tradition and innovation - Developmental trends at lower and middle track schools in Baden-Württemberg and Saxony]*. Tübingen: Projektbericht an die Kultusministerien der Länder.

Koivisto, P., Vuori, J., & Nykyri, E. (2007). Effects of the School-to-Work Group Method among young people. *Journal of Vocational Behavior, 70*, 277–296. https://doi.org/10.1016/j.jvb.2006.12.001

Köller, O., Watermann, R., Trautwein, U., & Lüdtke, O. (2004). *Wege zur Hochschulreife in Baden-Württemberg. TOSCA – Eine Untersuchung an allgemein bildenden und beruflichen Gymnasien [Pathways to high school graduation in Baden-Württemberg. TOSCA - An investigation at general and vocational academic track schools]*. Opladen: Leske+Budrich.

Korendijk, E., Hox, J. J., Moerbeek, M., & Maas, C. J. M. (2011). Robustness of parameter and standard error estimates against ignoring a contextual effect of a subject-level covariate in cluster-randomized trials. *Behavior Research Methods, 43*, 1003–1013. https://doi.org/10.3758/s13428-011-0094-8

Kracke, B. (1997). Parental behaviors and adolescents' career exploration. *Career Development Quarterly*, *45*(4), 341–350. https://doi.org/10.1002/j.2161-0045.1997.tb00538.x

Lazowski, R. A., & Hulleman, C. S. (2016). Motivation interventions in education: A meta-analytic review. *Review of Educational Research*, *86*(2), 602–640. https://doi.org/10.3102/0034654315617832

Low, K. S. D., Yoon, M., Roberts, B. W., & Rounds, J. (2005). The stability of vocational interests from early adolescence to middle adulthood: A quantitative review of longitudinal studies. *Psychological Bulletin*, *131*(5), 713–737. https://doi.org/10.1037/0033-2909.131.5.713

Luzzo, D. A., Hasper, P., Albert, K. A., Bibby, M. A., & Martinelli Jr., E. A. (1999). Effects of self-efficacy-enhancing interventions on the math/science self-efficacy and career interests, goals, and actions of career undecided college students. *Journal of Counseling Psychology*, *46*(2), 233–234. https://doi.org/10.1037/0022-0167.46.2.233

Markus, H., & Nurius, P. (1986). Possible Selves. *American Psychologist*, *41*(9), 954–969. https://doi.org/10.1037/0003-066X.41.9.954

Marsh, H. W., Lüdtke, O., Robitzsch, A., Trautwein, U., Asparouhov, T., Muthén, B., & Nagengast, B. (2009). Doubly-latent models of school contextual effects: Integrating multilevel and structural equation approaches to control measurement and sampling error. *Multivariate Behavioral Research*, *44*, 764–802.

https://doi.org/10.1080/00273170903333665

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standarized test scores. Reciprocal effects models of causal ordering. *Child Development*, *76*(2), 397–416. https://doi.org/0009-3920/2005/7602-0007

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods*, *22*(1), 114–140. https://doi.org/10.1037/met0000078

Muthén, L. K., & Muthén, B. O. (1998-2012). *Mplus user's guide. Seventh edition.* Los Angeles, CA: Muthén & Muthén.

Noack, P., Kracke, B., Gniewosz, B., & Dietrich, J. (2010). Parental and school effects on students' occupational exploration: A longitudinal and multilevel analysis. *Journal of Vocational Behavior*, *77*(1), 50–57. https://doi.org/10.1016/j.jvb.2010.02.006

OECD. (2004a). *Career guidance and public policy: Bridging the gap*. Paris: OECD Publishing. https://doi.org/10.1787/9789264105669-en

OECD. (2004b). *Lernen für die Welt von morgen. Erste Ergebnisse von PISA 2003 [Learning for tomorrow's world: First results from PISA 2003]*. Paris: OECD Publishing.

Oyserman, D., & Destin, M. (2010). Identity-based motivation: Implications for intervention. *The Counseling Psychologist*, *38*(7), 1001–1043. https://doi.org/10.1177/0011000010374775

Parker, P., Nagy, G., Trautwein, U., & Lüdtke, O. (2014). Predicting career aspirations and university majors from academic ability and self-concept: A longitudinal application of the internal-external frame of reference model. In I. Schoon & J. S. Eccles (Eds.), *Gender Differences in Aspirations and Attainment: A Life Course Perspective* (pp. 224–246). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139128933.015

Päßler, K., & Hell, B. (2012). Do interests and cognitive abilities help explain college major choice equally well for women and men? *Journal of Career Assessment*, *20*(4), 479–496. https://doi.org/10.1177/1069072712450009

Patton, W., & Creed, P. A. (2001). Developmental issues in career maturity and career decision status. *The Career Development Quarterly*, *49*(4), 336–351.

https://doi.org/10.1002/j.2161-0045.2001.tb00961.x

Piesch, H., Häfner, I., Gaspard, H., Flunger, B., Nagengast, B., & Harackiewicz, J. M. (2019). Helping parents support adolescents' career orientation: Effects of a parent-based utility-value intervention. *Unterrichtswissenschaft, 47*(3), 271–293. https://doi.org/10.1007/s42010-018-0024-x

Praskova, A., Creed, P. A., & Hood, M. (2015). Career identity and the complex mediating relationships between career preparatory actions and career progress markers. *Journal of Vocational Behavior*, *87*, 145–153. https://doi.org/10.1016/j.jvb.2015.01.001

Raudenbush, S. W. (1997). Statistical analysis and optimal design for cluster randomized trials. *Psychological Methods*, *2*(2), 173–185. https://doi.org/10.1037/1082-989X.2.2.173

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.

Rosenzweig, E. Q., Harackiewicz, J. M., Priniski, S. J., Hecht, C. A., Canning, E. A., Tibbetts, Y., & Hyde, J. S. (2018). Choose your own intervention: Using choice to enhance the effectiveness of a utility-value intervention. *Motivation Science*. Advance online publication. https://doi.org/10.1037/mot0000113

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist*, *51*(2), 146–163. https://doi.org/10.1080/00461520.2016.1154792

Rozek, C. S., Svoboda, R. C., Harackiewicz, J. M., Hulleman, C. S., & Hyde, J. S. (2017). Utility-value intervention with parents increases students' STEM preparation and career pursuit. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(5), 909–914. https://doi.org/10.1073/pnas.1607386114

Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys*. New York, NY: Wiley. https://doi.org/10.1002/9780470316696

Savickas, M. L. (2002). Career construction: A developmental theory of vocational behavior. In D. Brown (Ed.), *Career choice and development* (pp. 149–205). San Francisco, CA: Jossey-Bass.

Schmidt, S., Ennemoser, M., & Krajewski, K. (Eds.). (2013). *Deutscher Mathematiktest für 9. Klassen [German mathematics test for Grade 9]*. Göttingen: Hogrefe.

Seifert, K. H., & Stangl, W. (1986). Der Fragebogen Einstellungen zur Berufswahl und beruflichen Arbeit [Questionnaire about attitudes towards career choice and work]. *Diagnostica*, *32*(2), 153–164.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, *42*(1), 70–83. https://doi.org/10.1037/0012-1649.42.1.70

Spybrook, J., Bloom, H., Congdon, R., Hill, C., Martinez, A., & Raudenbush, S. W. (2011). *Optimal design plus empirical evidence: Documentation for the "Optimal Design" software Version 3.0*. Retrieved from www.hlmsoft.net.

Stoll, G., & Trautwein, U. (2017). Vocational interests as personality traits: Characteristics, development, and significance in educational and organizational environments. In J. Specht (Ed.), *Personality Development Across the Lifespan* (pp. 401–417). London: Academic Press. https://doi.org/10.1016/B978-0-12-804674-6.00025-9

Super, D. E., & Kidd, J. M. (1979). Vocational maturity in adulthood: Toward turning a model into a measure. *Journal of Vocational Behavior*, *14*(3), 255–270. https://doi.org/10.1016/0001-8791(79)90054-X

Taskinen, P., Asseburg, R., & Walter, O. (2008). Wer möchte später einen naturwissenschaftsbezogenen oder technischen Beruf ergreifen? Kompetenzen, Selbstkonzept und Motivationen als Prädiktoren der Berufserwartungen in PISA 2006 [Who aspires to a scientific or technical career? Student literacy, self-concept, and motivation as predictors of career aspirations in PISA 2006]. In M. Prenzel & J. Baumert (Eds.), *Vertiefende Analysen zu PISA 2006* (pp. 79–105). Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-91815-0_5

Tracey, T. J. G., Robbins, S. B., & Hofsess, C. D. (2005). Stability and change in interests: A longitudinal study of adolescents from grades 8 through 12. *Journal of Vocational Behavior*, *66*, 1–25. https://doi.org/10.1016/j.jvb.2003.11.002

Tymms, P. (2004). Effect sizes in multilevel models. In I. Schagen & K. Elliot (Eds.), *But what does it mean? The use of effect sizes in educational research* (pp. 55–66). London: National Foundation for Educational Research.

Van Tuijl, C., & Van der Molen, J. H. W. (2016). Study choice and career development in STEM fields: an overview and integration of the research. *International Journal of Technology and Design Education*, *26*(2), 159–183. https://doi.org/10.1007/s10798-015-9308-1

Volodina, A., & Nagy, G. (2016). Vocational choices in adolescence: The role of gender, school achievement, self-concepts, and vocational interests. *Journal of Vocational Behavior*, *95–96*, 58–73. https://doi.org/10.1016/j.jvb.2016.07.005

Weisgram, E. S., & Bigler, R. S. (2006). Girls and science careers: The role of altruistic values and attitudes about scientific tasks. *Journal of Applied Developmental Psychology*, *27*, 326–348. https://doi.org/10.1016/j.appdev.2006.04.004

Wigfield, A., Tonks, S., & Klauda, S. L. (2009). Expectancy-value theory. In K. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 55–75). New York, NY: Routledge.

