Research Article – Extended

Stability of Vocational Interests During University Studies

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Abstract: Students' vocational interests can be described by Holland's theory of occupational choice. Holland distinguishes six interest dimensions here: realistic, investigative, artistic, social, enterprising, and conventional. Although these attributes are relatively stable during adolescence, their stability increases dramatically during university studies. Because vocational interests are often a factor in career counseling and the choice of what to study, it is essential to investigate the extent to which they develop during the first years of college. This study examines the NEPS first-year student cohort to investigate the stability of students' interests and aspirations. The paper analyzes 2,442 male and 3,435 female students who studied within one of six major study clusters and provided data about their vocational interests at Wave 1 (study entry) and Wave 9 (about 4.5 years later close to the end their studies). The study's results show strong and highly significant correlations for all interest dimensions, as well as a high stability of students' aspirations. The correlations were strongest for artistic interests and weakest for conventional interests and were distinguishable between most dimensions. Furthermore, the analyses showed notable differences with respect to gender and field of study. Further analyses went beyond a variable-centered towards a person-centered approach showing that students with a stable interest vector also displayed higher profile correlations and a higher person-environment fit. The analysis shows that 28% of the sample are still developing their interests. This indicates notable adaption processes during university time that should be factored into course design, career counseling, and further research.

Keywords: vocational interests, Holland model, university freshmen, congruence, interest stability

The trajectory from school to work is an important process in an individual's life. Several inventories support this process and especially the respective decision for occupation by assessing an individual's vocational interests (Holland, 1997) and by providing vocational interest profiles of occupations (e.g., AIST: Bergmann & Eder, 2019; Explorix: Jörin Fux et al., 2003, SDS: Holland et al., 1973; O*NET, 2018). When using such inventories, an individual can evaluate how far their own vocational interests fit the vocational interests of different occupations, which he or she may consider as a career option (*person-environment fit/congruence*). Meta-analyses, for example, Nye and colleagues (2012), indicate that a good person-environment fit increases performance and persistence, while a low fit is often associated with lower outcomes or even dropping out of a course of study (e.g., Ertl et al., 2022; Mouton et al., 2020).

While students who go into Vocational Education and Training (VET) usually work, at least partially, during VET and thereby already experience the environment of the occupation that they chose, this is different for university students: They enroll in a study program that provides a much more abstract and general, *academic*, education that is less connected to the environment of the occupation they aspire; moreover the range of possible occupations is quite broad for some study areas like, for example, economics while in medicine most students aim at becoming medical doctors. The time at university is therefore a transition phase from school to an occupation. It furthermore often provides a quite different, *academic*, environment for the students than the later occupation: in Germany, for example, teacher education programs are mainly theoretical during university time and very different to a teaching environment in the classroom later (Hartmann et al., 2022). Hence, missing interest (in a very unspecified meaning of interest) has been shown to be one of the main reasons for students dropping out (Mouton et al., 2020). This difference in the environments of university and occupation has the consequence for career inventories that they may either focus on the academic environment of the university program or rather the environment of the occupation that students aspire to enter after study time. Especially regarding the latter, the stability of the individual's vocational interests gets an important aspect because due to the development of the individual's vocational interests during study time also the fit with the occupation suggested by the inventory may change.

Although research on interest stability reveals that vocational interests are relatively stable through college years (Low et al., 2005; Stoll et al., 2021), this research also indicates that there is room for interest changes, *developments*, which also can be related to a change in terms of person-environment fit. Normative transitions, for example, from high school to university, are supposed to provide a setting in which changes in vocational preferences have an increased probability to occur (Stoll et al., 2021). According to Holland (1997), individuals seek environments that fit their interests. In these environments, however, the individuals may further develop their vocational interests in accordance with the environmental requirements for gaining a better fit. As a result, the development of vocational interests should be convergent for students who are entering the same academic environment, adapting to the same requirements, and different for students choosing another subject area. While this process is well investigated on a general level (e.g., Hanna et al., 2021; Nye et al., 2021), there is a need for delving deeper into specific, "atypical" areas: Based on vocational interests, Gottfredson (2005) defines the *sex type* of an occupation. Depending on characteristics of vocations, several occupations are perceived as male, especially technological ones, several as female, primarily caring ones, and several as neutral. Of note, female persons in a male occupation (e.g., STEM: Science, Technology, Engineering, and Mathematics) would be in an atypical environment. Su and colleagues (2009) developed this further by predicting the proportion of female students in a field by the difference between *technical* (realistic in the notion of Holland, 1997) and *social* vocational interests. This distinction of occupations as male and female based on vocational interests raises the question about the stability of the vocational interests of individuals that are in an atypical area like female students in the area of STEM that widely is considered male. It furthermore points to the question if there are specific profiles of individuals who are developing their vocational interests.

So far, little is known about domain-specific developments of vocational interests, especially for students in atypical areas which are characterized by a sex type that does not match their own gender identity. After the attempt to replicate previous findings on interest stability, the current study, therefore, has a specific focus on the gender-specific and study area-specific *stability* of vocational interests using a large-scale dataset of university students. Furthermore, the study focuses on profiles of individual interest *development* and the prediction of these profiles by characteristics of vocational interests, subject area, and gender. We include congruence as a measure for the person-environment fit in the analyses and furthermore the persistence in a study area for the prediction of the latent profiles.

Vocational Interests

Holland (1997) provided a seminal model for describing vocational interests that distinguish six types of interests representing different manners of how people interact with their environment. Each of these types describes a characteristic repertoire of attitudes and behaviors: *Realistic* (R), comprising interests related to mechanical, technical, electrical, and agricultural activities; *Investigative* (I), with interests regarding mathematical and scientific fields; *Artistic* (A), comprising interests with respect to languages, arts, music, acting, or writing; *Social* (S), referring to interpersonal relations such as teaching, training, supplying, or caring; *Enterprising* (E), including interests regarding leading and convincing people; and *Conventional* (C), comprising interests with respect to ordering and sorting things (see also Rocconi et al., 2020). Holland (1997) postulates that these six interest types can be arranged in a hexagonal order by placing similar types into juxtaposition. According to his model, an individual's personality structure can be characterized by the shape of these interest types. Many career counseling inventories (e.g., Bergmann & Eder, 2019; Holland et al., 1973; Jörin Fux et al., 2003; O*NET, 2018) implement the Holland (1997) model and thereby suggest career paths and study areas to individuals that predict a good fit to the individuals' interest profiles. However, as this counseling usually takes place before enrolling in a study area, developing or changing interest profiles may result in an increased or decreased person-environment fit at the end of the study. For being able to estimate the merit of such inventories that are filled out before studies and suggest later occupations it is therefore essential to look deeper into the stability of vocational interests.

Measuring Interest Stability

There are many ways to measure interest stability or change (Tracey & Sodano, 2008; Xu & Tracey, 2016). The frequently used *rank-order stability* gives the relative order of people compared to other people on the RIASEC scales. If the rank-order stability indicates high stability, a person who has, for example, higher Realistic interests than others at the first measurement time also ranks high at the second measurement time. As such, rank-order stability indicates *interindividual* interest stability. In contrast, a *profile correlation*, the correlation of a person's RIASEC profiles of two measurement times, indicates the *intraindividual* stability of interests. Both rank-order stability and profile correlation are reported in the meta-analysis by Low and colleagues (2005). As a third measure, the meta-analysis by Hoff and colleagues (2018) reports *mean-level changes* that indicate the *absolute changes* in the RIASEC scale scores between two measurement times (Tracey & Sodano, 2008).

These three measures are not interchangeable, but each method focuses on a different aspect of interest stability (Tracey & Sodano, 2008).

Meta-Analytic Findings on the Stability of Vocational Interests

Low and colleagues (2005) implemented a meta-analysis including 59 publications and 114 studies that observed the stability of the individuals' interests over a median time span of 4.00 years ($M = 6.85$). They reported high stability of the individuals' interests ranging from about $r = .55$ in the age group of 12–13.9 years up to $r = .83$ in the age group between 25 and 29.9 years of age. Many of the studies (38) focused on college freshmen in the age group of 18–21.9 who filled out the interest inventories upon study entry (Low et al., 2005). The stability of their interests was considerably high, with correlations slightly below $r = .7$. This result is ambiguous because it indicates that interests within this age group are relatively stable, albeit still leaving some room for change. Of note, the results regarding the interested stability of the different age groups show some heterogeneity depending on the measure applied (rank-order vs. profile correlations) and the time interval between both measurements (see Low et al., 2005). Yet, when distinguishing the type of stability coefficient, the estimated stability (across age groups) was higher based on profile correlation (.70) compared to the estimated stability based on rank-order correlation (.60).

