Understanding the Persistence of Occupational Sex Segregation: The Role of Gender Stereotypes on Study Choice

Milena Gaede

Note that some graphs/tables/images have been removed in order to comply with copyright restrictions.

M.Sc. in Education (Comparative and International Education), 2025

DECLARATION BY THE CANDIDATE AS AUTHOR OF THE DISSERTATION

1. I understand that I am the owner of this dissertation and that the copyright rests with me unless I specifically transfer it to another person.
2. I allow the Department to deposit on my behalf a copy of this dissertation in the Oxford University Research Archive ('ORA') where it shall be freely available online for use in accordance with ORA's Terms and Conditions of Use [https://ora.ox.ac.uk/terms_of_use].
3. I understand that this dissertation should not contain material that can be used to personally identify individuals or specific groups of individuals (unless permission has been obtained from the individuals) and that such material should be removed before this dissertation is deposited in ORA.
4. I agree to be bound by the terms of the ORA Grant of Non-exclusive Licence [https://ora.ox.ac.uk/deposit_agreements] and I warrant that to the best of my knowledge, making my thesis available on the internet will not infringe copyright or any other rights of any other person or party, nor contain defamatory material.
5. I agree that my dissertation shall be available for download in ORA in accordance with paragraphs 2, 3 and 4 above.

Signed [an electronic signature is sufficient]:	
Date:	18.12.2025

Abstract

Despite notable progress in female higher education attainment and labour market participation over the past decades, large gender inequalities persist in modern labour markets, which are largely attributable to occupational sex segregation. The choices young people make when transitioning from secondary school into higher education and vocational training are a crucial lever maintaining this segregation, especially in labour markets with low occupational mobility such as Germany. The underlying factors of gender typical study choice, however, remain insufficiently understood. Building on previous research that points to the central role of gender stereotypes and in line with Expectancy-Value theory, this study examined both direct and indirect links between gender stereotypes and study choice, incorporating central motivational factors, namely vocational interests and academic self-concepts. Using data from the German National Educational Panel Study (NEPS), Startin Cohort 3 (SC3, N=1,337), the current study examined whether gender stereotypes, measured as gender role attitudes in grade 6, predict gender typical study choice when entering higher education. Results confirmed that gender role attitudes in grade 6 were significantly related to gender typical study choice among boys, but not for girls. Furthermore, gender role attitudes in grade 6 significantly predicted lower interests in gender atypical interest domains among both boys and girls, underlining limiting effects of gender stereotypes. Indirect effects were not evident, neither via interests nor academic self-concept. While effect sizes were small and only explained a small part of the variance, these findings suggest that gender stereotypes play role for study choice, as early as grade 6, calling for further research to confirm these early influences of gender stereotypes for study choice, and consequently, the persisting occupational sex segregation.