Xu, H., & Tracey, T. J. G. (2016). Stability and change in interests: A longitudinal examination of grades 7 through college. *Journal of Vocational Behavior*, *93*, 129–138. https://doi.org/10.1016/j.jvb.2016.02.002

## Appendix

Table A1

*All Items of all Outcome Variables*

| | |
|---|---|
| Importance of math for career aspirations | How important is math for this career? |
| Importance of physics for career aspirations | How important is physics for this career? |
| Career exploration | I talk to as many people as possible about careers I am interested in. |
| | I try to figure out what my vocational interests are. |
| | I gather information about jobs that I am interested in in many different ways (internships, books, discussions). |
| | I try to figure out which careers best match my strengths and weaknesses. |
| | When I read up on a career, I also try to find out about the negative aspects of it. |
| | I try to gather detailed information about one career instead of exploring different careers. |
| | I consider various career options and try to find out about all alternatives in detail. |
| Career decidedness | I do not know at all which careers would be good for me to consider. |
| | I already know pretty well what the requirements are for working in my preferred career. |
| | I do not know at all what I will be able to do for work later. |
| | I know very little about the requirements of various jobs. |
| | I have no idea what it will be like when I go to work. |
| | I already know pretty well which jobs I am best suited for. |
| | How do you rate your interest in the following six areas of activity: |
| Realistic | "realistic" activities (e.g., working with machines or technical equipment, working with wood, metal, or other materials, repairing engines or machines, …) |

| | |
|---|---|
| Investigative | “investigative” activities (e.g., conducting experiments, reading scientific literature, working on abstract problems, developing new ideas, closely observing and analyzing, …) |
| Artistic | “artistic” activities (e.g., drawing, painting, making music, translating texts, dealing with art and literature, acting, …) |
| Social | “social” activities (e.g., looking after other people, nursing, teaching, advising, supporting other people, collaborating, caring for other people, …) |
| Enterprising | “enterprising” activities (e.g., organizing, managing a company, supervising, influencing, leading other people, advertising, selling, …) |
| Conventional | “conventional” activities (e.g., creating documents or statistics, conducting correspondence, drafting and applying new laws and regulations, accounting, …) |
| Career aspirations | Which career or occupational field would you like to work in later? |
| Educational aspirations | What further educational plans (e.g., which field of study or what kind of vocational training) will you engage in after school? |

**Supplemental Material**

Table S1

*Intervention Effects on Importance of Math and Physics, Career Exploration, and Career Decidedness at Posttest and Follow-Up – for 77 Classes*

| | Posttest | | | | | | | | | | | | Follow-up | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Importance of math | | | Importance of physics | | | Career exploration | | | Career decidedness | | | Importance of math | | | Career exploration | | |
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.49 | .03 | <.001 | 0.54 | .02 | <.001 | 0.54 | .03 | <.001 | 0.75 | .02 | <.001 | 0.46 | .03 | <.001 | 0.44 | .03 | <.001 |
| Gender | -0.16 | .06 | .004 | -0.25 | .05 | <.001 | 0.10 | .05 | .033 | -0.04 | .04 | .372 | -0.05 | .05 | .355 | 0.20 | .05 | <.001 |
| Math grade | -0.01 | .03 | .666 | -0.02 | .03 | .624 | -0.02 | .03 | .518 | 0.08 | .02 | .001 | 0.02 | .03 | .434 | 0.04 | .03 | .238 |
| Intrinsic value | 0.13 | .04 | <.001 | 0.04 | .04 | .326 | 0.06 | .03 | .078 | -0.03 | .03 | .273 | 0.10 | .04 | .006 | 0.09 | .04 | .013 |
| Cost | -0.03 | .03 | .354 | -0.01 | .04 | .766 | 0.02 | .03 | .589 | 0.03 | .03 | .230 | -0.05 | .04 | .247 | 0.10 | .04 | .015 |
| Self-concept | -0.05 | .05 | .315 | -0.03 | .05 | .490 | 0.01 | .05 | .876 | 0.08 | .04 | .057 | 0.00 | .05 | .935 | 0.02 | .06 | .755 |
| Self-efficacy | 0.09 | .03 | .008 | 0.09 | .04 | .018 | -0.03 | .04 | .488 | 0.03 | .03 | .410 | 0.08 | .04 | .041 | 0.03 | .04 | .511 |
| Effort | 0.04 | .03 | .162 | 0.06 | .02 | .004 | 0.03 | .03 | .327 | 0.00 | .02 | .984 | -0.01 | .02 | .756 | 0.08 | .03 | .003 |
| Speed test | 0.01 | .03 | .824 | -0.01 | .03 | .772 | -0.05 | .02 | .055 | 0.03 | .02 | .232 | 0.02 | .03 | .495 | -0.03 | .04 | .319 |
| *Class level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.47 | .11 | <.001 | 0.59 | .09 | <.001 | 0.52 | .11 | <.001 | 0.75 | .09 | <.001 | 0.60 | .10 | <.001 | 0.34 | .15 | .020 |
| Gender | -0.12 | .18 | .517 | -0.20 | .17 | .237 | -0.02 | .14 | .883 | -0.20 | .12 | .107 | -0.19 | .15 | .217 | 0.17 | .22 | .425 |
| Math grade | -0.08 | .09 | .346 | -0.01 | .08 | .863 | 0.13 | .09 | .130 | -0.05 | .06 | .467 | -0.04 | .08 | .613 | 0.01 | .13 | .964 |
| Intrinsic value | -0.02 | .14 | .868 | -0.11 | .14 | .443 | 0.25 | .13 | .056 | 0.05 | .11 | .673 | -0.09 | .13 | .478 | -0.02 | .19 | .904 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cost | -0.19 | .18 | .293 | -0.17 | .14 | .239 | -0.15 | .16 | .342 | 0.01 | .10 | .923 | 0.08 | .17 | .633 | 0.02 | .22 | .940 |
| Self-concept | -0.15 | .25 | .554 | 0.03 | .21 | .873 | -0.20 | .22 | .367 | -0.22 | .18 | .209 | 0.51 | .19 | .009 | -0.07 | .26 | .796 |
| Self-efficacy | 0.03 | .18 | .855 | -0.17 | .15 | .255 | -0.10 | .16 | .516 | 0.05 | .15 | .749 | -0.25 | .13 | .058 | -0.05 | .23 | .836 |
| Effort | -0.05 | .13 | .675 | 0.08 | .11 | .463 | 0.05 | .08 | .565 | 0.09 | .10 | .391 | -0.01 | .12 | .926 | 0.03 | .14 | .821 |
| Speed test | -0.03 | .09 | .761 | 0.02 | .07 | .731 | -0.05 | .06 | .460 | -0.03 | .05 | .521 | -0.14 | .10 | .147 | -0.04 | .10 | .700 |
| Teacher | 0.11 | .08 | .175 | 0.15 | .06 | .016 | 0.05 | .05 | .331 | -0.07 | .05 | .163 | 0.09 | .07 | .246 | 0.05 | .08 | .549 |
| Master's student | 0.12 | .06 | .048 | 0.17 | .05 | <.001 | 0.05 | .05 | .347 | -0.03 | .05 | .463 | 0.09 | .06 | .123 | -0.04 | .07 | .631 |

*Note*. $N$ = 1,725

Table S2

*Intervention Effects on Vocational Interests at Posttest – for 77 Classes*

| | Realistic | | | Investigative | | | Artistic | | | Social | | | Enterprising | | | Conventional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.62 | .02 | <.001 | 0.51 | .02 | <.001 | 0.64 | .02 | <.001 | 0.60 | .02 | <.001 | 0.57 | .03 | <.001 | 0.49 | .02 | <.001 |
| Gender | -0.32 | .05 | <.001 | -0.21 | .05 | <.001 | 0.24 | .05 | <.001 | 0.31 | .04 | <.001 | 0.06 | .04 | .149 | 0.04 | .05 | .409 |
| Math grade | 0.01 | .03 | .819 | -0.04 | .03 | .156 | -0.01 | .03 | .861 | -0.01 | .03 | .864 | -0.04 | .03 | .176 | 0.02 | .03 | .608 |
| Intrinsic value | 0.01 | .03 | .654 | 0.07 | .03 | .028 | -0.01 | .03 | .783 | 0.01 | .03 | .892 | -0.06 | .03 | .054 | -0.05 | .04 | .193 |
| Cost | -0.03 | .03 | .334 | -0.05 | .03 | .096 | -0.02 | .03 | .394 | 0.04 | .03 | .229 | -0.02 | .03 | .610 | -0.03 | .04 | .487 |
| Self-concept | 0.04 | .04 | .341 | -0.04 | .04 | .317 | -0.05 | .04 | .181 | -0.03 | .04 | .453 | 0.00 | .05 | .980 | 0.09 | .05 | .061 |
| Self-efficacy | 0.02 | .03 | .466 | 0.06 | .04 | .095 | 0.04 | .03 | .244 | 0.02 | .03 | .662 | 0.04 | .04 | .280 | -0.02 | .04 | .714 |
| Effort | -0.02 | .02 | .406 | -0.01 | .03 | .754 | 0.00 | .02 | .985 | 0.02 | .02 | .363 | 0.04 | .03 | .087 | 0.03 | .03 | .333 |
| Speed test | -0.02 | .02 | .474 | -0.01 | .03 | .748 | -0.01 | .03 | .590 | -0.03 | .02 | .154 | 0.00 | .03 | .917 | 0.06 | .03 | .019 |
| *Class level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.85 | .09 | <.001 | 0.69 | .08 | <.001 | 0.78 | .09 | <.001 | 0.71 | .09 | <.001 | 0.46 | .13 | <.001 | 0.62 | .12 | <.001 |
| Gender | -0.45 | .15 | .003 | -0.19 | .10 | .102 | 0.13 | .18 | .446 | 0.20 | .15 | .179 | -0.37 | .11 | <.001 | -0.27 | .14 | .053 |
| Math grade | -0.04 | .08 | .616 | -0.04 | .06 | .505 | -0.14 | .07 | .037 | 0.05 | .07 | .472 | 0.01 | .07 | .887 | -0.05 | .10 | .612 |
| Intrinsic value | 0.11 | .11 | .316 | 0.09 | .11 | .447 | 0.13 | .12 | .286 | 0.00 | .11 | .992 | -0.11 | .10 | .305 | 0.05 | .15 | .725 |
| Cost | 0.12 | .16 | .446 | -0.06 | .11 | .633 | 0.21 | .11 | .050 | 0.11 | .12 | .356 | 0.10 | .12 | .383 | -0.20 | .14 | .166 |
| Self-concept | 0.02 | .18 | .919 | -0.09 | .13 | .531 | -0.08 | .16 | .610 | 0.15 | .20 | .466 | -0.03 | .21 | .894 | 0.05 | .19 | .809 |
| Self-efficacy | -0.24 | .15 | .106 | -0.02 | .11 | .891 | 0.10 | .12 | .432 | 0.13 | .15 | .393 | 0.04 | .15 | .818 | -0.29 | .13 | .021 |
| Effort | 0.19 | .12 | .100 | -0.14 | .12 | .255 | -0.20 | .09 | .038 | -0.07 | .10 | .485 | 0.18 | .08 | .028 | -0.06 | .11 | .590 |
| Speed test | 0.22 | .06 | <.001 | 0.03 | .08 | .722 | -0.05 | .06 | .389 | -0.14 | .07 | .028 | -0.08 | .05 | .139 | -0.10 | .07 | .129 |
| Teacher | -0.18 | .06 | .004 | 0.05 | .04 | .328 | -0.01 | .05 | .880 | 0.08 | .06 | .167 | -0.05 | .05 | .308 | 0.02 | .06 | .766 |
| Master’s student | -0.09 | .05 | .092 | 0.00 | .04 | .931 | -0.06 | .04 | .168 | 0.02 | .06 | .689 | -0.11 | .04 | .009 | -0.03 | .06 | .672 |