Hoff and colleagues (2018) also carried out a meta-analysis but focused on the mean-level changes in interests and found that mean levels generally increased with age. Of particular note was that interests involving people (Artistic, Social, and Enterprising) tended to increase during young adulthood. Overall, Hoff and colleagues (2018) concluded that normative changes in vocational interests from adolescence to adulthood provide important implications for developmental theories. This conclusion is supported by a recent (non-meta-analytic) study by Stoll and colleagues (2021) who longitudinally tracked students after high school. They found that vocational interests show high stability and follow specific developmental patterns. These are characterized less by maturity in life, and are more associated with transitions, for example, from high school to university, or later on to the labor market. Stoll and colleagues (2021) conclude that "normative social transitions may be a key to better understanding longitudinal interest development" (p. 1091).

Developing the Person-Environment Fit

While the development of an individual's interests can be seen as a part of personality development, a change of interests may also have consequences on the P-E fit: if, for example, a student of mathematics would especially develop Social interests during study time, this person then might fit better to a mathematics teacher (interest profile Social/Investigative/Artistic) than to a mathematician (interest profile Investigative/Conventional/Artistic). Nye and colleagues (2012) have generally been able to show the importance of interest congruence as a predictor of study outcomes and persistence. Looking at the high numbers of university dropouts (e.g., Heublein, 2014), frequent reasons like *false expectations* or *loss of interest* (Mouton et al., 2020) indicate a bad P-E fit as the reason for students' university dropout. Considering the students who persist at university, Donohue (2006) found that students with a low congruence changed their study subject for increasing congruence as a result. The *gravitation* hypothesis (e.g., Wille et al., 2014) conceptualizes such changes in the subject of study and respective occupational aspirations by postulating that individuals gravitate toward better-fitting environments. Complementarily, Yang and Barth (2015) discussed how students' interests may align with occupational goal affordances via *socialization* processes (also De Cooman et al., 2009). Both phenomena point toward the developmental processes of students' interests during their time at university and ask for a closer look into interest stability during study time at a university. Recent evidence (Etzel & Nagy, 2021; Hanna et al., 2021) indicates that, in the context of vocational interests, a change of P-E fit is more due to the selection of a new environment than to adapt to an existing environment. However, these studies also indicate that interest change takes place. In the study by Nye and colleagues (2021), changes in interests were related to changes in the work environment, which suggests that even after moving to a better-fitting work environment, individuals' interests may still change as a result of the experiences the individuals make in this work environment. In addition, theories dealing with interest development in general (Hidi & Renninger, 2006; Holland, 1997; Lent et al., 1994; Renninger & Hidi, 2016) highlight the role of environmental triggers. Thus, selecting a new environment is possibly preceded by a change of interests due to previous environmental triggers (Hanna et al., 2021).

Person-Centered Versus Variable-Centred Perspectives

So far, research regarding the stability or change of vocational interests has used variable-centered approaches focusing on the stability of the RIASEC variables across individuals. For example, the meta-analysis by Low and colleagues (2005) estimates the stability to be .67 for Realistic interests and .62 for Social interests. This result includes the hypothesis that the population is homogenous regarding the stability of Realistic and Social interests. A *person-centered* approach, in contrast, relaxes this assumption (Hofmans et al., 2020) and accounts for the possibility of a heterogeneous population comprising different subpopulations with specific profiles of interest stability (e.g., stable Realistic but increasing Social interests). Using a person-centered approach means classifying individuals based on their similarity with respect to a specified set of variables (Howard & Hoffman, 2018), for example, the mean-level changes regarding the six RIASEC dimensions.

By including a person-centered perspective, the current study can contribute to a more comprehensive picture of the stability of vocational interests since it aims to reveal different subpopulations with distinct interest developments. Although person-centered approaches are explorative, they still leave room for expectations regarding the nature of possible developmental profiles (Hofmans et al., 2020; Morin et al., 2018). For example, based on the results of variable-centered studies that indicate a high level of interest stability in general (e.g., Stoll et al., 2021), we would expect a group of students that barely shows any interest changes. However, there may also be some students who generally gain or lose interest or students who change only regarding some interest dimensions depending on the requirements and triggers of their (aspired) environment. This may especially be the case for students in atypical areas that also show gender differences with respect to the characteristics of the vocational interests, for example, females in STEM (Ertl & Hartmann, 2019; Su & Rounds, 2015).

Theoretical Perspectives on Interest Stability Considering Gender and Different Academic Environments

The results of the aforementioned meta-analyses indicate high stability of vocational interests in terms of rank-order stability, profile correlation, and mean levels (Hoff et al., 2018; Low et al., 2005), but at the same time, they indicate that there is also room for interest change, which can be explained by theories dealing with interest development including Holland's (1997) theory of vocational choice, the social cognitive career theory (SCCT; Lent et al., 1994), and Hidi and Renninger's (2006; Renninger & Hidi, 2016) four-phase model of interest development (Hoff et al., 2018). Although these theoretical approaches set different priorities, all three emphasize that it is the environment (or situation) and the interaction between person and environment that trigger interest development. Focusing college students from this perspective, different interest development may result from students with different vocational interests acting in and being exposed to different academic environments. In accordance with the corresponsive principle (Caspi et al., 2005; Roberts et al., 2003) an environment most likely affects those interests that guided an individual to choose this environment. For example, a student who chooses biology due to his or her high Investigative interests should deepen his or her Investigative interests, whereas a student of arts should develop his or her Artistic interests. In addition to differences between students from different academic majors, men, and women also differ within the same academic major, especially regarding the Realistic and Social dimensions. This applies to both STEM and non-STEM fields with men showing higher Realistic interests and women showing higher Social interests (Ertl & Hartmann, 2019; Su & Rounds, 2015). Thus, entry characteristics may differ systematically between male and female students and also within academic majors. Finally, the same characteristics of an academic environment can be perceived quite differently by males and females. For example, STEM fields, in which men are overrepresented, are likely to be perceived as threatening by females but not by males (Casad et al., 2019; Schuster & Martiny, 2017). Research in school suggests that social triggers that are related to basic human needs, such as a sense of belonging, are likely to impact already well-developed (enduring) interests (e.g., Bergin, 2016; Krapp, 2005; see also Hoff et al., 2018). This would mean, that males and females experience social triggers in the same environment differently, which might lead to different interest developments.

Empirical Evidence of Interest Stability and Change Considering Gender and Different Academic Environments

In the light of several empirical studies that found different interest profiles of male and female students (e.g., Ertl & Hartmann, 2019; Su & Rounds, 2015; Su et al., 2009), the question arises if interests of male and female students develop similarly despite the differences in the interest profiles. Only a small amount of the studies of the meta-analyses by Low and colleagues (2005) and Hoff and colleagues (2018) surveyed male and female students, and even fewer analyzed the differences between both. Herzberg and colleagues (1954) did this, using rank-order stability and finding significant gender differences; they report female students having higher interest stability, with Herzberg and Bouton (1954) finding this for high school students. Stoll and colleagues (2021), who were studying stability and change in interests across 10 years and 6 timepoints, reported gender differences in terms of rank-order stability, mean-level changes, and profile stability that mostly concerned only single dimension or single time-point. A consistent gender difference was observed for the rank-order stability of Realistic interests. Males showed a higher stability of Realistic interests for all time intervals, but with the difference being significant only for the interval from the second to the third time point. In their meta-analysis, Hoff and colleagues (2018) report a significant gender difference for an adult age group (18–42) regarding mean-level changes of Realistic interests ($\Delta d = .27$). None of these studies considered academic majors as environments providing different social triggers, such as different gender distributions, that might guide interest development.

Regarding interest stability in different academic environments, Gehman and Gehman (1968) distinguish three different engineering subjects, reporting stabilities from $r = .444$ to $r = .616$. However, the difference between these correlations was not significant, most plausibly caused by the low sample sizes between 23 and 37 students per subject. Most of the subsequent studies on interest stability (e.g., Pässler & Hell, 2020; Xu & Tracey, 2016) shifted their focus toward (early) K-12 or toward longer timeframes (partially) outside university studies (e.g., Hoff et al., 2020; Nye et al., 2021; Schultz et al., 2017) so that an in-depth analysis of university students distinguishing different academic majors on a large-scale basis is missing. Similarly, we were not able to find studies about the stability of interests considering the gender distribution (as a proxy for the sex type mentioned by Gottfredson, 2005) of academic majors as social triggers for interest development (e.g., with an overrepresentation of males).