Contents

1. Introduction 10

2. Occupational Sex Segregation 12

2.1. Definition and Current Trends 12

2.2. Theoretical Explanations 15

2.3. Gender, Gender Stereotypes and Gender Role Attitudes 17

3. Study Choice and Gender 21

3.1. Expectancy-Value Theory 21

3.2. Determinants of Study Choice 22

3.3. Role of Gender Stereotypes for Study Choice 26

3.4. Study Aim and Research Questions 31

4. Methodology 33

4.1. Database 33

4.2. Ethics 33

4.3. The Sample 34

4.4. Measures 35

4.5. Analytic Procedures 41

4.6. Preliminary Analyses 42

5. Results 45

5.1. Descriptive Statistics 46

5.2. Inferential Statistics 49

6. Discussion 57

7. Conclusion 63

8. Sources 65

A. Appendix 74

A.1 NEPS Study Design *74*

A.2 Data Assumptions *75*

A.3 Missing Data Analysis *116*

A.4 Data Preparation *119*

A.5 Data Use Agreement *124*

List of Tables

1 Measurement points, respondents and survey mode 35

2 Descriptive Statistics 46

3 Most common study majors 47

4 Bivariate correlations 48

5 Gender differences 51

6 Summary of Fit Statistics for Indirect Path Models, by sex 53

A.1 Skewness and Kurtosis 75

A.2 Internal Consistency of the observed variables 113

A.3 Missing data per variable 115

A.4 Average female share within each study area (Destatis 2010/11) 120

List of Figures

1 Average sex distribution across university majors in Germany 14

2 Gender attributions among 15-year-olds 19

3 Hypothesized Path Model 32

4 Model I, direct effects 52

5 Modell II, direct and indirect effects (boys) 54

6 Modell II, direct and indirect effects (girls) 55

A.1 Multi Cohort Sequence Design of the NEPS 74

A.2 Histogram of IILS-R, boys 76

A.3 Histogram of IILS-R, girls 76

A.4 Normal Q-Q Plot of IILS-R, boys 77

A.5 Normal Q-Q Plot of IILS-R, girls 77

A.6 Histogram of IILS-I, boys 78

A.7 Histogram of IILS-I, girls 78

A.8 Normal Q-Q Plot of IILS-I, boys 79

A.9 Normal Q-Q Plot of IILS-I, girls 79

A.10 Histogram of IILS-A, boys 80

A.11 Histogram of IILS-A, girls 80

A.12 Normal Q-Q Plot of IILS-A, boys 81

A.13 Normal Q-Q Plot of IILS-A, girls 81

A.14 Histogram of IILS-S, boys 82

A.15 Histogram of IILS-S, girls 82

A.16 Normal Q-Q Plot of IILS-S, boys 83

A.17 Normal Q-Q Plot of IILS-S, girls 83

A.18 Histogram of IILS-E, boys 84

A.19 Histogram of IILS-E, girls 84

A.20 Normal Q-Q Plot of IILS-E, boys 85

A.21 Normal Q-Q Plot of IILS-E, girls 85

A.22 Histogram of IILS-C, boys 86

A.23 Histogram of IILS-C, girls 86
A.24 Normal Q-Q Plot of IILS-C, boys 87
A.25 Normal Q-Q Plot of IILS-C, girls 87
A.26 Histogram of ASC-M, boys 88
A.27 Histogram of ASC-M, girls 88
A.28 Normal Q-Q Plot of ASC-M, boys 89
A.29 Normal Q-Q Plot of ASC-M, girls 89
A.30 Histogram of ASC-G, boys 90
A.31 Histogram of ASC-G, girls 90
A.32 Normal Q-Q Plot of ASC-G, boys 91
A.33 Normal Q-Q Plot of ASC-G, girls 91
A.34 Histogram of GRA, boys 92
A.35 Histogram of GRA, girls 92
A.36 Normal Q-Q Plot of GRA, boys 93
A.37 Normal Q-Q Plot of GRA, girls 93
A.38 Histogram of Gender Typicality of Study Major, boys 94
A.39 Histogram of Gender Typicality of Study Major, girls 94
A.40 Normal Q-Q Plot of Gender Typicality of Study Major, boys 95
A.41 Normal Q-Q Plot of Gender Typicality of Study Major, girls 95
A.42 Bivariate Scatterplot of GRA and Study Major, boys 96
A.43 Bivariate Scatterplots of RIASEC, ASC and Study Major, boys 97
A.44 Bivariate Scatterplots of GRA and RIASEC, ASC, boys 97
A.45 Bivariate Scatterplot of GRA and Study Major, girls 98
A.46 Bivariate Scatterplots of RIASEC, ASC and Study Major, girls 99
A.47 Bivariate Scatterplots of GRA and RIASEC, ASC, girls 101
A.48 Standardized Residuals vs. Fitted Values, IILS-R, boys 102
A.49 Standardized Residuals vs. Fitted Values, IILS-I, boys 102
A.50 Standardized Residuals vs. Fitted Values, IILS-A, boys 103
A.51 Standardized Residuals vs. Fitted Values, IILS-S, boys 103
A.52 Standardized Residuals vs. Fitted Values, IILS-E, boys 104

A.53 Standardized Residuals vs. Fitted Values, IILS-C, boys 104
A.54 Standardized Residuals vs. Fitted Values, ASC-M, boys 105
A.55 Standardized Residuals vs. Fitted Values, ASC-G, boys 105
A.56 Standardized Residuals vs. Fitted Values, Gender Typicality, boys 106
A.57 Standardized Residuals vs. Fitted Values, IILS-R, girls 106
A.58 Standardized Residuals vs. Fitted Values, IILS-I, girls 107
A.59 Standardized Residuals vs. Fitted Values, IILS-A, girls 107
A.60 Standardized Residuals vs. Fitted Values, IILS-S, girls 108
A.61 Standardized Residuals vs. Fitted Values, IILS-E, girls 108
A.62 Standardized Residuals vs. Fitted Values, IILS-C, girls 109
A.63 Standardized Residuals vs. Fitted Values, ASC-M, girls 109
A.64 Standardized Residuals vs. Fitted Values, ASC-G, girls 110
A.65 Standardized Residuals vs. Fitted Values, Gender Typicality, girls 110
A.66 Q-Q Plot of Mahalanobis Distances, boys 111
A.67 Q-Q Plot of Mahalanobis Distances, girls 111
A.68 Mahalanobis Distances for Endogenous Variables, boys 112
A.69 Mahalanobis Distances for Endogenous Variables, girls 113
A.70 Location of missing data across all variables 115
A.71 Relationship between missing data across the predictor variable 117