*Note*. $N$ = 1,725

Table S3

*Intervention Effects on Vocational Interests at Follow-Up – for 77 Classes*

| | Realistic | | | Investigative | | | Artistic | | | Social | | | Enterprising | | | Conventional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.60 | .02 | <.001 | 0.52 | .02 | <.001 | 0.62 | .02 | <.001 | 0.58 | .03 | <.001 | 0.49 | .03 | <.001 | 0.46 | .03 | <.001 |
| Gender | -0.32 | .05 | <.001 | -0.12 | .04 | .006 | 0.34 | .05 | <.001 | 0.30 | .05 | <.001 | 0.07 | .05 | .153 | 0.05 | .06 | .434 |
| Math grade | -0.01 | .03 | .598 | -0.03 | .04 | .464 | 0.01 | .02 | .687 | -0.01 | .03 | .683 | 0.03 | .03 | .315 | -0.01 | .03 | .804 |
| Intrinsic value | 0.05 | .03 | .039 | 0.11 | .03 | <.001 | -0.02 | .03 | .458 | 0.03 | .03 | .317 | -0.10 | .04 | .010 | -0.01 | .04 | .769 |
| Cost | -0.05 | .03 | .083 | -0.03 | .03 | .308 | -0.05 | .03 | .069 | 0.02 | .03 | .488 | 0.00 | .03 | .942 | 0.00 | .04 | .992 |
| Self-concept | 0.05 | .04 | .207 | -0.09 | .04 | .055 | -0.10 | .05 | .028 | -0.09 | .05 | .069 | 0.05 | .05 | .299 | 0.02 | .05 | .727 |
| Self-efficacy | -0.02 | .03 | .630 | 0.09 | .04 | .012 | 0.06 | .03 | .054 | 0.00 | .04 | .953 | 0.01 | .04 | .872 | 0.03 | .04 | .525 |
| Effort | 0.01 | .02 | .573 | 0.03 | .03 | .237 | 0.01 | .03 | .827 | 0.01 | .03 | .859 | 0.10 | .03 | .001 | 0.11 | .03 | <.001 |
| Speed test | -0.04 | .03 | .127 | -0.02 | .03 | .389 | -0.01 | .02 | .599 | -0.01 | .03 | .793 | 0.03 | .03 | .377 | 0.00 | .03 | .887 |
| *Class level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.77 | .07 | <.001 | 0.52 | .09 | <.001 | 0.60 | .10 | <.001 | 0.50 | .09 | <.001 | 0.65 | .14 | <.001 | 0.51 | .13 | <.001 |
| Gender | -0.32 | .14 | .020 | 0.04 | .14 | .790 | 0.41 | .19 | .031 | 0.26 | .14 | .069 | -0.33 | .13 | .013 | -0.55 | .15 | <.001 |
| Math grade | -0.06 | .07 | .417 | -0.07 | .07 | .344 | -0.12 | .07 | .106 | -0.09 | .08 | .235 | -0.06 | .07 | .447 | -0.15 | .08 | .058 |
| Intrinsic value | 0.02 | .11 | .892 | 0.23 | .14 | .110 | -0.01 | .13 | .926 | 0.11 | .12 | .343 | 0.12 | .15 | .424 | 0.25 | .13 | .048 |
| Cost | 0.00 | .15 | .998 | 0.22 | .14 | .104 | 0.16 | .12 | .189 | 0.08 | .15 | .599 | 0.23 | .14 | .100 | 0.43 | .15 | .004 |
| Self-concept | -0.01 | .17 | .968 | -0.12 | .17 | .486 | -0.03 | .20 | .891 | 0.26 | .20 | .206 | 0.03 | .20 | .879 | 0.07 | .20 | .733 |
| Self-efficacy | -0.14 | .15 | .334 | 0.16 | .14 | .255 | 0.09 | .16 | .581 | -0.25 | .13 | .061 | -0.17 | .17 | .317 | -0.14 | .15 | .334 |
| Effort | 0.06 | .11 | .593 | -0.26 | .11 | .016 | -0.04 | .11 | .722 | -0.01 | .12 | .930 | 0.06 | .10 | .593 | 0.18 | .12 | .131 |
| Speed test | 0.07 | .06 | .236 | 0.01 | .08 | .905 | 0.03 | .07 | .652 | -0.12 | .08 | .102 | 0.01 | .08 | .905 | -0.01 | .07 | .943 |
| Teacher | -0.06 | .06 | .329 | 0.15 | .06 | .013 | 0.07 | .05 | .149 | 0.06 | .05 | .244 | -0.07 | .06 | .225 | -0.09 | .06 | .104 |
| Master's student | -0.04 | .05 | .413 | 0.12 | .06 | .034 | 0.02 | .05 | .684 | -0.02 | .05 | .681 | -0.09 | .05 | .073 | -0.08 | .05 | .131 |

*Note*. $N = 1{,}725$

Table S4

*Intervention Effects on STEM Career Aspirations at Posttest and Follow-Up – for 77 Classes*

| | STEM career aspirations | | | | | |
|---|---|---|---|---|---|---|
| | Posttest | | | Follow-up | | |
| | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | |
| Pretest | 3.73 | .22 | <.001 | 3.43 | .21 | <.001 |
| Gender | -0.39 | .23 | .083 | -0.35 | .20 | .084 |
| Math grade | -0.05 | .13 | .706 | 0.15 | .12 | .228 |
| Intrinsic value | 0.09 | .15 | .551 | 0.16 | .14 | .247 |
| Cost | -0.13 | .17 | .435 | -0.14 | .14 | .325 |
| Self-concept | 0.06 | .20 | .759 | 0.03 | .17 | .873 |
| Self-efficacy | 0.15 | .18 | .412 | 0.15 | .16 | .356 |
| Effort | 0.10 | .11 | .369 | -0.06 | .10 | .583 |
| Speed test | -0.09 | .12 | .452 | 0.12 | .12 | .316 |
| *Class level* | | | | | | |
| Pretest | 4.55 | .85 | <.001 | 3.90 | .85 | <.001 |
| Gender | 0.35 | .66 | .595 | 0.70 | .62 | .260 |
| Math grade | 0.30 | .35 | .394 | 0.29 | .40 | .477 |
| Intrinsic value | 0.33 | .57 | .561 | 0.17 | .65 | .798 |
| Cost | 0.32 | .61 | .608 | 0.08 | .69 | .910 |
| Self-concept | -0.55 | .90 | .542 | 0.76 | 1.03 | .458 |
| Self-efficacy | 0.51 | .63 | .414 | -0.21 | .67 | .760 |
| Effort | 0.43 | .55 | .431 | -0.12 | .55 | .828 |
| Speed test | 0.26 | .33 | .436 | 0.33 | .36 | .365 |
| Teacher | -0.10 | .30 | .730 | 0.00 | .29 | .993 |
| Master's student | -0.03 | .28 | .911 | -0.26 | .34 | .445 |

*Note. N* = 1,725. STEM career aspirations are coded as 1 = STEM and 0 = non-STEM.

Table S5

*Differences in Outcome Variables between the three Conditions at Pretest*

| | Teacher condition vs. Master's student condition | | Teacher condition vs. Control condition | | Master's student condition vs. Control condition | |
|---|---|---|---|---|---|---|
| | Δ*M* | *d* [CI] | Δ*M* | *d* [CI] | Δ*M* | *d* [CI] |
| Importance of math for career aspirations | -0.11 | -0.12 [-0.24; -0.01] | -0.04 | -0.04 [-0.17; 0.08] | 0.07 | 0.08 [-0.04; 0.2] |
| Importance of physics for career aspirations | -0.14 | -0.14 [-0.26; -0.02] | 0.07 | 0.07 [-0.05; 0.19] | 0.22 | 0.22 [0.09; 0.33] |
| Career exploration | 0.01 | 0.01 [-0.1; 0.14] | -0.03 | -0.06 [-0.18; 0.07] | -0.04 | -0.07 [-0.19; 0.05] |
| Career decidedness | -0.08 | -0.10 [-0.22; 0.02] | -0.01 | -0.01 [-0.13; 0.11] | 0.07 | 0.08 [-0,03; 0.21] |
| Realistic | -0.25 | -0.09 [-0.21; 0.02] | 0.53 | 0.22 [0.1; 0.34] | 0.78 | 0.30 [0.18; 0.42] |
| Investigative | -0.29 | -0.12 [-0.24; -0.01] | 0.02 | 0.01 [-0.08; 0.09] | 0.31 | 0.13 [0.05; 0.22] |
| Artistic | -0.02 | -0.01 [-0.13; 0.11] | -0.18 | -0.07 [-0.15; 0.02] | -0.16 | -0.06 [-0.14; 0.02] |
| Social | 0.17 | 0.07 [-0.05; 0.19] | -0.05 | -0.02 [-0.14; 0.1] | -0.22 | -0.09 [-0.21; 0.03] |
| Enterprising | 0.24 | 0.11 [-0.01; 0.22] | 0.19 | 0.09 [-0.03; 0.21] | -0.04 | -0.02 [-0.14; 0.1] |
| Conventional | 0.30 | 0.13 [0.02; 0.25] | 0.11 | 0.05 [-0.07; 0.17] | -0.19 | -0.08 [-0.2; 0.04] |
| STEM career aspirations | -0.07 | -0.13 [-0.27; -0.01] | 0.00 | 0.01 [-0.13; 0.15] | 0.07 | 0.14 [0; 0.28] |

*Note*. Δ*M* = raw mean difference, *d* = effect size; CI = 95% confidence interval.