Research Questions

To sum up, meta-analytic findings (e.g., Low et al., 2005) and recent investigations (e.g., Stoll et al., 2021) indicate high stability of vocational interests during university time, and at the same time, they indicate some room for change in interests. In this context, the current study aims at investigating three main research questions. First, we attempt to replicate the results of previous research regarding interest stability in terms of rank-order stability and profile correlation. We try to expand the current state of research by considering that students from different academic majors show different entry characteristics in terms of vocational interests and that they find themselves in different environments with different social triggers, especially with respect to gender distributions. Since theories on interest development (Hidi & Renninger, 2006; Holland, 1997; Lent et al., 1994; Renninger & Hidi, 2016) claim that interest stability or changes in interests depend on the interaction between people and their environments, it is reasonable to assume that students in different academic environments show different interest developments. For example, according to the corresponsive principle (Caspi et al., 2005; Roberts et al., 2003), students should especially evolve those interests that were the reason to choose their academic major. In addition, previous research indicates that male and female students differ regarding their entry characteristics in terms of vocational interests even within STEM and non-STEM fields (Ertl & Hartmann, 2019; Su & Rounds, 2015), which may lead to different interest changes in male and female students within the same academic environment, especially for students in atypical academic environments. Also, male and female students may react differently to the same social trigger in an environment such as a specific gender distribution (Casad et al., 2019; Schuster & Martiny, 2017). Therefore, we systematically investigate whether interest stability is the same for male and female students across different academic majors. The respective research questions are:

Research Question 1 (RQ 1): To what extent do students' interests remain stable during their course of study?

Research Question 1a (RQ 1a): To what extent is this stability different for male and female students?

Research Question 1b (RQ 1b): To what extent is this stability different for various subject areas?

Hypothesis 1 (H1): According to the literature, we can expect that students' interests are considerably stable (see Low et al., 2005). We, as a result, expect significant correlations with substantial effect sizes. The impact of gender and study subject has not to date been investigated systematically, which is why we will not postulate hypotheses for this factor. However, Herzberg and colleagues (1954) indicate higher stability for female students (using a slightly younger sample) and Stoll and colleagues (2021) reported gender differences with respect to some timepoints and some interest dimensions.

Previous research used variable-centered approaches to study the interest stability of university students. This perspective implies the assumption that interest development is similar for all students and that there are no subpopulations with different patterns of interest development. Going beyond a variable-centered approach, the investigation of the second research question aims to relax this assumption and applies a person-centered approach (see Hofmans et al., 2020) that focuses on the exploration of different developmental profiles.

Research Question 2 (RQ 2): To what extent is students' interest stability reflected by different profiles of interest development?

Being explorative in nature, person-centered approaches usually do not include the formulation of precise hypotheses. However, according to the results regarding interest stability reported in the literature (Low et al., 2005; Stoll et al., 2021), we would expect a large subpopulation of students with stable interests. Other developmental patterns may be a general gain or loss of interests or the evolvement of some but not all RIASEC interest dimensions. When considering theories dealing with interest development (Hidi & Renninger, 2006; Holland, 1997; Lent et al., 1994; Renninger & Hidi, 2016), we assume that different profiles of interest development should result from different students interacting with their respective environments. For example, persons with strong Realistic interests are likely to choose STEM fields – such as engineering – and this academic environment may promote the evolvement of Realistic interests instead of other RIASEC dimensions. In addition, students in an environment who have different characteristics (e.g., male vs. female) may respond differently to the same environmental trigger (e.g., an unbalanced gender composition). That is, female engineering students might perceive the overrepresentation of males differently as compared to male engineering students. In the context of RQ 3, we, therefore, try to predict different interest developments by personal and environmental characteristics. This includes students' gender and their RIASEC interests in wave 1 as well as different academic majors as indicators for different environments – with a focus on their inherent gender distributions as a social trigger to which male and female students may react differently. Considering the interest alignment hypothesis (Yang & Barth, 2015), we would also expect students' congruence at wave 9 as a predictor for some profiles. Complementary to this, we also expect missing persistence as an indicator for reorientation processes for other profiles as Donohue (2006) describes. RQ 3 focuses on predicting profiles of interest development by considering personal and environmental characteristics.

> *Research Question 3 (RQ 3)*: To what extent can these latent profiles be predicted by gender, congruence, persistence, and interests at study entry and study area?

Overall, the current study contributes to expanding the current state of research by systematically examining the stability of interests of male and female students in STEM and non-STEM fields. In addition, the person-centered approach can reveal different patterns of interest development and help to find out whether socialization and gravitation are not mutually exclusive developments, but only apply to certain subpopulations.

Method

This paper analyses data from the National Educational Panel Study (NEPS; Blossfeld & Roßbach, 2019; see also Acknowledgments). NEPS is a German national panel that focuses on the educational trajectories of persons of all age groups with over 60,000 respondents. It initially comprised six starting cohorts from infants (starting cohort 1) to adults (starting cohort 6) that are still followed longitudinally since 2010.

Sample

This paper focuses on the starting cohort of first-year students (SC5:14:0.0; NEPS Network, 2021) which entered the panel during the winter term 2010/2011 (FDZ-LIfBi, 2018b). SC5 has a target population of all first-year students that were enrolled for the first time in a public or state-approved university or university of applied sciences. From this target population a random cluster sample was drawn (see Zinn et al., 2017) with an intended oversampling of teacher candidates and students at state-approved universities. The data for this study comes from wave 1, that is, study entry in the autumn of 2010, and wave 9 which was surveyed in the spring of 2015. This paper is, therefore, able to analyze the stability of students' interests between study entry, followed by a point in time approximately 4.5 years later and close to the end of regular study.

This paper focuses on the age cohort born in the years 1988–1991. These students had an age between 18 and 23 years at study entry (a common entry age range for typical educational careers), and consequently between 23 and 27 years at wave 9. The sample participating in wave 1 and wave 9, both times, is comprised of 2,442 male and 3,435 female students. These numbers decreased due to missing information regarding students' aspirations with respect to congruence. The study focuses on six study areas that distinguish with respect to their proportion of female students with a low/medium/high proportion of female students and with respect to the study field. The rationale for the clustering was to distinguish STEM and non-STEM areas not only on a dichotomous level but according to the proportion of female students in the subjects. This specific approach is more deeply explained by Ertl and colleagues (2017) with respect to the threshold of 30% and 70% for distinguishing subjects with a low/medium/high proportion of females and by Ertl and Hartmann (2019) with respect to the selection of subject areas. The specific areas are STEM-L with a low proportion of female students that is less than 30%, STEM-M with a medium proportion of female students that is between 30% and 70%, medicine

(Life) and economics with balanced gender proportions (30–70%), and education and languages with a high proportion of female students (more than 70%). See the Electronic Supplementary Material 1 (ESM 1, E1) for the specific distribution.

Measures

Students' vocational interests were measured at wave 1 and wave 9 by the Interest Inventory Life Span, which is a short-scale instrument for assessing vocational interests in large-scale studies (IILS-II; von Maurice & Nagy, 2009; Wohlkinger et al., 2011; see also FDZ-LIfBi, 2018a, pp. 699–704). The IILS-II comprised three items for each dimension, with each measured by a five-point Likert scale with acceptable internal consistencies for short scales (Cronbach's α [wave 1/wave 9] for Realistic: α = .701/.699; Investigative: α = .628/.651; Artistic: α = .630/.630; Social: α = .746/.747; Enterprising: α = .528/.529; Conventional: α = .564/581). Regarding interests, we performed a selectivity analysis to check if the interests of the students present at wave 9 distinguished from the interests of the students not more present at wave 9 (see ESM 1: E10). This analysis indicated, although being significant for Investigative and Artistic interests, zero effects ($\eta_p^2 \leq .001$) for all interest dimensions. Students that were not more present at wave 9, however, showed notably less persistence in their initial study course ($\eta_p^2 = .234$). Furthermore, the hexagonal structure of the interest dimensions (see Hubert & Arabie, 1987) could be confirmed by the Randomization Test of Hypothesized Order Relations using the RANDALL program (see Tracey, 1997; CI = .806; $p = .017$; wave 1; see also Ertl & Hartmann, 2019).

The dataset furthermore contains questions about students' vocational aspirations at wave 9. This was a question about the professions that were most plausible (e.g., "What profession will you actually pursue in the future?"). Of note, there were several students that did not articulate aspirations that, however, only affect congruence data. The aspirations were used for the calculation of congruence as measures for the P-E fit.