List of Acronyms

CFI	Comparative Fit Index
CUREC	Central University Research Ethics Committee
DESTATIS	Federal Statistical Office of Germany
EVT	Expectancy-Value Theory
FIML	Full Information Maximum Likelihood
IAT	Implicit Association Tests
IILS	Interest Inventory Life Span
ISCED	International Standard Classification of Education
LIfBi	Leibniz Institute for Educational Trajectories
MAR	Missing At Random
MCAR	Missing Completely At random
ML	Maximum Likelihood
MLR	Robust Maximum Likelihood
NEPS	National Educational Panel Study
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modeling
SRMR	Standardized Root Mean Square Error
STEM	Science, Technology, Engineering, and Mathematics
SUF	Scientific Use file
VIF	Variance Inflation Factors

1. Introduction

Despite notable progress in female higher education attainment and labour market participation over the past decades, large gender inequalities persist in modern labour markets (Ochsenfeld, 2016). In Germany, the unequal distribution of incomes is particularly high with a gender pay gap of 18% in 2023, ranking fifth to last within the European Union (Federal Statistical Office of Germany, 2024). A large body of research attributes a substantial share of this gap to the segregation of women and men into different occupations, leading scholars to argue that "the study of gender-based inequalities reduces in large part to the study of occupational segregation" (Charles and Grusky, 2004; O'Brien, 2009).

Occupational sex segregation is often portrayed as a phenomenon that will gradually disappear as women's educational attainment and labour force participation increase (Charles and Grusky, 2004; Rendtorff, Kleinau, and Riegraf, 2016). In line with this view, the educational success of girls is frequently interpreted as evidence that remaining gender differences are either unproblematic or will diminish over time (Hannover and Wolter, 2022). However, empirical evidence suggests otherwise. Scholars have argued that "there is little hope that closing the gender gap in labour force participation or educational attainment will close the remaining gaps in occupational positions and earnings" (Humlum, Nandrup, and Smith, 2019). Germany provides a striking example of this pattern. Although women are overrepresented among school graduates with university entrance qualification (*Abitur*) (Federal Statistical Office of Germany, 2025a), they earn less compared to men, continue to be largely underrepresented in management positions (Federal Statistical Office of Germany, 2023) and are concentrated in a relatively narrow range of professions. Women dominate service, healthcare and educational professions, while men remain overrepresented in technical and manual fields (Bächmann, Kleinert, and Schels, 2024), with no meaningful change since the early 1990s (Federal Statistical Office of Germany, 2025b).

The choices young people make when transitioning from secondary school into higher education and vocational training are a crucial lever maintaining this segregation, especially in labour markets with low occupational mobility such as Germany (Aisenbrey and Brückner, 2008). Indeed, university major choice plays a particularly decisive role: approximately three-quarters of the gender earnings gap at labour

market entry in Germany can be explained by differences in fields of study among graduates with comparable qualifications (Braakmann, 2008). The underlying factors of gender typical study choice, however, remain insufficiently understood.

While research largely points to gendered preferences and differences in academic self-concepts as central determinants for gender typical study choice (Ochsenfeld, 2016), often treating study choice as largely self-determined, further research needs to be done to understand patterns leading to these gender differences in preferences and academic self-concepts. From an Expectancy-Value theory perspective (Wigfield and Eccles, 2000), motivational factors shaping educational choices such as study choice are viewed to be shaped in long-lasting socialisation processes with gender roles and gender stereotypes playing a particularly central role. Supporting this perspective, recent findings have confirmed links between gender role attitudes and gender typical occupational aspirations among German adolescents (e.g. Chesters, 2022, 2023). However, research extending these links on study choice remains scarce, constituting a relevant research gap. Furthermore, much of the research around study choice focuses on the few years before university entry, potentially dismissing long-term influences on central motivational factors that lead to consistently gender patterns. Similarly, practical measures currently in place in education to address occupational sex segregation are largely focused on career counselling in upper secondary education[1], which may be too late if gender stereotypes shape boys' and girls' preferences and self-concepts from early childhood on.

Addressing these research gaps, the present study adopts a longitudinal perspective using a representative sample from the German National Educational Panel Study (NEPS) and investigates whether gender stereotypes, measured as gender role attitudes in grade 6, predict gender-typical study choice when entering higher education.