Table S6

*Intervention Effects on Importance of Math and Physics, Career Exploration, and Career Decidedness at Posttest and Follow-Up*

| | Posttest | | | | | | | | | | | | Follow-up | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Importance of math | | | Importance of physics | | | Career exploration | | | Career decidedness | | | Importance of math | | | Career exploration | | |
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.48 | .03 | <.001 | 0.54 | .02 | <.001 | 0.54 | .03 | <.001 | 0.75 | .02 | <.001 | 0.46 | .03 | <.001 | 0.44 | .03 | <.001 |
| Gender | -0.15 | .06 | .006 | -0.25 | .05 | <.001 | 0.10 | .05 | .036 | -0.04 | .04 | .302 | -0.04 | .05 | .401 | 0.20 | .05 | <.001 |
| Math grade | -0.01 | .03 | .735 | -0.01 | .03 | .671 | -0.02 | .03 | .471 | 0.08 | .02 | .001 | 0.03 | .03 | .386 | 0.04 | .03 | .209 |
| Intrinsic value | 0.13 | .04 | <.001 | 0.04 | .04 | .271 | 0.07 | .03 | .054 | -0.03 | .03 | .255 | 0.10 | .04 | .005 | 0.09 | .04 | .010 |
| Cost | -0.03 | .03 | .376 | -0.01 | .04 | .782 | 0.02 | .04 | .517 | 0.03 | .03 | .242 | -0.05 | .04 | .220 | 0.10 | .04 | .014 |
| Self-concept | -0.05 | .05 | .304 | -0.03 | .05 | .475 | 0.00 | .05 | .952 | 0.08 | .04 | .054 | -0.01 | .05 | .916 | 0.02 | .06 | .750 |
| Self-efficacy | 0.09 | .03 | .008 | 0.09 | .04 | .018 | -0.03 | .04 | .491 | 0.03 | .03 | .394 | 0.08 | .04 | .037 | 0.03 | .04 | .503 |
| Effort | 0.04 | .03 | .139 | 0.07 | .02 | .002 | 0.03 | .03 | .346 | 0.00 | .02 | .964 | -0.01 | .02 | .817 | 0.08 | .03 | .002 |
| Speed test | 0.01 | .03 | .738 | -0.01 | .02 | .839 | -0.04 | .02 | .110 | 0.03 | .02 | .231 | 0.02 | .03 | .510 | -0.03 | .03 | .361 |
| *Class level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.46 | .11 | <.001 | 0.59 | .09 | <.001 | 0.53 | .10 | <.001 | 0.75 | .09 | <.001 | 0.60 | .10 | <.001 | 0.33 | .15 | .024 |
| Gender | -0.13 | .18 | .461 | -0.21 | .17 | .205 | -0.03 | .14 | .810 | -0.19 | .12 | .115 | -0.15 | .16 | .336 | 0.20 | .21 | .355 |
| Math grade | -0.09 | .09 | .332 | -0.02 | .08 | .845 | 0.13 | .09 | .129 | -0.05 | .06 | .475 | -0.04 | .08 | .655 | 0.01 | .13 | .972 |
| Intrinsic value | -0.03 | .14 | .814 | -0.11 | .14 | .420 | 0.24 | .13 | .064 | 0.05 | .11 | .642 | -0.06 | .13 | .619 | -0.01 | .18 | .971 |
| Cost | -0.18 | .18 | .298 | -0.17 | .14 | .244 | -0.15 | .16 | .344 | 0.01 | .10 | .935 | 0.07 | .17 | .679 | 0.02 | .22 | .946 |
| Self-concept | -0.13 | .25 | .597 | 0.05 | .21 | .826 | -0.18 | .22 | .401 | -0.23 | .18 | .196 | 0.45 | .20 | .024 | -0.10 | .26 | .697 |
| Self-efficacy | 0.02 | .18 | .896 | -0.18 | .15 | .239 | -0.11 | .16 | .477 | 0.05 | .15 | .729 | -0.22 | .13 | .096 | -0.03 | .23 | .892 |
| Effort | -0.05 | .13 | .722 | 0.09 | .11 | .432 | 0.06 | .09 | .512 | 0.08 | .10 | .415 | -0.04 | .12 | .763 | 0.02 | .14 | .885 |
| Speed test | -0.03 | .09 | .744 | 0.02 | .07 | .745 | -0.04 | .06 | .467 | -0.03 | .05 | .528 | -0.13 | .10 | .163 | -0.04 | .10 | .693 |
| Teacher | 0.10 | .08 | .193 | 0.14 | .06 | .018 | 0.04 | .05 | .385 | -0.06 | .05 | .182 | 0.11 | .07 | .149 | 0.06 | .08 | .463 |
| Master's student | 0.12 | .06 | .050 | 0.17 | .05 | <.001 | 0.05 | .05 | .353 | -0.03 | .05 | .472 | 0.10 | .06 | .112 | -0.03 | .07 | .645 |

Table S7

*Intervention Effects on Vocational Interests at Posttest*

| | Realistic | | | Investigative | | | Artistic | | | Social | | | Enterprising | | | Conventional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.62 | .02 | <.001 | 0.51 | .02 | <.001 | 0.63 | .02 | <.001 | 0.59 | .02 | <.001 | 0.57 | .03 | <.001 | 0.49 | .02 | <.001 |
| Gender | -0.32 | .05 | <.001 | -0.20 | .05 | <.001 | 0.24 | .05 | <.001 | 0.31 | .04 | <.001 | 0.07 | .04 | .125 | 0.04 | .05 | .484 |
| Math grade | 0.01 | .03 | .793 | -0.04 | .03 | .196 | -0.01 | .03 | .802 | -0.01 | .03 | .840 | -0.03 | .03 | .236 | 0.01 | .03 | .644 |
| Intrinsic value | 0.01 | .03 | .622 | 0.07 | .03 | .035 | -0.01 | .03 | .842 | 0.01 | .03 | .866 | -0.05 | .03 | .083 | -0.05 | .04 | .203 |
| Cost | -0.03 | .03 | .332 | -0.05 | .03 | .090 | -0.02 | .03 | .392 | 0.04 | .03 | .223 | -0.02 | .03 | .648 | -0.02 | .04 | .533 |
| Self-concept | 0.04 | .04 | .367 | -0.04 | .04 | .329 | -0.06 | .04 | .144 | -0.04 | .04 | .375 | 0.01 | .05 | .995 | 0.09 | .05 | .051 |
| Self-efficacy | 0.02 | .03 | .465 | 0.06 | .04 | .113 | 0.04 | .03 | .222 | 0.01 | .03 | .764 | 0.04 | .04 | .302 | -0.02 | .04 | .675 |
| Effort | -0.02 | .02 | .396 | -0.01 | .03 | .803 | 0.00 | .02 | .977 | 0.02 | .02 | .353 | 0.04 | .03 | .090 | 0.03 | .03 | .374 |
| Speed test | -0.02 | .02 | .495 | -0.01 | .03 | .708 | -0.02 | .03 | .576 | -0.03 | .02 | .222 | 0.00 | .03 | .970 | 0.06 | .03 | .012 |
| *Class level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.85 | .09 | <.001 | 0.69 | .09 | <.001 | 0.79 | .09 | <.001 | 0.71 | .08 | <.001 | 0.47 | .13 | <.001 | 0.61 | .12 | <.001 |
| Gender | -0.44 | .15 | .003 | -0.17 | .11 | .139 | 0.10 | .18 | .566 | 0.21 | .15 | .157 | -0.38 | .11 | .001 | -0.28 | .14 | .044 |
| Math grade | -0.04 | .08 | .620 | -0.04 | .07 | .527 | -0.14 | .07 | .033 | 0.05 | .07 | .473 | 0.01 | .07 | .900 | -0.05 | .10 | .604 |
| Intrinsic value | 0.11 | .11 | .301 | 0.10 | .12 | .389 | 0.11 | .12 | .365 | 0.00 | .10 | .982 | -0.11 | .10 | .264 | 0.05 | .15 | .748 |
| Cost | 0.12 | .16 | .440 | -0.06 | .12 | .612 | 0.22 | .11 | .047 | 0.10 | .12 | .368 | 0.11 | .12 | .375 | -0.20 | .14 | .170 |
| Self-concept | 0.01 | .18 | .950 | -0.11 | .15 | .444 | -0.04 | .16 | .786 | 0.14 | .20 | .478 | -0.01 | .21 | .957 | 0.06 | .19 | .768 |
| Self-efficacy | -0.24 | .15 | .109 | -0.01 | .13 | .958 | 0.08 | .13 | .532 | 0.13 | .15 | .377 | 0.03 | .15 | .856 | -0.30 | .13 | .018 |
| Effort | 0.19 | .12 | .102 | -0.15 | .12 | .217 | -0.18 | .10 | .063 | -0.07 | .09 | .463 | 0.19 | .08 | .021 | -0.05 | .11 | .614 |
| Speed test | 0.22 | .06 | <.001 | 0.03 | .08 | .701 | -0.06 | .06 | .357 | -0.14 | .06 | .028 | -0.08 | .05 | .132 | -0.11 | .07 | .125 |
| Teacher | -0.18 | .06 | .004 | 0.06 | .05 | .248 | -0.02 | .05 | .667 | 0.09 | .06 | .146 | -0.06 | .05 | .240 | 0.02 | .06 | .808 |
| Master's student | -0.09 | .05 | .089 | 0.01 | .05 | .904 | -0.06 | .04 | .151 | 0.02 | .06 | .687 | -0.11 | .04 | .008 | -0.03 | .06 | .660 |