Estimating Interest Profile Stability

Most of the studies summarized by Low and colleagues (2005), either use rank-order correlations for the interest dimensions (correlating the first and the second time point for each interest dimension, for example, realistic interests, separately for the whole group) or profile correlations (correlating all six interest dimensions for one individual for the two timepoints and build than a mean between these correlations for estimating the profile correlation for the whole group). The correlations for the interest dimensions as well as the profile correlations analyze the stability of students' interests between wave 1 and wave 9. Profile correlations were Fisher's *z* transformed for all analyses, and their results were re-transformed for better comparability. We will apply both methods with respect to RQ 1 for getting our results comparable to previous research. We further include a multi-regression approach with latent variables (see ESM 1: E6–E8) that models the six interest dimensions at wave 1 and wave 9 as latent variables based on the respective three items for each dimension at both waves. This model estimates the stability of the interest profiles by regressing the dimensions at wave 9 on the values at wave 1. It offers a better estimation of errors, accounts for different reliabilities of the interest dimensions, and also allows covariances between the variables which has, however, the consequence that its results are hardly comparable with previous research. Therefore, we decided to primarily put these models into the supplement and to discuss them just briefly in the results part. ESM 1: E9 also includes mean level differences as a measure of interest stability as used by Hoff and colleagues (2018). RQ 2 estimates the latent profiles also based on mean level differences (see ESM 1: E5a and E5b).

Estimating the Person-Environment Fit

Several approaches aim at conceptualizing *congruence* in the context of Holland's (1997) theory. These approaches differ with respect to how many interest dimensions they consider, for example, by only comparing the strongest interest dimensions of a profile versus all dimensions; how far they incorporate the hexagonal structure of the model; and the algorithms applied for calculating the fits. Several algorithms implement a weighted ranking of the interest dimensions (see e.g., Brown & Gore, 1994), correlate the profile of the individual and the environment, or describe the interest profile as a vector in the hexagonal model (e.g., Eder, 1998; Prediger, 1982). Tracey and Sodano (2013) estimate the Euclidean distance of the vectors of the individual's interests and the environmental profile as preferable because of their "ease of calculation, the unneeded assumption of independence of scales, and the easy extrapolation to more than two dimensions" (p. 115).

For calculating congruence values, the interest codes provided by the O*NET (2018) database were applied. O*NET contains expert ratings for the occupations listed for all six interest dimensions (environmental interest profiles). These were converted to an interest vector for each occupation based on the procedure described by Ertl and Hartmann (2019). Congruence was calculated by the mentioned Euclidean distance (see Tracey & Sodano, 2013) between the vector of the interest profile of the student at wave 9 and the interest profile of the occupation aspired at wave 9. A high congruence was here indicated by a short distance.

We further provide information on how far a student persisted in the initial study program by reporting how far the subject that started in wave 1 was finished successfully.

All numerical analyses were implemented using SPSS 25 at the remote NEPS site at LIfBi in Bamberg, Germany. The multi-regression modeling of stability in ESM 1: E6–E8, the classification of latent profiles of research question 2, and the multinominal regressions for the latent profile predictors (RQ 3) were implemented using MPLUS 8.2 at this location. The multinominal regressions were estimated in the context of latent profile analysis by the r3step algorithm.

Results

Research Question 1: Correlations of Students' Interests at Waves 1 and 9

RQ 1 focused on the stability of students' interests during study time. In this regard, we can see highly significant correlations between students' interests in wave 1 and wave 9 for all six interest dimensions with large effect sizes. However, we can also see that these correlations vary between different dimensions (Table 1, lines Total). Here, we observe two clusters of correlations with similar stabilities: Realistic-Investigative-Social with higher stability and Enterprising-Conventional with significantly lower stability (see ESM 1: E2 for the means of the interests). Artistic interests were significantly more stable than all other interests with small to medium effect sizes for all comparisons ($.126 < q < .369$; see ESM 1: E3b). The mean profile correlation between both waves was high. The multi-regression approach (ESM 1: E6) was also able to identify significant differences between the interest dimensions with Artistic interests also showing the highest stability. Due to the consideration of covariances between the interest dimensions, Investigative and Social interests now show lower stabilities compared to Artistic and Realistic interests. They are now similar to Enterprising and Conventional interests.

Table 1. Correlations, 95% confidence intervals (CIs), and *N*s of interests and means of the individuals' profile correlations, between wave 1 and wave 9 for all, male and female students

	R	I	A	S	E	C	PC
Total							
r	.647	.641	.715	.655	.499	.485	.756
Lower CI	.632	.626	.703	.641	.480	.466	.745
Upper CI	.661	.655	.727	.669	.517	.504	.766
N	5,871	5,872	5,876	5,870	5,876	5,873	5,858
Male							
r	.638	.578	.636	.610	.521	.507	.754
Lower CI	.614	.551	.612	.585	.492	.477	.737
Upper CI	.660	.603	.659	.634	.549	.535	.770
N	2,439	2,440	2,442	2,438	2,442	2,442	2,435
Female							
r	.571	.659	.692	.600	.486	.461	.757
Lower CI	.549	.640	.675	.579	.461	.435	.743
Upper CI	.593	.677	.709	.620	.511	.486	.770
N	3,432	3,432	3,434	3,432	3,434	3,431	3,432
Diff.							
p	< .01	< .01	< .01	*ns*	< .10	< .05	*ns*

Note. R = Realistic; I = Investigative; A = Artistic; S = Social; E = Enterprising; C = Conventional; PC = profile correlation; Diff. = Significance of differences between the correlations between male and female students according to Eid and colleagues (2011, p. 547, double sided tested). For the interpretation of the confidence intervals, we refer to Field and colleagues (2019) who elaborates that touching borders of two 95% confidence intervals allow to reject the null hypothesis of no differences on a $p = .01$ level while a moderate overlap of the confidence intervals characterizes a $p < .05$ level (p. 85f.).

Research Question 1a

Focusing now on gender, we see differences for almost all interest dimensions when comparing male and female students (see Table 1) with significant effects for Realistic, Investigative, and Artistic interests. Furthermore, most of these gender-split correlations were descriptively lower than the correlations for the whole sample. Male students showed a significantly higher stability of Realistic interests ($q = .106$) while female students contrastingly showed a significantly higher stability for Investigative ($q = .132$) and Artistic interests ($q = .100$, see ESM 1: E3a). The profile correlations did not differ significantly between male and female students. Looking at the multi-regression results, we can still see significant differences between the six interest dimensions for male as well as for female students (ESM 1: E7–8). However, comparing the values of each of the interest dimensions for male and female students, we observe that the differences in the correlational analyses disappear for the R^2s and the βs. However, we see instead notable differences in the covariances between the six interest dimensions (like visualized in ESM 1: E7c–8c). Thus, it seems that the gender differences moved from the level of the six interest dimensions to the levels of covariances between these six dimensions.

Research Question 1b

Delving deeper into the different subject areas, we can see notable differences even *within the interest dimensions*. Generally, all correlations of interests between wave 1 and wave 9 were significant, although with a lower size than in the total sample for most interest dimensions besides Enterprising and Conventional interests. They overall were higher than .4 except for male students in education. Beyond reporting their values in ESM 1, we do not consider them further in our analysis because of the low

Table 2. Correlations, 95% confidence intervals (CIs), and *N*s of interests and profile correlation between wave 1 and wave 9 for the different subject areas for male students

Male	R	I	A	S	E	C	PC
STEM-L							
r	.547	.475	.607	.536	.502	.444	.754
Lower CI	.509	.433	.572	.497	.461	.400	.730
Upper CI	.583	.515	.640	.573	.542	.486	.776
N	1,318	1,318	1,319	1,318	1,319	1,319	1,317
STEM-M							
r	.583	.628	.601	.539	.502	.547	.743
Lower CI	.523	.573	.543	.475	.435	.484	.702
Upper CI	.637	.677	.653	.597	.564	.604	.779
N	513	512	513	511	513	513	510
Life							
r	.499	.427	.577	.480	.544	.600	.812
Lower CI	.350	.267	.442	.327	.403	.470	.740
Upper CI	.624	.564	.686	.608	.660	.704	.865
N	117	117	117	117	117	117	117
Eco							
r	.566	.470	.588	.557	.502	.512	.747
Lower CI	.478	.370	.503	.468	.406	.417	.688
Upper CI	.643	.559	.662	.635	.587	.596	.796
N	260	262	262	261	262	262	260
Education[a]							
r	.569	.364	.500	.046	.347	.658	.806
Lower CI	.317	.064	.228	−.265	.045	.440	.663
Upper CI	.746	.604	.699	.348	.591	.803	.892
N	41	41	41	41	41	41	41
Language							
r	.589	.593	.673	.499	.453	.561	.739
Lower CI	.488	.493	.587	.384	.333	.455	.667
Upper CI	.674	.678	.744	.598	.559	.651	.797
N	190	190	190	190	190	190	190
Range[ab]	.090	.201	.096	.077	.087	.156	.073

Note. R = Realistic; I = Investigative; A = Artistic; S = Social; E = Enterprising; C = Conventional; PC = profile correlation. For the interpretation of the confidence intervals, we refer to Field and colleagues (2019) who elaborate that touching borders of two 95% confidence intervals allow to reject the null hypothesis of no differences on a $p = .01$ level while a moderate overlap of the confidence intervals characterizes a $p < .05$ level (p. 85f.). [a]Male students of education were not included in the statistical comparisons because of the low sample size. [b]Difference between the minimum and the maximum of the correlation coefficients.