[1] See e.g. the initiative "Klischeefrei" (Cliché free) of the Federal Ministry of Education (2020).

2. Occupational Sex Segregation

The following chapter examines the phenomenon of occupational sex segregation and its continued persistence despite progress in female education attainment and labour market entry. First, key definitions and current empirical trends are outlined, with a particular focus on the German context. The chapter then reviews central theoretical explanations, spanning institutional, neo-classical, and sociological perspectives, to explain both demand- and supply-side mechanisms behind gendered occupational patterns. Finally, it turns to gender stereotypes as a potential factor influencing educational choices.

2.1. Definition and Current Trends

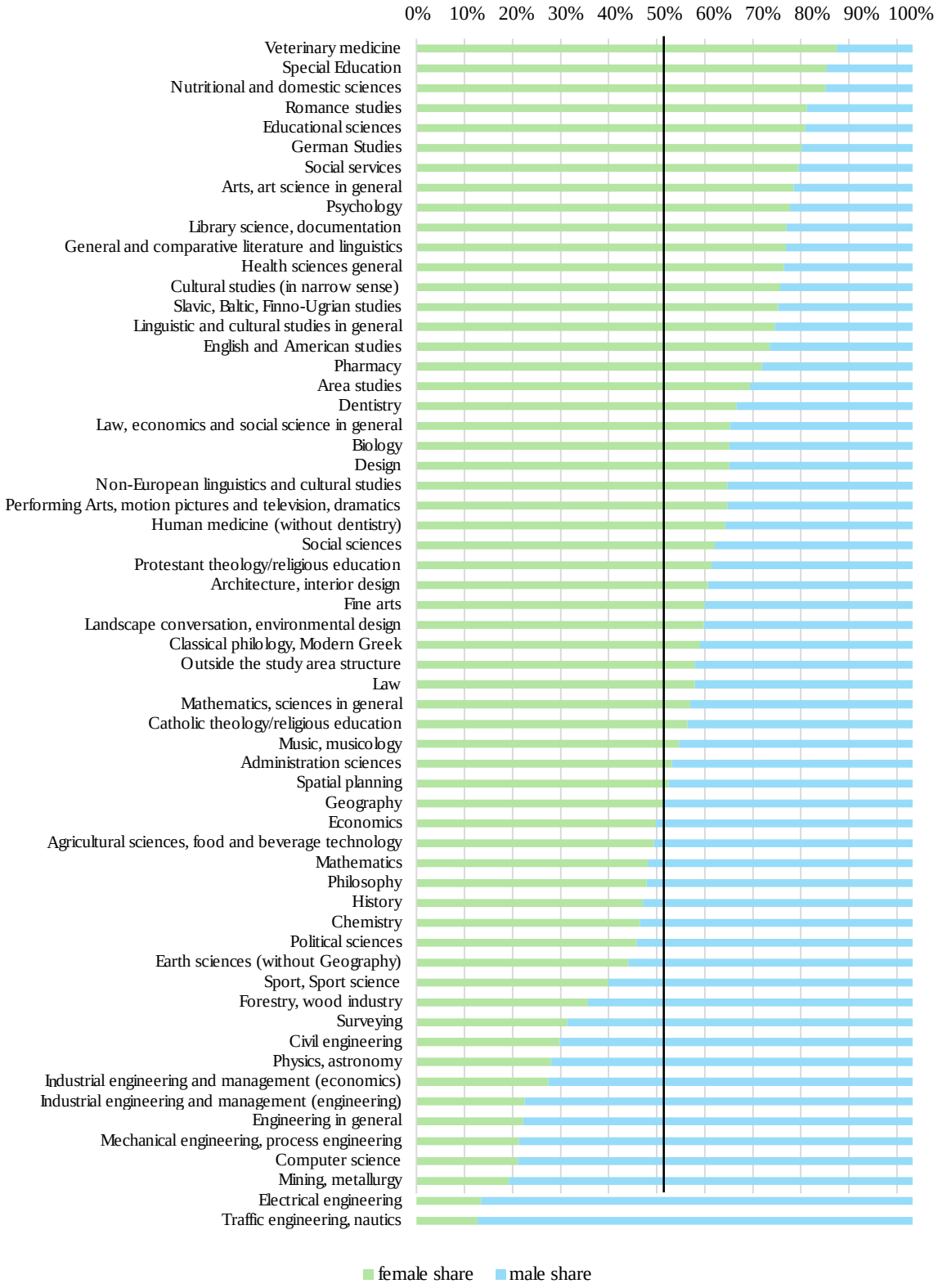
Labour markets globally continue to be highly segregated by sex (Charles and Grusky, 2004). This *occupational sex segregation* can be defined as the unequal distribution of women and men across occupations, jobs and work places (O'Brien, 2009). Most people work in occupations largely dominated by individuals of their own sex, while men dominate leadership positions. According to Charles and Grusky (2004), two distinct dynamics drive this segregation, "a horizontal dynamic that segregates men and women across the manual-nonmanual divide, and a vertical dynamic that allocates men to the most desirable occupations on both sides of this divide" (Charles and Grusky, 2004). The horizontal dynamic is especially prevalent among women, who tend to be concentrated in a limited range of occupations that are associated with lower wages and limited career advancement (Polavieja and Platt, 2014), thus considerably contributing to persisting gender inequalities in the labour market.