Table S8

*Intervention Effects on Vocational Interests at Follow-Up*

| | Realistic | | | Investigative | | | Artistic | | | Social | | | Enterprising | | | Conventional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.61 | .02 | <.001 | 0.52 | .02 | <.001 | 0.61 | .02 | <.001 | 0.58 | .02 | <.001 | 0.49 | .03 | <.001 | 0.46 | .03 | <.001 |
| Gender | -0.32 | .05 | <.001 | -0.12 | .04 | .008 | 0.33 | .05 | <.001 | 0.29 | .05 | <.001 | 0.06 | .05 | .165 | 0.05 | .06 | .417 |
| Math grade | -0.02 | .03 | .577 | -0.02 | .04 | .500 | 0.01 | .02 | .802 | -0.02 | .03 | .583 | 0.04 | .03 | .293 | -0.01 | .03 | .830 |
| Intrinsic value | 0.06 | .03 | .028 | 0.11 | .03 | <.001 | -0.02 | .03 | .592 | 0.03 | .03 | .309 | -0.09 | .04 | .015 | -0.01 | .04 | .732 |
| Cost | -0.05 | .03 | .112 | -0.03 | .03 | .321 | -0.05 | .03 | .085 | 0.02 | .03 | .465 | 0.00 | .03 | .967 | 0.01 | .03 | .994 |
| Self-concept | 0.05 | .04 | .260 | -0.08 | .04 | .061 | -0.11 | .05 | .017 | -0.09 | .05 | .061 | 0.05 | .05 | .330 | 0.02 | .05 | .663 |
| Self-efficacy | -0.02 | .03 | .580 | 0.09 | .04 | .014 | 0.06 | .03 | .049 | 0.00 | .04 | .973 | 0.01 | .04 | .837 | 0.02 | .04 | .568 |
| Effort | 0.01 | .02 | .506 | 0.03 | .03 | .227 | 0.01 | .03 | .798 | 0.00 | .03 | .960 | 0.10 | .03 | <.001 | 0.11 | .03 | .001 |
| Speed test | -0.04 | .03 | .169 | -0.02 | .03 | .443 | -0.01 | .02 | .563 | -0.01 | .03 | .760 | 0.03 | .03 | .411 | 0.01 | .03 | .854 |
| *Class level* | | | | | | | | | | | | | | | | | | |
| Pretest | 0.79 | .07 | <.001 | 0.52 | .09 | <.001 | 0.62 | .10 | <.001 | 0.50 | .08 | <.001 | 0.64 | .14 | <.001 | 0.51 | .13 | <.001 |
| Gender | -0.30 | .14 | .036 | 0.05 | .14 | .722 | 0.35 | .19 | .069 | 0.26 | .14 | .062 | -0.32 | .13 | .015 | -0.54 | .14 | <.001 |
| Math grade | -0.06 | .07 | .429 | -0.06 | .07 | .363 | -0.12 | .08 | .102 | -0.09 | .08 | .232 | -0.06 | .07 | .448 | -0.14 | .08 | .060 |
| Intrinsic value | 0.03 | .11 | .824 | 0.23 | .14 | .091 | -0.04 | .14 | .757 | 0.11 | .12 | .336 | 0.13 | .15 | .392 | 0.26 | .13 | .043 |
| Cost | 0.00 | .15 | .982 | 0.22 | .14 | .109 | 0.18 | .13 | .170 | 0.08 | .15 | .591 | 0.23 | .14 | .101 | 0.43 | .15 | .004 |
| Self-concept | -0.03 | .17 | .883 | -0.14 | .17 | .417 | 0.04 | .21 | .863 | 0.26 | .20 | .189 | 0.02 | .20 | .941 | 0.06 | .20 | .782 |
| Self-efficacy | -0.14 | .15 | .353 | 0.16 | .14 | .230 | 0.05 | .17 | .747 | -0.25 | .13 | .060 | -0.16 | .17 | .342 | -0.14 | .15 | .355 |
| Effort | 0.05 | .11 | .610 | -0.27 | .11 | .012 | -0.01 | .11 | .965 | -0.01 | .12 | .930 | 0.05 | .10 | .636 | 0.18 | .12 | .140 |
| Speed test | 0.08 | .06 | .184 | 0.01 | .08 | .888 | 0.03 | .08 | .725 | -0.12 | .08 | .099 | 0.01 | .08 | .893 | 0.00 | .07 | .963 |
| Teacher | -0.05 | .06 | .371 | 0.15 | .06 | .007 | 0.05 | .06 | .402 | 0.06 | .05 | .222 | -0.07 | .06 | .264 | -0.08 | .05 | .122 |
| Master's student | -0.04 | .05 | .386 | 0.12 | .06 | .033 | 0.02 | .05 | .748 | -0.02 | .05 | .685 | -0.09 | .05 | .077 | -0.08 | .05 | .138 |

Table S9

*Intervention Effects on STEM Career Aspirations at Posttest and Follow-Up*

| | STEM career aspirations | | | | | |
|---|---|---|---|---|---|---|
| | Posttest | | | Follow-up | | |
| | β | SE | *p* | β | SE | *p* |
| *Student level* | | | | | | |
| Pretest | 3.72 | .22 | <.001 | 3.42 | .21 | <.001 |
| Gender | -0.38 | .23 | .094 | -0.35 | .20 | .084 |
| Math grade | -0.04 | .13 | .735 | 0.15 | .12 | .213 |
| Intrinsic value | 0.11 | .15 | .470 | 0.19 | .14 | .186 |
| Cost | -0.12 | .16 | .465 | -0.14 | .14 | .310 |
| Self-concept | 0.04 | .20 | .840 | 0.00 | .18 | .993 |
| Self-efficacy | 0.14 | .18 | .438 | 0.14 | .16 | .362 |
| Effort | 0.11 | .11 | .285 | -0.05 | .10 | .637 |
| Speed test | -0.07 | .13 | .572 | 0.11 | .11 | .317 |
| *Class level* | | | | | | |
| Pretest | 4.41 | .87 | <.001 | 3.86 | .85 | <.001 |
| Gender | 0.17 | .69 | .804 | 0.67 | .60 | .265 |
| Math grade | 0.28 | .36 | .429 | 0.28 | .40 | .483 |
| Intrinsic value | 0.22 | .56 | .698 | 0.15 | .65 | .818 |
| Cost | 0.35 | .62 | .576 | 0.08 | .68 | .905 |
| Self-concept | -0.35 | .92 | .700 | 0.79 | 1.03 | .443 |
| Self-efficacy | 0.44 | .63 | .492 | -0.22 | .67 | .748 |
| Effort | 0.52 | .55 | .347 | -0.11 | .55 | .845 |
| Speed test | 0.24 | .33 | .474 | 0.33 | .36 | .365 |
| Teacher | -0.19 | .31 | .543 | -0.01 | .28 | .973 |
| Master’s student | -0.03 | .28 | .905 | -0.26 | .34 | .446 |

*Note*. STEM career aspirations are coded as 1 = STEM and 0 = non-STEM.

# 5 General Discussion

The choice of a career is an important challenge for adolescents and can have a crucial influence on their lives (Dietrich, Parker, & Salmela-Aro, 2012). However, many adolescents have difficulty deciding between different career options and are not sure about their own interests and abilities (Heine, Willich, & Schneider, 2010; Oechsle, 2009). Supporting adolescents' selection of a career is therefore an important task for socializers. The present dissertation investigated how adolescents can be supported in their career choices through relevance interventions. However, before intervening in students' career-related behaviors and beliefs, it is important to know more about the development of these beliefs. Therefore, it was first examined how vocational interests and subject interests, as important antecedents of career choices, develop during adolescence. To address these questions, three empirical studies were conducted within this dissertation. Study 1 took a closer look at interests as important precursors of career decisions by examining their development and differentiation, because differentiated interests facilitate the successful choice of a career. Study 2 investigated how a parent-based relevance intervention can support students and parents in the career orientation process. Study 3 tested the potential of a classroom-based relevance intervention in math to support students in choosing a career. In the following section, the results of the three studies will be summarized and presented in a broader research context. Special emphasis is put on the intraindividual pattern of motivational beliefs and the specific characteristics of the two relevance interventions with respect to supporting students in choosing a career. Afterwards, the strengths and limitations of this dissertation will be discussed. In the last two sections, implications of the findings for future research and educational practice will be explored.

## 5.1 Discussion of General Findings

### 5.1.1 Summary of central findings

The empirical studies that constitute this dissertation focused on adolescents' career-related behavior and choices, with an emphasis on precursors of such decisions and means of supporting adolescents. Study 1 investigated the development of vocational and subject interests during early adolescence by looking at the structural development and differentiation of these two constructs separately and at the development of their interrelations. The results revealed that a differentiation of vocational interests took place during the period from fifth to eighth grade, as seen in the more differentiated patterns of associations among the RIASEC interests as well as their better fit with the theoretically proposed circular structure in higher grades. In contrast, subject interests showed hardly any changes with respect to their structural development over time. Dimensions of vocational and subject interests that referred to related activities and content partially exhibited strong associations that increased over time, also pointing towards a differentiation of interests. However, some of the associations went against the expectations.

Study 2 was designed to examine a parent-based relevance intervention's potential to support parents and students in the career orientation process. The intervention's effects on parents' motivational beliefs and career support as well as students' motivational beliefs and career orientation behavior were evaluated. The intervention, which took place via a website, aimed to help parents support their children in the career orientation process. The findings showed negative intervention effects on parental career support and the perceived importance of this support. The intervention had no effects on other parental outcomes or on students' beliefs and behaviors.

In Study 3, the effects of another relevance intervention on students' career-related outcomes were tested. This intervention focused on the relevance of math for students' future lives and careers, with a specific emphasis on STEM careers. It was implemented in math classrooms and was evaluated with respect to its potential to support students in their career decision-making process. During the intervention, students learned about the usefulness of math for their future lives and drew personal connections between the intervention material and their own future careers. The results showed that the intervention was able to foster students' perceptions of the importance of math and physics for the career to which they aspired. Moreover, the intervention had mixed effects on vocational interests, whereas it did not affect students' career orientation or STEM career aspirations.

Taken together, the results of the three studies provide insights into adolescents' career decision processes and the precursors of these decisions. They reveal associations between students' motivational beliefs in different domains, which are important for their career choices. Moreover, they provide hints as to how adolescents can be supported in choosing a career through relevance interventions—as well as the limitations of such interventions. In the following sections, the three empirical studies will be further discussed in the light of these two aspects, that is, students' intraindividual patterns of motivational beliefs, and the potential of relevance interventions to support adolescents' career choices.