Table 3. Correlations, 95% confidence intervals (CIs), and *N*s of interests and profile correlation between wave 1 and wave 9 for the different subject areas for female students

Female	R	I	A	S	E	C	PC
STEM-L							
r	.513	.542	.587	.563	.511	.485	.679
Lower CI	.431	.463	.514	.487	.429	.400	.617
Upper CI	.586	.612	.652	.631	.584	.561	.732
N	344	345	346	345	346	344	334
STEM-M							
r	.503	.654	.676	.563	.489	.462	.731
Lower CI	.455	.617	.641	.519	.441	.412	.701
Upper CI	.548	.688	.708	.604	.534	.509	.758
N	991	992	991	992	992	992	990
Life							
r	.584	.490	.637	.405	.502	.494	.826
Lower CI	.495	.288	.556	.294	.402	.393	.782
Upper CI	.661	.580	.706	.505	.590	.583	.862
N	242	242	242	241	242	242	241
Eco							
r	.484	.516	.680	.520	.480	.440	.711
Lower CI	.407	.442	.625	.447	.403	.360	.660
Upper CI	.554	.583	.728	.586	.550	.514	.755
N	416	415	416	416	416	416	413
Education							
r	.527	.487	.677	.406	.415	.437	.835
Lower CI	.450	.406	.618	.318	.327	.351	.802
Upper CI	.596	.561	.728	.487	.495	.515	.863
N	370	370	370	370	370	370	369
Language							
r	.542	.530	.660	.483	.444	.426	.776
Lower CI	.499	.486	.625	.436	.395	.376	.752
Upper CI	.583	.571	.692	.421	.490	.473	.798
N	1,069	1,068	1,069	1,068	1,068	1,069	1,077
Range[b]	.100	.167	.093	.158	.096	.068	.156

Note. R = Realistic; I = Investigative; A = Artistic; S = Social; E = Enterprising; C = Conventional; PC = profile correlation. For the interpretation of the confidence intervals, we refer to Field and colleagues (2019) who elaborate that touching borders of two 95% confidence intervals allow to reject the null hypothesis of no differences on a $p = .01$ level while a moderate overlap of the confidence intervals characterizes a $p < .05$ level (p. 85f.). [b]Difference between the minimum and the maximum of the correlation coefficients.

subsample size. Tables 2 and 3 show that the range of the differences in the correlation coefficients is around .1 for most dimensions for male students, except for Investigative and Conventional interests where it was close to .2. This is also reflected in the effect sizes of the differences between the correlations. For Investigative interests, 6 of 10 comparisons had small effect sizes ($.166 \leq q \leq .282$; see ESM 1: E3f), for Artistic and Conventional 4 of 10 ($.112 \leq q \leq .216$), and for the other three dimensions one or two of 10 ($.105 \leq q \leq .121$). This was slightly similar for female students, who showed a broader range for both Investigative and Social interests. Regarding Social interests, 8 of 15 comparisons showed small effects of the differences ($.110 \leq q \leq .208$), and regarding Investigative interests 5 of 15 ($.175 \leq q \leq .250$; see ESM 1: E3g). The other dimensions had lower numbers (4/3/2; $.102 \leq q \leq .156$) and for Conventional interests, there were no effects. Male students showed 4 of 10 subject areas with small effect sizes for the differences between the respective profile correlations ($.144 \leq |q| \leq .185$; see ESM 1: E3i) and female students 9 of 15 comparisons with small effect sizes and additional 3 with medium ones ($.104 \leq |q| \leq .377$; see ESM 1: E3j) with STEM-L showing the lowest profile correlation. While most profile correlations generally did not distinguish between female and male students when comparing both genders in almost all subject areas, this was different for STEM-L in which females showed a lower profile correlation than their male counterparts with a small effect size ($q = .155$; see ESM 1: E3k).

Regarding the question of whether, *within the subject areas*, the six RIASEC dimensions show different levels of stability, we see differences for the male students with at least small effect sizes for at least one-third of the comparisons for each subject area ($.106 \leq q \leq .328$; see ESM 1: E3c), for example, in STEM-L and the languages with Artistic interests being most stable and in STEM-M with Investigative interests. For female students, we see significant differences ($.106 \leq q \leq .393$; see ESM 1: E3d) with Artistic interests being most stable for all areas. Generally, the effect sizes for the comparisons of female students were higher in their number and larger in their effect sizes. Furthermore, we observed, based on the effect sizes, that we had more differences between the stabilities of the interest dimensions when focusing on the different interest dimensions within one subject area rather than when focusing on the different subject areas within one interest dimension.

We finally analyzed mean level differences for revealing more information about interest stability (see ESM 1: E9). Effect sizes for the mean-level differences ranged from $d = -.135$ for Realistic interests to $d = .419$ for Enterprising interests (see ESM 1: E9b) in the total sample. Here we see that the effect sizes of the mean level differences partially increase for the subgroups. We can specifically see that the effect sizes of the mean level differences are larger for female students (range $d = -.156$ for Realistic interests to $d = .472$ for Enterprising interests) in many dimensions compared to male students (range $d = -.106$ for Realistic interests to $d = .346$ for Enterprising interests; see ESM 1: E9d). We furthermore see that, for each of the interest dimensions, at least one of the gendered subgroups shows a significantly larger effect size of the mean differences than the whole sample (see ESM 1: E9g–E9j).

Summary

We observe a notable stability of students' interests between the beginning and completion of their studies. However, we also observed differences in the stability of interests between the interest dimensions. Gender effects as well as effects of the study area were identified and generally, the correlation sizes decreased when subsamples were analyzed. This was partially different for the mean level differences. Here we observed that some of the differences for the gendered subgroups increased substantially compared to the overall mean level difference. Based on these mean-level differences we can therefore conclude that the reduced correlation sizes can rather be attributed to characteristics of the gender- and subject-area-specific subsamples, especially to the heterogeneity across these groups, rather than to a restriction of range. A multi-regression approach was able to verify differences between the interest dimensions for the whole sample while gendered differences moved from the coefficient level to the structure of the covariances between the interest dimensions. Looking at the profile correlations, we did not find significant differences for gender in general. However, when distinguishing subjects we found significant differences, especially for female students, with the lowest profile correlation in STEM-L. These analyses were able to give insights into the stability of the different interest variables. They could, however, not reveal how far the interests of an individual are stable or developing and if there are differences between the individuals. This will be discussed in the next research question.