### 5.1.2 The development of adolescents' intraindividual patterns of motivational beliefs

Expectancy-value theory states that adolescents make their career-related choices on the basis of intraindividual hierarchies of expectancies and values (Eccles, 2005). That is, in a specific decision, such as choosing a course, beliefs about different subjects come into play that increase or decrease the student's probability of taking the course. Previous research taking into account motivational beliefs about two or more subjects has found positive effects of beliefs in one domain on outcomes (e.g., university major choices) in that domain, and negative effects of these beliefs on outcomes in other, nonmatching domains (e.g., Gaspard, Wille, Wormington, & Hulleman, 2019; Nagy, Trautwein, Baumert, Köller, & Garrett, 2006). It thus seems to be important to take motivational variables for multiple subjects into account. Study 1 focused on interests in three academic subjects (math, German, and English) and examined their interrelations over the course of four years in adolescence. That is, before examining the joint power of interests in several subjects to predict later career-related decisions, this study concentrated on trends in the interplay between these interest dimensions. Moreover, subject interests were combined with another important interest construct, namely vocational interests according to Holland (1997), which is defined as a multidimensional construct with six interest dimensions. Thus, Study 1 included multiple interest dimensions as well as constructs from different research traditions, and thus offered a comprehensive view of individual interests in adolescence. More specifically, the study focused on the development of these interests over time and investigated structural changes both within and between constructs. The expected differentiation of interests over time could partially be verified. Whereas vocational interests exhibited a more differentiated pattern in higher grades, and most dimensions were related to the others in the ways assumed by the circular model, subject interests changed only slightly. In addition, the associations between vocational interests and math interests changed more differentially than those with verbal subject interests. Moreover, the greatest changes occurred between seventh and eighth grade, in line with previous research (e.g., Darcy & Tracey, 2007). As this study was the first to jointly investigate vocational and subject interests, it provides initial insights into adolescents' intraindividual interest patterns with respect to these two constructs. It emphasizes the need to assess motivational beliefs such as interests in several subjects in order to gain a complete picture of their interactions. More evidence on how different interest dimensions relate to each other and how their relations change over time might add to our overall understanding of interest formation in adolescence.

Study 3 examined another aspect of intraindividual relations between motivational beliefs in several subjects. Here, it was tested whether a math relevance intervention could also promote beliefs in physics as a related subject. The results showed that the intervention had positive effects on the importance of physics for students' career aspirations. On the continuum of academic subjects from math to verbal subjects (Marsh & Shavelson, 1985), math and physics are both located on the math end of the continuum, which implies that their content is related. Thus, these results suggest that students perceive math and physics as related subjects and transfer relevance arguments from one to the other. They seem to particularly overlap with regard to specific careers in the STEM field. Evidence on the effects of relevance interventions on subjects other than the target subject is scarce. Analyses of data from the MoMa 1 study revealed negative effects of the math relevance intervention on students' value beliefs in German, which means that the intervention had unintended side effects on an opposite subject (Gaspard et al., 2016). Complementing these results, Study 3 showed that the math relevance intervention also had positive side effects, pointing out to the possibility to foster motivational beliefs for STEM subjects in general.

### 5.1.3 Supporting adolescents' career choices with relevance interventions

One major component of this dissertation was to investigate the potential of relevance interventions to support adolescents in making career-related choices. The rationale behind this concern was twofold. On the one hand, relevance interventions, especially in math and science subjects, are often implemented with the long-term goal of enhancing students' course and career choices in the STEM field or keeping them in their STEM courses and university programs (Harackiewicz, Tibbetts, Canning, & Hyde, 2014). Corresponding results have been found before, such as positive effects of relevance interventions on students' course choices or career pursuit (Canning et al., 2018; Harackiewicz, Rozek, Hulleman, & Hyde, 2012). On the other hand, most relevance interventions contain a clear focus on career-related topics, meaning that students deal with questions directly related to their own career orientation during the intervention (e.g., Gaspard et al., 2015). Therefore, a promotion of specific career-related choices with regard to content (e.g., a higher chance of aspiring to a STEM career after the math relevance intervention) as well as an overall fostering of students' overall career orientation (e.g., higher career exploration) was expected. Studies 2 and 3 revealed a mixed pattern of results for a broad set of students' beliefs and behaviors. Whereas the math relevance intervention successfully promoted some outcomes, such as the perceived importance of math and physics for career aspirations and students' investigative interests, there were no intervention effects for other outcomes, such as career orientation behavior or STEM career aspirations. Parental career support as well as students' realistic and enterprising interests even decreased after the interventions.

Previous research has shown that many adolescents perceive their career choice as complex and experience difficulties during this process, at least partially resulting from the large number of career possibilities and students' lack of certainty about their own preferences and skills (Heine et al., 2010; Oechsle, 2009; Praskova, Creed, & Hood, 2015). In addition, the career decision process usually spans a period of several years and is not always straightforward: Adolescents often have certain careers in mind, but modify their ideas in light of the new information they receive about different careers or as a result of their interests, which might change over time. Moreover, they might gain practical experience, for instance through an internship, that either strengthens their career aspiration or leads them towards other career possibilities. The opinions of significant others, such as parents or friends, as well as external influences, such as labor market conditions for one's favored career, can also affect adolescents' career decisions. All of these factors, and perhaps many more, combine to form a complex arrangement that affects adolescents' career choices. Against this background, it does not seem surprising that the effects of the relevance interventions tested in Studies 2 and 3 were limited, given the short duration of the interventions and the fact that they had only a single opportunity to influence the complex career decision process. However, in Study 3, the positive intervention effects on motivational beliefs in math and physics as well as on investigative interests indicated that connecting the course content to students' later careers had a beneficial effect on their attitudes regarding corresponding subjects and activities.

As outlined above, the career decision process comprises different aspects and steps, which are all small pieces contributing to the process as a whole. Theoretical approaches to the career decision-making process have proposed models with several steps or phases of career choices, ranging from becoming aware of the necessity to choose a career to generating a list of possible career options and making a final decision (e.g., Hirschi & Läge, 2007; for a review of different phases of career choices, see Dietrich et al., 2012). Depending on the phase of career decision-making adolescents are in, they grapple with different questions and engage in different activities. Thus, they might also differ in their need for support during the different phases of the career decision process. The interventions implemented in Studies 2 and 3 addressed two different target groups who are likely to be at different points in their career decision process. Whereas the students in Study 2 were in the eighth grade in middle schools, and were thus approaching their final year of schooling, the students in Study 3 were in ninth grade at academic track schools, and thus still had three years until graduation. Previous research has found that students' ability to make an appropriate career choice increases in higher grades (Patton & Creed, 2001), which indicates that they usually intensify their career-related activities towards the end of school. Therefore, one could assume that the two groups of students targeted by the interventions differed in terms of their current career decision status. The middle school students were already quite engaged in choosing a career and probably had more or less specific ideas about their future careers, whereas the academic track students were not strongly engaged and had rather vague ideas about their future careers. Some support for this pattern was found in the analyses independent of the intervention: Both students and parents in Study 2 reported relatively high involvement in career decision-making, whereas a large number of students in Study 3 gave unspecific answers about their career aspirations. This pattern indicates that it is students who are closer to the transition from school to work who seem to be more mature in terms of their career choice, not students at higher ages. This emphasizes that proximity to the school-to-work transition—rather than age—should be used as a measurement indicator when comparing the career decision-making status of different groups of students. However, these results refer to average tendencies in students' behavior. There are likely to be large differences within samples or even within single classes, with some students already knowing quite well what they want to do for work and others only beginning to think about this question during the intervention. Despite these individual differences, it seems advisable to adapt interventions to address students' needs in their specific situations as much as possible.

The foci of the two interventions slightly differed in accordance with the different stages of career decision-making the students were assumed to be in. The intervention in Study 2 was explicitly designed to support parents and students in making a career choice and presented detailed information on a broad variety of careers. Thus, it aimed to directly initiate students' and parents' active engagement in career orientation behavior, such as career exploration, to help them prepare for the school-to-work transition in the near future. In addition, the intervention focused on the usefulness of different subjects and of school in general to provide opportunities for students to connect to a broad range of subjects and careers. Despite this career focus, the intervention did not have the desired effects on students. As discussed in the manuscript, this could be due to the students' low level of active participation, which was due to the fact that the intervention took place at home.

In contrast, the intervention in Study 3 was implemented in the classroom, and thus provided greater control with regard to the exact implementation. Research on implementation quality of interventions has found that students' actual amount of involvement and responsiveness to an intervention is central to its effectiveness (e.g., Hulleman & Cordray, 2009; Nagengast et al., 2018). Thus, given that most students who participated in the intervention completed the provided tasks, their active involvement was probably higher than in the parent intervention, which could have contributed to the positive effects. However, the intervention was not able to foster students' overall career orientation behavior, as students were not explicitly asked to engage in such activities.

## 5.2 Strengths and limitations

When interpreting the findings of the studies conducted as part of the present dissertation, some strengths and limitations should be acknowledged. First, all three studies employed strong research designs and methods to answer their respective research questions. In Studies 2 and 3, randomized controlled trials were conducted, which are seen as the gold standard in evaluation research due to the causal inferences that can be drawn from their results (Shadish, Cook, & Campbell, 2002; Torgerson, Torgerson, & Taylor, 2015). The studies included pre- and posttest measures as well as a follow-up (Study 3) and used waitlist control conditions as comparison groups. Thus, causal inferences could be drawn from the intervention to the effects that were found. In Study 1, a longitudinal data set was used, which provided the chance to examine the development of students' interests over the course of four years. Moreover, all three studies used appropriate state-of-the-art statistical methods. Circular unidimensional scaling, which was applied in Study 1, is a relatively new method that has not often been used to examine the structure of interests, and has never been used for subject interests. In Study 2, complier average causal effect analyses were conducted, which was a helpful approach for obtaining deeper insights into the implementation of the intervention and the effects of students' and parents' responsiveness. In Study 3, multilevel modeling was applied to account for the clustering of students within classes (Raudenbush & Bryk, 2002), while a model-based correction of standard errors was used for this purpose in Studies 1 and 2 (McNeish, Stapleton, & Silverman, 2017). Appropriate methods for handling missing data, namely full information maximum likelihood estimation (Studies 1 and 2) and multiple imputation (Study 3), were applied (Rubin, 1987; Schafer & Graham, 2002).