Research Question 2: Profiles for the Changes in Interests

RQ 2 focuses on students' profiles of interest stability. Here, a latent profile analysis was performed using MPlus (version 8.2) based on the differences in the manifest mean levels for the six interest dimensions between wave 1 and wave 9. The first step of analysis compared models with 3–25 distinct profiles. The criteria for model selection were a minimum of the BIC, high entropy, a high minimum for average latent profile probabilities, and the replicability of the best solution (see Spurk et al., 2020). The adjusted Lo-Mendell-Rubin (LMR) test suggested only three profiles and was disregarded based on the advantage of the bootstrapped likelihood ratio test (BLRT) as discussed by Nylund and colleagues (2007). The model with 13 profiles as well as all models with 15 or more profiles was unable to replicate the best solution, and therefore not considered trustworthy. These were left out of the further comparisons (see ESM 1: E4 for an overview of the model parameters). The BLRT was significant for all solutions up to 14 profiles. Of the remaining models, the solution with 6 profiles showed the lowest BIC (79,686.737) with an entropy of .629 and a minimum average latent profile probability of .635. The solution with 12 profiles showed the lowest sample size-adjusted BIC (79,475.294) with a higher entropy (.666), but a lower minimum of the average latent profile probability of .578. When comparing both solutions, the 6-profile solution had one large profile comprising 72.35% of the sample, while in the 12-profile solution, the largest profile still comprised 68.40% of the sample and

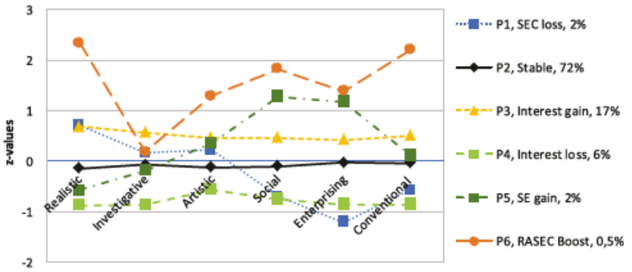

Figure 1. Latent profiles of the six-profile solution with the standardized values (*z*-standardized) of the differences shown in ESM 1: E5. A bar-chart representation of this figure can be found in ESM 1: E5d and bar charts of the different profile lines in figures ESM 1: E5e–E5j.

showed the same interest structure. This indicates that the additional six profiles of the 12-profile solution resulted in only a variety of marginal profiles. Therefore, we selected the 6-profile solution.

Figure 1 displays the characteristics of the six-profile solution and Table 4 shows its descriptive statistics. The figure shows the *z*-values of the differences between wave 1 and wave 9 (absolute and standardized values can be found in ESM 1: E5a and 5b; profile means for all interest dimensions in ESM 1: E5c). The largest group of students with a similar profile is found in P2 (solid black line) which comprises 72% of the sample and indicates stable interests. Almost parallel to this, the second largest profile (P3, dashed yellow line) with 17% shows slightly increasing interest in general, while the third largest profile (P4, dashed light green line) with 6% shows generally decreasing interest. Profile 1 (dotted blue line) and Profile 5 (dot-dashed dark green line), each with about 2%, show either a decrease in Enterprising and Social interests (P1) or an increase in them (P5). The last profile (P6, dashed orange line) comprises only 0.5% of the sample and indicates an increase in all but Investigative interests.

The profiles P1 (SEC loss) and P6 (RASEC boost) show a low profile correlation. This can be also concluded from the lines in Figure 1 that indicate quite different stabilities for the interest dimensions of this group. Without significant differences between each other, both profiles show a significantly lower profile correlation than P5 (SE gain) which shows a medium one. P3 (interest gain) and P4 (interest loss) show a significantly higher profile correlation than the previous profiles, albeit without significant differences between each other. The stable profile (P2) has a small but significantly higher profile correlation than P3 and P4 ($F[5, 5{,}870] = 66.197$; $p < .01$; significances based on a post hoc comparison with Bonferroni adjustment).

In total, we see most students (about 72%) showing stable interests during their studies. We furthermore see a minor number of students (23%) with either a general increase or decrease in interest. Finally, we see a small number of students (about 5%) with a large and specific change in their interests with the Social and Enterprising dimension characterizing these profiles. We furthermore could see that the large latent profile (P2) of students with stable interests holds even when doubling the number of latent profiles. RQ 3 will now delve deeper into the characteristics of these profiles by predicting profile membership based on further variables.

Research Question 3

RQ 3 focuses on predictors for latent profile membership. These predictions were estimated in the context of the latent profile analysis in Mplus by a multinomial logistic regression using the 3-step method by the r3step algorithm. This algorithm first estimates the latent profile analysis without covariates then classifies the cases to the latent profiles in a second step before it predicts the classified cases by the variables used in this MLR in a third step (see Asparouhov & Muthén, 2013). The reference profile was the largest profile (P2) that indicates stable interests. Subject areas were dummy coded with the subject area of economics as a reference. This was chosen because economics shows a balanced proportion of male and female students because it is outside the STEM area and furthermore comprises a reasonable number of students. In the following, all effects that are significant on a five-percent level are reported. The effect of each variable holds for the case that all other variables are controlled. Although Mplus is not able to provide a Pseudo R^2 for the multinominal regressions predicting LPA profile membership, an independent logistic regression would report a McFadden Pseudo $R^2 = .165$ (Nagelkerke Pseudo $R^2 = .305$).

Profile 1 – SEC Loss

A lower profile correlation and higher scores regarding the Social dimension and Enterprising dimension at wave 1 each were significantly associated with a higher probability to experience an SEC interest loss (P1) instead of interest stability (P2). Considering furthermore that, although missing the significance level, studying STEM-L was associated with a higher probability of belonging to this profile, we interpret this profile in a way that the academic environment does not facilitate Social and Enterprising interests as much as students' profiles would expect it.

Profile 3 – Interest Gain

A general interest gain from wave 1 to wave 9 (P3) instead of interest stability (P2) was associated with a lower congruence (lower values mean a higher congruence) at wave 9 and a lower profile correlation. The probability to experience a general interest gain also was higher when the RIASEC interest scores at wave 1 had been at a low level.

Table 4. Number of cases in the latent profiles, proportions, average latent profile probabilities for most likely latent profile membership, and means of the individuals' profile correlations (PC)

Profile	Label	Cases	Proportion of the total sample	Proportion of the male subsample	Proportion of the female subsample	Probability	PC
1	SEC loss	124	2.1%	1.8%	2.3%	.635	.333
2	Stable	4,252	72.4%	71.3%	73.1%	.756	.775
3	Interest gain	1,009	17.2%	18.8%	16.0%	.687	.741
4	Interest loss	342	5.8%	5.2%	6.3%	.722	.729
5	SE gain	126	2.1%	2.5%	1.9%	.651	.520
6	RASEC boost	24	0.4%	0.5%	0.4%	.829	.209

Students of STEM-M and medicine as compared to students of economics had a higher probability to develop a general interest gain. Considering that this profile shows higher levels of interest but lower levels of congruence, we interpret belonging to this profile that students find themselves in a transition phase: Their interests develop toward something new but at the expense of congruence.

Profile 4 – Interest Loss

A general interest loss from wave 1 to wave 9 (P4) instead of interest stability (P2) was associated with a higher congruence (lower values mean a higher congruence) at wave 9 and a lower profile correlation. In addition, apart from Artistic, higher interest scores at wave 1 each significantly were associated with a higher probability of a general interest loss. In contrast to profile 3, we interpret this profile as an alignment profile: students adapt their interests toward a better congruence.

Profile 5 – SE Gain

An SE gain (P5) instead of interest stability (P2) was associated with a lower profile correlation as well as with higher scores on the Realistic dimension and lower scores on the Social and Enterprising dimension at wave 1. For this profile, we see that, although missing a significance level, being female and studying medicine is associated with a higher membership probability. Considering that the effect of congruence is not significant, we interpret students in this profile as developing their interests specifically, that is, for personal growth rather than related to occupational choices.

Profile 6 – RASEC Boost

With respect to profile 6, the results indicate that a lower profile correlation, lower Realistic, and lower Conventional interests at wave 1 each were associated with a higher probability of a RASEC boost instead of interest stability; however, this profile only comprises $N = 24$ students. Looking at the profile line and the values in ESM 1: E5c we can see that only the Investigative dimension stays stable while all others increase between wave 1 and wave 9. We interpret this profile, as primarily Investigative interests are not sufficient for university studies and that students align their interests (Table 5).

When comparing these six profiles, we discover three "level"-profiles that either show a stability of interests (P2), a general increase in interests (P3), or a general loss in interests (P4). Besides this general gain or loss in interests, both profiles show effects on the congruence at wave 9 with P4 (interest loss) having a higher congruence at wave 9 and P3 (interest gain) a lower. Therefore, we interpreted P4 as an interest alignment profile toward an existing environment and P3 as an interest development profile toward a new environment. Of note, students of the STEM(-M) subjects or in medicine had higher chances to be in the P3 profile as compared to economics students. The two profiles with the specific SE pattern, P1 (SEC loss) and P5 (SE gain) are quite inconspicuous with respect to further predictors and just with tendencies STEM-L (as compared to economics students) have a higher probability to be in P1 (SEC loss) and medicine students (as compared to economics students) have a higher probability to be in P5 (SE gain). Considering this, we interpreted P1 as a profile, for the environment of STEM-L rather inhibited Social and Enterprising interests; for P5, however, we were a little bit cautious about establishing a link between the growth of these SE interests and the area of medicine although it seems plausible that these interests are important for running a medical practice. Regarding the subject-specific results, we have to note that the characteristics of the subject areas are also represented by the initial values of the six interest dimensions. Therefore, the effects regarding the dichotomous dummy variables for the subject areas always have to be interpreted against the background that the multinominal regression aims to keep the interest variables constant.