Second, the studies were based on large samples stemming from different school tracks and grades. They spanned the phase of early to middle adolescence, including students from Grade 5 to Grade 9. This phase of adolescence has been shown to be crucial for the development of motivational beliefs in general and of interests in particular (e.g., Wigfield & Cambria, 2010), which is why the results of Study 1 contributed to interest research from a developmental perspective. Moreover, adolescence is an important period for career-related decisions, as students usually engage in career orientation behavior and specify their career aspirations during this phase (e.g., Dietrich et al., 2012). Thus, the studies' samples were appropriate for addressing this dissertation's research questions. Nevertheless, students in later adolescence or young adults beginning to enter the job market were not included in the samples. As choosing a career is usually a process that takes place over a longer period, the further development of students' interests in the years after Grade 8 (in Study 1) or their long-term attitudes and career-related behaviors after the interventions (in Study 2 and 3) would have been interesting as well. In particular, examining adolescents' further engagement in career decision behavior or interests as they approach the school-to-work transition could provide fruitful insights into their career-related development. Moreover, the three studies covered the full range of the German secondary school system in terms of school tracks, with one sample of low and middle track schools (Study 1), one sample of middle track schools (Study 2), and one sample of academic track schools (Study 3). These groups of students usually differ in terms of their social and educational backgrounds as well as their academic outcomes (Trautwein, Neumann, Nagy, Lüdtke, & Maaz, 2010). Additionally, with respect to the topic of this dissertation, they have to make career decisions at different ages. Therefore, the three studies made it possible to provide a more complete picture of adolescents' career choices. However, it must be noted that the samples came from only two German federal states. Hence, the results cannot be generalized to all states or to other countries. In addition, the groups from the different school tracks could not be directly compared, as they were not examined in the same study.

Third, different perspectives were used to assess students' beliefs and behaviors. Whereas Studies 1 and 3 considered students' perspectives only, Study 2 benefitted from the additional inclusion of parents' perspectives on their children's career orientation. However, all three studies exclusively relied on data from self-report measures. No other sources, such as observational or behavioral data, could be used. Observations require significant time and financial resources, making them difficult to apply in large samples. Specifically with respect to students' career choices, the actual university majors, apprenticeships or jobs they choose would have been valuable outcomes to connect to the interventions. The careers students aspire to are frequently used as a proxy for their later career choices (e.g., Chow & Salmela-Aro, 2011), but it is unclear whether adolescents' intentions actually translate into their choices and career pathways. Thus, following students over the course of the next few years and assessing their later career choices following the transition from school to work would have provided insights into their career pathways and the longitudinal effects of relevance interventions.

Fourth, the intervention studies in this dissertation exhibited high external validity, as the interventions were implemented in the classroom or at home. In contrast to interventions conducted in the laboratory, they took place in settings relevant to the students' everyday lives, in that they experienced a lesson in their normal classroom or searched for information on a website and discussed it with their parents. Thus, the interventions were tested under real-life conditions. However, the problem with such field interventions is that they usually result in a less standardized and less controlled implementation (Hulleman & Cordray, 2009), and that it is difficult to disentangle the mechanisms leading to the observed effects. This was especially the case for the parent intervention, as the study did not provide any insight into what exactly happened at students' homes and how they worked with the intervention material.

## 5.3 Implications for future research

The results of the studies making up this dissertation have several implications for future research. The following sections focus on the role of intraindividual patterns in students' motivational beliefs and the role of relevance interventions in supporting students' career-related outcomes. Open questions that should be addressed in future studies will be discussed with respect to the design and the evaluation of relevance interventions.

### 5.3.1 Investigation of intraindividual interest patterns

Students' motivational beliefs in one subject depend on their beliefs in other subjects (Eccles, 2005), which is why researchers should take into account intraindividual patterns of motivational beliefs when examining students' motivation. Moreover, these intraindividual patterns have been shown to be important for predicting adolescents' educational and occupational choices. Studies investigating the predictive power of beliefs in two or more subjects for course or career choices have focused on self-concept and value beliefs (e.g., Chow, Eccles, & Salmela-Aro, 2012; Gaspard et al., 2019), and less on interests. The results of the present dissertation revealed that interests in different domains develop in ways that are internally dependent. That is, the associations between different vocational interests, in particular, change over time, which is also related to changes in their overall levels (Holland, 1997). The analyses in Study 1 concentrated on the development of interests over time without attempting to predict students' later career-related choices. Thus, future research should examine the impact of students' intraindividual interest patterns for their course and career choices. Particular emphasis should be placed on interests in multiple dimensions, such as different school subjects or vocational interests as a multidimensional concept, in order to acknowledge their interrelations and joint predictive power. This dissertation concentrated on interests in math, German, and English, which are the main subjects in German secondary schools, but future research should also consider interests in other subjects.

The results of Study 1 indicated that students' interests become more differentiated during early adolescence, and that this pattern is stronger for vocational than for subject interests. As these results are based on a sample limited to low and middle track students from Germany, they should be replicated in future research, for example with samples of students from other school types or other countries. Moreover, Holland (1997) postulated that a differentiated pattern of interests would be helpful in successfully choosing a career, as it facilitates the decision in favor of a specific career or field of study. Thus, helping adolescents to differentiate their interests and become aware of their preferences and aversions regarding vocational activities might be one way of supporting them in their career decision-making. For instance, future research could investigate whether higher interest differentiation leads to a higher degree of decidedness regarding career choice. If this is indeed the case, intervention approaches might focus on fostering students' interest differentiation prior to their transition from school to work. Although vocational interests are relatively stable and their stability increases with age (Low, Yoon, Roberts, & Rounds, 2005), the results of Study 3 suggest that they can be changed through interventions. Therefore, interventions targeting students' interests should probably be implemented no later than in early adolescence.

### 5.3.2 Investigation of the effects of relevance interventions on behavioral career outcomes

The empirical studies of this dissertation have shown that relevance interventions can affect students' career-related outcomes, at least to some extent. However, all outcomes were measured in the short term and through self-reports only. Therefore, more research is warranted examining the long-term effects of relevance interventions and using behavioral measures. First empirical studies have shown that such interventions can have effects on students' later course choices or persistence in their university majors (Harackiewicz et al., 2012; Hecht et al., 2019). Unlike in this dissertation, these other studies investigated samples of students in higher high school grades who were closer to the transition to university, or even college students who had already chosen their field of study. Thus, it would be informative to assess long-term outcomes, such as university major or apprenticeship choices, among younger students to see whether the relevance arguments informed their later decisions. It is possible that the information the students received during the intervention was not relevant to them at that specific time because they were not yet engaged in their career decision-making. However, this could change at a later time point when their career choices become more important and urgent. This increased importance could lead students to reflect upon the relevance arguments or actively engage in career orientation behavior, possibly resulting in delayed intervention effects.

In addition, students' self-report measures might be biased due to social desirability or imprecise self-estimation. Moreover, the variables referring to career-related choices were mostly speculative, as they focused on the career students may choose later. Therefore, behavioral measures concerning later actual choices or evaluations by external persons, such as teachers or parents, could provide further valuable insights into the effects of the relevance interventions on students' behavior. Similarly, the parents, whose attitudes and behaviors regarding the career support they provide to their children were measured with self-reports only, could have provided biased answers because of social desirability. Thus, observing parent-child interactions and communication about career-related topics would be a way to gain additional insights into the role parents play in their children's career choices. However, such observations require significant resources and could be ethically problematic.

### 5.3.3 Investigation of different intervention components and different target groups

The interventions evaluated in this dissertation had some positive effects, but also a large share of nonsignificant effects and even a few negative effects, which were not intended. Still, researchers can learn from such results, as they can be important for gaining insights into what works and what does not, which might be helpful in terms of providing ideas on how to proceed. In this sense, one could raise the question of why these zero or unintended effects appeared and how to deal with these problems in future studies. As the former issue has already been discussed in the manuscripts, the latter will be focused on here. Future research should examine at least two aspects with respect to the effects of relevance interventions on career-related outcomes. First, it should take a closer look at different groups of students and their pre-intervention characteristics. Some students are likely to have benefitted more from the information they received in the intervention than others. For instance, students who already had an idea of their later career might presumably have been able to connect more easily to the examples they heard or read about in the intervention than students who had no clue about what to do after school. Consequently, these groups of students may have reacted differently to the intervention material, which might have led to differential effects. Thus, students' prior knowledge and attitudes should be included in the evaluation of intervention effects, for example by examining moderation variables. Previous studies have shown that relevance interventions were more beneficial for some students than for others (e.g., Hulleman & Harackiewicz, 2009; Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz, 2015), and analyzing more moderating variables when evaluating the effects of relevance interventions has been recommended (Rosenzweig & Wigfield, 2016). Differences among students with respect to pre-intervention characteristics imply that their needs for support also differ depending on their current career decision-making status. This might be related to the time point of their transition from school to work, which differs for students in different school tracks. Thus, specific target groups of students might have a higher need for support regarding their career choices than others, and these could form the focus of future research.

Second, future studies should examine the intervention components and their unique effects on students' outcomes in more detail. Not much is currently known about the mechanisms at play during relevance interventions, and it is unclear which parts of the intervention must be included in order for it to work. This issue is also connected to students' different situations and specific needs with regard to choosing a career. For instance, reflecting on the usefulness of a subject for one's own career might be difficult if one has no career in mind, which suggests that some students might need support finding a suitable career first. Allowing students to choose among different intervention components on an as-needed basis might be helpful in order to adapt interventions to students' individual needs. There are first indications that instructional concepts in the area of personalized education are beneficial for promoting students' interests (Reber, Canning, & Harackiewicz, 2018). These concepts could thus be applied to relevance interventions. More research is needed to figure out which tasks and information a relevance intervention should include to best support students in making career-related choices.