Discussion

Stability of Interests

RQ 1 investigated the stability of interests. Here, we found high stability of interest in terms of rank-order stability with

Table 5. Results of the categorical latent variable multinominal logistic regressions using the 3-Step procedure for the latent profiles compared to the largest profile P2 (stable)

	Tests of categorical latent variable multinominal logistic regressions using the 3-Step procedure			
	Unstandardized logistic regression coefficient	*SE*	Est./*SE*	Two-tailed *p*-value
Profile *1 SEC loss* (*N* = 124) with reference profile *2 stable* and economics as reference area for the subject areas				
Gender	0.274	0.570	0.481	.631
Congruence (W9)	−0.075	1.517	−0.050	.960
Persistence	0.620	0.538	1.151	.250
Profile correlation	−4.828	0.819	−5.893	.000***
Realistic (W1)	−1.330	0.925	−1.437	.151
Investigative (W1)	−0.458	0.373	−1.226	.220
Artistic (W1)	−0.238	0.477	−0.498	.618
Social (W1)	1.899	0.566	3.358	.001**
Enterprising (W1)	2.975	0.637	4.670	.000***
Conventional (W1)	0.060	0.334	0.179	.858
STEM-L	1.829	1.056	1.733	.083^{x}
STEM-M	1.037	0.951	1.091	.275
Life	−0.480	1.162	−0.413	.680
Education	−0.110	1.373	−0.080	.936
Language	−0.130	0.886	−0.147	.883
Intercept	−14.506	4.429	−3.275	.001
Profile *3 Interest gain* (*N* = 1,009) with reference profile *2 stable* and economics as reference area for the subject areas				
Gender	−0.192	0.229	−0.841	.400
Congruence (W9)	0.710	0.323	2.200	.028*
Persistence	0.318	0.198	1.601	.109
Profile correlation	−0.611	0.239	−2.555	.011*
Realistic (W1)	−0.897	0.146	−6.137	.000***
Investigative (W1)	−0.545	0.121	−4.521	.000***
Artistic (W1)	−0.315	0.121	−2.612	.009**
Social (W1)	−0.743	0.153	−4.848	.000***
Enterprising (W1)	−0.573	0.141	−4.062	.000***
Conventional (W1)	−0.636	0.132	−4.823	.000***
STEM-L	0.734	0.386	1.903	.057^{x}
STEM-M	0.970	0.359	2.701	.007**
Life	1.346	0.510	2.636	.008**
Education	0.721	0.454	1.589	.112
Language	−0.192	0.229	−0.841	.400
Intercept	9.276	1.020	9.097	.000
Profile 4 *Interest loss* (*N* = 342) with reference profile *2 stable* and economics as reference area for the subject areas				
Gender	0.158	0.313	0.504	.614
Congruence (W9)	−1.281	0.494	−2.593	.010*
Persistence	0.255	0.274	0.930	.352
Profile correlation	−0.688	0.325	−2.120	.034*
Realistic (W1)	0.545	0.165	3.311	.001**
Investigative (W1)	0.777	0.152	5.122	.000***
Artistic (W1)	0.317	0.175	1.811	.070^{x}
Social (W1)	1.056	0.272	3.885	.000***
Enterprising (W1)	1.029	0.235	4.375	.000***
Conventional (W1)	1.348	0.211	6.374	.000***
STEM-L	0.230	0.603	0.381	.704

(Continued on next page)

Table 5. (Continued)

	Tests of categorical latent variable multinominal logistic regressions using the 3-Step procedure			
	Unstandardized logistic regression coefficient	*SE*	Est./*SE*	Two-tailed *p*-value
STEM-M	0.447	0.529	0.845	.398
Life	−0.752	0.684	−1.100	.271
Education	0.248	0.702	0.353	.724
Language	−0.051	0.557	−0.091	.928
Intercept	−18.434	2.0989	−8.787	.000
Profile *5 SE gain* (*N* = 126) with reference profile *2 stable* and economics as reference area for the subject areas				
Gender	0.892	0.515	1.734	.083ˣ
Congruence (W9)	−0.624	0.844	−0.739	.460
Persistence	−0.023	0.430	−0.053	.958
Profile correlation	−3.119	0.515	−6.061	.000***
Realistic (W1)	0.512	0.254	2.019	.043*
Investigative (W1)	0.417	0.324	1.288	.198
Artistic (W1)	−0.510	0.281	−1.813	.070ˣ
Social (W1)	−2.010	0.302	−6.660	.000***
Enterprising (W1)	−1.632	0.354	−4.613	.000***
Conventional (W1)	−0.053	0.257	−0.206	.837
STEM-L	−0.939	0.772	−1.217	.224
STEM-M	−0.467	0.843	−0.554	.580
Life	1.815	0.997	1.822	.069ˣ
Education	1.286	1.393	0.924	.356
Language	1.184	1.031	1.149	.251
Intercept	8.758	1.845	4.747	.000
Profile *6 RASEC boost* (*N* = 24) with reference profile *2 stable* and economics as reference area for the subject areas				
Gender	−0.583	0.697	−0.837	.403
Congruence (W9)	−0.371	0.897	−0.413	.680
Persistence	−0.527	0.663	−0.795	.426
Profile correlation	−4.157	0.975	−4.262	.000***
Realistic (W1)	−1.564	0.610	−2.564	.010*
Investigative (W1)	−0.097	0.418	−0.233	.816
Artistic (W1)	−0.325	0.472	−0.689	.491
Social (W1)	−1.182	0.885	−1.336	.182
Enterprising (W1)	−0.657	0.596	−1.104	.270
Conventional (W1)	−2.437	0.787	−3.095	.002**
STEM-L	0.582	1.159	0.503	.615
STEM-M	0.903	1.137	0.794	.427
Life	1.440	1.684	0.855	.393
Education	0.040	2.402	0.017	.987
Language	0.162	1.395	0.116	.907
Intercept	15.629	2.993	5.223	.000

Note. **p* < .05; ***p* < .01; ****p* < .001.

correlations around .6–.7 for the total sample, and profile correlations between .7 and .8, meaning that we can confirm Hypothesis 1. This is also reflected in the latent profile analysis based on mean-level changes with a large profile of almost stable interests that comprises 72% of the students (P2). The overall stability results align well with previous research, especially the meta-analysis by Low and colleagues (2005) who reported similar magnitudes as well as with many other studies that reported stable interests with room for change (e.g., Stoll et al., 2021; Wille et al., 2014). When looking closer at the single dimensions, we saw that Enterprising and Conventional interests showed lower stability values and that these results are in line with previous research, particularly Mullis and colleagues (1998) and Wille and colleagues (2014).

When focusing on the interest stability separately for gender and subject areas, we see a decrease in stability for all but Enterprising and Conventional interests. In these groups, the strength of correlations is much more homogeneous and especially the Enterprising and Conventional interests now show a similar size to the others. Thus, we see that especially the stability of the interests that show gender differences in their means (e.g., reported by Ertl & Hartmann, 2019; Stoll et al., 2021; Su & Rounds, 2015), decrease in their stability when analyzed separately for gender and subject area. The finding indicates that the high values of interest stability reported in the literature (especially Low et al., 2005) may – at least for some studies – be attributed to subsamples with different interest levels. This interpretation is supported by the mean level analyses that show quite substantial effect sizes for interest development: the lower interest stability combined with partially higher effect sizes of the mean level differences in more homogeneous subgroups allows us to contextualize our results with other recent publications (e.g., Hanna et al., 2021; Stoll et al., 2021) who investigated samples with a much higher heterogeneity: From a general psychological perspective, the interested stability in a representative sample is most interesting. This perspective is, however, less informative when looking at individual differences, for example, when looking at an individual's interests for the sake of career counseling. From this background, we would estimate that *university* students generally show an interest rank-order stability coefficient around r = .5 within their own reference group of individuals with the same sex and a similar subject area, and the higher stabilities of the total sample may result from differences regarding gender and/or subject areas like described, for example, by Ertl and Hartmann (2019), Stoll and colleagues (2021) and Su and Rounds (2015).

The notably lower correlation coefficients of the gendered subsamples and subject areas that partially were predictors for several latent profiles indicate that individual interest development is underestimated in heterogeneous samples and should further be investigated, for example, by more differentiated profile analyses with respect to the different subject areas.

Profiles of Interest Development

RQs 2 and 3 focused on profiles for developing interests as well as on their prediction. In RQ 1, we saw stabilities between .4 and .6 for the most interest dimensions when focusing on the subject areas – which is pretty low compared to the much higher values for the total sample and the profile correlations. This indicated a notable development of the individual's interests during university time, especially when further considering the effect sizes in the mean level differences. This was also reflected by the latent profile analysis: Besides the large profile with almost stable interests, we got twice two corresponding profiles like interest gain (P3) and interest loss (P4) as well as SEC loss (P1) and SE gain (P5). These corresponding profiles reflect individual development with some profiles focusing on specific interest dimensions like the SEC loss (P1) and SE gain (P5). Gender was not a major predictor for these profiles; however, Realistic and Social interests were predictors for several profiles and thus the notable gender differences in both dimensions (on a mean level) that are reported by several authors (e.g., Ertl & Hartmann, 2019; Stoll et al., 2021; Su & Rounds, 2015) may already account for the gender effects. Furthermore, we found congruence at wave 9 to be a significant predictor for some profiles with P4 (interest loss) being one of them and showing a higher congruence than the stable profile. This could indicate interest alignment processes toward a better fit described, for example, by Yang and Barth (2015). The opposite is true for P3 (interest gain) which is characterized by a lower congruence at wave 9 compared to the stable profile. Looking into further indicators, students of STEM fields and medicine have higher chances to be in this profile. As our previous studies found lower congruence of students in the STEM fields (Ertl & Hartmann, 2019), we would assert that the lower values reflect the STEM students in this profile.

We assumed lower stability of students in atypical areas like, especially, female students in STEM-L although we could not provide enough evidence from the literature to state a clear hypothesis about that. The analyses of this paper were primarily able to provide evidence for this assumption by revealing a significantly lower profile correlation of female students in STEM-L – in comparison with their male mates in STEM-L but also in comparison with their female mates in all other subject areas. This points toward issues, for example, belonging uncertainty (see Ertl et al., 2022; Höhne & Zander, 2019) that characterizes female students in atypical areas much more than male students in atypical ones (Zander & Höhne, 2021). For male students, however, we did not find a similar effect and indeed, Artistic interests are most stable in the languages. This may be a phenomenon of male students in atypical areas who seem to appreciate being surrounded by female mates (see Zander & Höhne, 2021).

Besides that, we saw quite substantial mean level differences for several interests and subject areas during university time that should be considered during career counseling and also investigated by further area-specific analyses, for example, of latent profiles for the different areas.

When summarizing our insights from these analyses, we can see specific developmental profiles for students' interests with some of them being more associated with specific subject areas. Furthermore, we see different stabilities of vocational interests with respect to the interest dimension, gender, and study area. We realized that for more homogeneous subsamples, the sizes of the correlation decreased while the effect sizes of the mean level differences partially increased – an issue that calls for more in-depth analyses of subject areas.

Limitations

The limitations of this study emerge from its large-scale panel study design and relate to panel loss and the compromises required for large-scale studies (see also Ertl et al., 2022). Its longitudinal approach required students to be present at both times of the survey, that is, a time spanning four and a half years. As with every panel study, NEPS was subject to panel loss. Because panel loss may result from vocational re-orientation, dropout, or failing a university program, we cannot consider these students as missing at random. Furthermore, Heublein (2014) shows subject-specific differences in university dropout rates. Considering both, we do not have sound prerequisites for common imputation algorithms like Full-Information-Maximum-Likelihood (FIML) and have to narrow our results to the students that are persisting in the panel for both waves. Our results must therefore be interpreted conservatively: Stoll and colleagues (2021) discuss that interest changes are more likely to occur during normative transitions and dropping out or failing in a study program may be one of those. Furthermore, Mouton and colleagues (2020) already reported a loss of interest as a major reason for university dropout. Thus, we should assume that the true effects may be larger than reported in this study.

Another limitation of this study relates to the large-scale design that allows the survey to have a large number of students, while also implying the use of short scales for interest assessment. In the current study, NEPS assessed vocational interests with only three items per dimension (see Wohlkinger et al., 2011). The issue of expectably low reliabilities and their respective validity is increasingly being discussed in psychological research (Rammstedt & Beierlein, 2014) with Ziegler and colleagues (2014) mentioning that these kinds of short scales can be appropriate for correlational studies like we did, even when showing lower reliabilities.

The third limitation relates to the sample size. Although the sample of SC5 initially comprised 17,910 students, the longitudinal design, the focus on a specific age group, and the subject- and gender-specific analyses resulted in shrinking sample sizes. The most apparent example of this was male students in education who are generally under-represented in this subject area. For the comparisons of gender and subject-specific interest stability, only 41 students remained as an available sample.

Finally, the current study used profile correlations as a measure of respondents' interest stability. A profile correlation compares the profiles' shape (instead of its scatter or elevation; Cronbach & Gleser, 1953; Kenny et al., 2006), which is the most important profile component in the framework of Holland's (1997) theory. According to Furr (2008), calculating profile correlation between two raw and unadjusted profiles means measuring the overall interest stability, which can be related to the normativeness problem. Building upon Furr's work and considering aspects of distinctiveness and normativeness, future studies could additionally give insights into further components of interest stability. Determining cross-profile normativeness components (e.g., the similarity between a person's interest profile at time 1 and the average interest profile across all individuals at time 2), for example, could show to what extent a student is more or less mature in his or her interest development than his or her mates. For the current study, however, we wanted to show gender and subject differences for interest stability with measures comparable to earlier research. Providing further aspects of interest stability as well as further measures like, for example, latent correlations would, although being interesting, rather have blurred the key findings of this paper rather than brought substantially more insights. Comparing the specifics and differences between such stability measures, however, should be a focus of future research.

Summary and Conclusion

We motivated this paper with a focus on university time as a transition between school and occupation and interest inventories that support students in their decision for a future occupation. The stability of interests is an essential aspect for such settings because inventories try to forecast a fit to an occupation that may be entered several years later. Our study localized the high stability of students' vocational interests on the level of the total sample. Looking deeper into their profiles, we could identify a large group of students with almost stable interests which seems to be a sound background for such forecasts. However, we also found several smaller groups with notable changes in their interests. Furthermore, the study revealed a trend of decreasing stability of interests for more homogeneous subsamples. This implicates notable interest development during university time relative to one's own reference group (students of the same gender in the same study field) that should be considered when discussing issues like university dropouts (see also Mouton et al., 2020).

The development, however, differs with respect to the various interest dimensions, gender, and subject areas: Without significant gender differences in the profile correlations, we identified a higher stability in Investigative and Artistic and a lower stability for Realistic interests with female students. We also found specific subject effects with differences in the stability of students' interests in some areas. This points toward the necessity to distinguish between study areas when looking into the stability of interests. Of note, female students in STEM-L showed significantly lower profile correlations that may indicate that female students in STEM-L feel a stronger need to develop their interests than other students. The measure of profile correlation thereby indicates that especially the ranking of the six interest dimensions between both waves changes significantly more for female students in STEM-L than for male students or female students of other subject areas. Reflecting on the variety of initiatives for bringing the female student into STEM(-L) areas, one should consider that it might not be enough just to bring these students into STEM but that also support during this process of interest development should be developed and offered.

The comparably lower correlations for the gendered subject areas as well as the effect sizes of the mean level differences show substantial interest development within them and call for more detailed analyses, for example, by latent profile analyses or latent transition analyses to reveal how far students develop from one profile to another. Such analyses could go deeper into specific aspects of person-environment fit and reveal student characteristics that make students align their interests (e.g., Yang & Barth, 2015) or gravitate to another area (e.g., Wille et al., 2014) and thereby improve career counseling for university students. The challenge for this, however, lies in the shrinking sample sizes when looking with greater differentiation into the subject areas as discussed in Ertl and colleagues (2020). So, while meta-analyses like Low and colleagues (2005) and Hoff and colleagues (2018) can provide an impression of the general stability of interests, future research can go into greater detail by focusing on specific types of developments that are associated with different environments. These should also be considered when analyzing predictors for the stability of interests, as found, for example, by Hirschi (2010).

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1027/1614-0001/a000392

ESM 1. Additional tables and figures for the methods and results section.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Authorship

All authors contributed to the study's conception and design. Material preparation, data analysis was performed by Bernhard Ertl, Anja Wunderlich. The first draft of the manuscript was written by Bernhard Ertl and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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