## 5.4 Implications for policy and practice

As previously discussed, further research is needed to replicate and extend the findings of this dissertation. Nevertheless, several implications for educational policy and practice can be derived from the findings. Interventions that target students' motivational beliefs and career choices are of high relevance for educational practice, as students' beliefs are central to their achievement, effort, and career choices (Wigfield, Tonks, & Klauda, 2009), and career choices can in turn affect students' subsequent career pathways and future lives (Dietrich et al., 2012). The successful choice of a career is associated with higher well-being, whereas problems in finding the right career can result in dissatisfaction, long search periods, and even dropout from educational programs (Oechsle, 2009). Therefore, thoughtfully deciding upon a suitable career should be the aim of not only students, but also socializers such as teachers and parents as well as decision-makers in policy and society. The math relevance intervention evaluated in this dissertation exhibited some positive effects on students' beliefs and career-related outcomes. It was a short classroom-based intervention that could be relatively easily implemented during a normal class. Furthermore, the intervention seemed to be effective and feasible when implemented by regular teachers, and thus could be integrated into the regular curriculum. This has the advantage of enabling the intervention to be embedded within regular lessons that introduce the topic beforehand and maintain the focus on connections between course material and students' lives and careers afterwards. As some of the intervention effects occurred with a time delay, and career-related decisions often take time, it might be beneficial to have not just one intervention session, but to try to encourage students to engage in making a career choice over a longer period. Thus, the intervention could be conceptualized within the broader topic of career orientation, which is usually part of the regular curriculum and is particularly focused on in the last few years of schooling. However, it is also important to keep the unintended effects of the intervention in mind. Thus, the implementation described above should only be considered in the long run after several successful scaling-up studies. Before taking such a step, further testing of the intervention and its specific components would be necessary and related risks would need to be calculated carefully. In addition, teachers would need to receive training on how to implement the intervention and would need to be made aware of the importance of topics related to choosing a career.

The results of this dissertation indicated that a large proportion of students had only vague ideas about their future career. This corresponds with previous findings (Heine et al., 2010; Oechsle, 2009) and highlights the need to make students aware of the importance of thinking about their career choice. As this task is quite difficult, it can only be successfully accomplished with the combined work of several actors. Alongside schools, parents are important influencers of their children's career choices (e.g., Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001). The results of this dissertation show that parents' influence seems to depend on the way in which parents are supported in helping their children, which indicates that particular attention should be paid to the assistance parents receive in supporting their children's career choices. In addition, institutions such as counseling services are needed to support students with regard to their specific needs regarding their current career decision status. They should try to help adolescents explore their skills and interests and foster their interests in a comprehensive way. Special emphasis should be placed on the differentiation of interests, as this might help students determine their preferences and consequently identify careers that might be interesting for them in the future.

All in all, this dissertation contributed to our understanding of adolescents' career-related choices. It underscored the importance of promoting interests and motivation in adolescents, who are learning not only for school, but also for their future lives. Connecting course content to students' future careers helps them realize the usefulness of what they are learning for their lives and the importance of engaging in the process of choosing a career. Relevance interventions might be one promising approach to achieving this goal.

## References

Canning, E. A., Harackiewicz, J. M., Priniski, S., Hecht, C. A., Tibbetts, Y., & Hyde, J. S. (2018). Improving performance and retention in introductory biology with a utility-value intervention. *Journal of Educational Psychology*, *110*(6), 834–849. https://doi.org/10.1037/edu0000244

Chow, A., Eccles, J. S., & Salmela-Aro, K. (2012). Task value profiles across subjects and aspirations to physical and IT-related sciences in the United States and Finland. *Developmental Psychology*, *48*(6), 1612–1628. https://doi.org/10.1037/a0030194

Chow, A., & Salmela-Aro, K. (2011). Task-values across subject domains: A gender comparison using a person-centered approach. *International Journal of Behavioral Development*, *35*(3), 202–209. https://doi.org/10.1177/0165025411398184

Darcy, M. U. A., & Tracey, T. J. G. (2007). Circumplex structure of Holland's RIASEC interests across gender and time. *Journal of Counseling Psychology*, *54*(1), 17–31. https://doi.org/10.1037/0022-0167.54.1.17

Dietrich, J., Parker, P., & Salmela-Aro, K. (2012). Phase-adequate engagement at the post-school transition. *Developmental Psychology*, *48*(6), 1575–1593. https://doi.org/10.1037/a0030188

Eccles, J. S. (2005). Subjective task values and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York, NY: Guilford.

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. *Developmental Psychology*, *51*(9), 1226–1240. https://doi.org/10.1037/dev0000028

Gaspard, H., Dicke, A.-L., Flunger, B., Häfner, I., Brisson, B. M., Trautwein, U., & Nagengast, B. (2016). Side effects of motivational interventions? Effects of an intervention in math classrooms on motivation in verbal domains. *AERA Open*, *2*(2), 1–14. https://doi.org/10.1177/2332858416649168

Gaspard, H., Wille, E., Wormington, S. V., & Hulleman, C. S. (2019). How are upper secondary school students' expectancy-value profiles associated with achievement and university STEM major? A cross-domain comparison. *Contemporary Educational Psychology*, *58*, 149–162. https://doi.org/10.1016/j.cedpsych.2019.02.005

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, *23*(8), 899–906. https://doi.org/10.1177/0956797611435530

Harackiewicz, J. M., Tibbetts, Y., Canning, E. A., & Hyde, J. S. (2014). Harnessing values to promote motivation in education. In S. A. Karabenick & T. C. Urdan (Eds.), *Motivational Interventions - Advances in Motivation and Achievement (Vol. 18)* (pp. 71–105). Bingley, UK: Emerald Group Publishing Limited. https://doi.org/10.1108/S0749-742320140000018002

Hecht, C. A., Harackiewicz, J. M., Priniski, S. J., Canning, E. A., Tibbetts, Y., & Hyde, J. S. (2019). Promoting persistence in the biological and medical sciences: An expectancy-value approach to intervention. *Journal of Educational Psychology*. Advance online publication. https://doi.org/10.1037/edu0000356

Heine, C., Willich, J., & Schneider, H. (2010). *Informationsverhalten und Entscheidungsfindung bei der Studien- und Berufswahl. Studienberechtigte 2008 ein halbes Jahr vor dem Erwerb der Hochschulreife*. *[Information seeking and decision making regarding course and career choices. 2008's high school graduates half a year before graduation]*. HIS Forum Hochschule.

Hirschi, A., & Läge, D. (2007). The relation of secondary students' career-choice readiness to a six-phase model of career decision making. *Journal of Career Development*, *34*(2), 164–191. https://doi.org/10.1177/0894845307307473

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources. https://doi.org/10.1016/0022-4405(74)90056-9

Hulleman, C. S., & Cordray, D. S. (2009). Moving from the lab to the field: The role of fidelity and achieved relative intervention strength. *Journal of Research on Educational Effectiveness*, *2*(1), 88–110. https://doi.org/10.1080/19345740802539325

Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science*, *326*(5958), 1410–1412. https://doi.org/10.1126/science.1177067

Jodl, K. M., Michael, A., Malanchuk, O., Eccles, J. S., & Sameroff, A. (2001). Parents' roles in shaping early adolescents' occupational aspirations. *Child Development*, *72*(4), 1247–1265. https://doi.org/10.1111/1467-8624.00345

Low, K. S. D., Yoon, M., Roberts, B. W., & Rounds, J. (2005). The stability of vocational interests from early adolescence to middle adulthood: A quantitative review of longitudinal studies. *Psychological Bulletin*, *131*(5), 713–737. https://doi.org/10.1037/0033-2909.131.5.713

Marsh, H. W., & Shavelson, R. (1985). Self-concept: Its multifaceted, hierarchical structure. *Educational Psychologist*, *20*(3), 107–123.

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods*, *22*(1), 114–140. https://doi.org/10.1037/met0000078

Nagengast, B., Brisson, B. M., Hulleman, C. S., Gaspard, H., Häfner, I., & Trautwein, U. (2018). Learning more from educational intervention studies: Estimating Complier Average Causal Effects in a relevance intervention. *Journal of Experimental Education*, *86*(1), 105–123. https://doi.org/10.1080/00220973.2017.1289359

Nagy, G., Trautwein, U., Baumert, J., Köller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. *Educational Research and Evaluation*, *12*(4), 323–345. https://doi.org/10.1080/13803610600765687

Oechsle, M. (2009). Berufsorientierungsprozesse unter Bedingungen entgrenzter Arbeit und entstandardisierter Lebensläufe – subjektives Handeln und institutionelle Einflüsse. [Career orientation processes under conditions of delimited work and de-standardised CVs - subjective action and institutional influences]. In M. Oechsle, H. Knauf, C. Maschetzke, & E. Rosowski (Eds.), *Abitur und was dann?* (pp. 23–44). Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-91750-4_2

Patton, W., & Creed, P. A. (2001). Developmental issues in career maturity and career decision status. *The Career Development Quarterly*, *49*(4), 336–351. https://doi.org/10.1002/j.2161-0045.2001.tb00961.x

Praskova, A., Creed, P. A., & Hood, M. (2015). Career identity and the complex mediating relationships between career preparatory actions and career progress markers. *Journal of Vocational Behavior*, *87*, 145–153. https://doi.org/10.1016/j.jvb.2015.01.001

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and* *data analysis methods*. Thousand Oaks, CA: Sage.

Reber, R., Canning, E. A., & Harackiewicz, J. M. (2018). Personalized education to increase interest. *Current Directions in Psychological Science*, *27*(6), 449–454. https://doi.org/10.1177/0963721418793140

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist*, *51*(2), 146–163. https://doi.org/10.1080/00461520.2016.1154792

Rozek, C. S., Hyde, J. S., Svoboda, R. C., Hulleman, C. S., & Harackiewicz, J. M. (2015). Gender differences in the effects of a utility-value intervention to help parents motivate adolescents in mathematics and science. *Journal of Educational Psychology*, *107*(1), 195–206. https://doi.org/10.1037/a0036981

Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys*. New York, NY: Wiley. https://doi.org/10.1002/9780470316696

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, *7*(2), 147–177. https://doi.org/10.1037/1082-989X.7.2.147

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton Mifflin Company.

Torgerson, C. J., Torgerson, D. J., & Taylor, C. A. (2015). Randomized controlled trials and nonrandomized designs. In J. S. Wholey, H. P. Hatry, & K. E. Newcomer (Eds.), *Handbook of Practical Program Evaluation (Third Edition)* (pp. 144–162). San Francisco, CA: Jossey-Bass. https://doi.org/10.1002/9781119171386.ch7

Trautwein, U., Neumann, M., Nagy, G., Lüdtke, O., & Maaz, K. (2010). *Schulleistungen von Abiturienten - die neu geordnete Gymnasiale Oberstufe auf dem Prüfstand. [School achievement of high-school graduates - The rearranged upper secondary school on the trial]*. Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-92037-5

Wigfield, A., & Cambria, J. (2010). Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Developmental Review*, *30*, 1–35. https://doi.org/10.1016/j.dr.2009.12.001

Wigfield, A., Tonks, S., & Klauda, S. L. (2009). Expectancy-value theory. In K. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 55–75). New York, NY: Routledge.