In Germany, labour market patterns reflect the global persistence of occupational sex segregation, with horizontal and vertical segregation continuing to shape gendered employment structures. Women continue to be significantly underrepresented in top level positions, making up less than a third of management positions (Federal Statistical Office of Germany, 2023), attesting the continuously high level of *vertical segregation*. In terms of *horizontal segregation*, roughly 55 per cent of employed women in Germany would have had to change their profession in 2019 for the distribution of men and women within professions to match their distribution in total employment (dissimilarity index) (Bächmann, Kleinert, and Schels, 2024). Women continue to be overrepresented in service, healthcare, and educational professions, while men dominate technical and manual occupations (Bächmann, Kleinert, and Schels, 2024). This horizontal segregation is already visible in the choice of university

majors, which continues to be highly segregated by sex, without any meaningful change over the past decades (Jusri, 2024). As in the labour market, women are overrepresented in service-, healthcare-, and education-related majors, while men dominate technical and manual fields (see **Figure 1**) (Eurostat, 2025, authors' calculations). Large proportions of students are enrolled in gender typical majors where their own sex is largely overrepresented. Among first-year students in 2023, 42% of women and 38% of men enrolled in majors with a female (male) share of 70% or above (Federal Statistical Office of Germany, 2025c, own calculations). No less than 37.5% of female (male) students would have needed to change their degree to achieve gender parity across university majors (Federal Statistical Office of Germany, 2025c, own calculations).

Taken together, these patterns illustrate that occupational sex segregation remains a persistent and multifaceted phenomenon. To understand why these gendered structures persist, the following section reviews central theoretical approaches that have been proposed to explain both the emergence and the persistence of occupational sex segregation.

Figure 1. Average sex distribution across university majors in Germany (2010-2025)



Source: Author's illustration based on data Destatis (Federal Statistical Office of Germany, 2025c).

2.2. Theoretical Explanations

The persistence of occupational sex segregation is striking, especially given the higher influx of women into employment. Scholars have proposed a range of theoretical explanations to answer the questions why women and men are unequally distributed across occupations and management positions and why this segregation persists (Steinmetz, 2012). Often, a distinction is made between demand-side and supply-side factors (Charles and Grusky, 2004; Philipp, 2023; Polavieja and Platt, 2014). Theories of sex segregation can be classified into three broad categories: institutional theories, neo-classical theories and sociological theories (Estévez-Abe, 2006; Steinmetz, 2012).

From an institutional perspective, occupational sex segregation is understood as the outcome of institutional structures and policy frameworks that shape individuals' opportunities and constraints, hence primarily focus on the demand-side (Steinmetz, 2012). Accordingly, institutional approaches highlight the role of formal regulations, welfare state arrangements, and labour market regulations in influencing gendered employment patterns (Steinmetz, 2012). Legislation such as anti-discrimination laws and protective labour regulations can either promote or hinder women's unrestricted access to certain occupations (Steinmetz, 2012). Likewise, family policies constitute a central mechanism through which welfare states aim to facilitate women's participation in the labour market and to reduce the conflict between work and family responsibilities (Steinmetz, 2012). However, empirical evidence shows that even countries most committed to gender equality and family-friendly policies remain deeply sex-segregated. For instance, Sweden—often regarded as highly egalitarian and supportive of work-family reconciliation—continues to exhibit a pronounced gendered division of labour (Charles and Grusky, 2004). While institutional reforms may contribute to delegitimise vertical forms of segregation, "the logic of egalitarian policy is not inconsistent with the persistence or even the growth of horizontal forms of segregation" (Charles and Grusky, 2004). However insightful, institutional perspectives alone are not sufficient in explaining occupational sex segregation, especially not the horizontal dimension, as they primarily focus on demand-side factors and thus do not account for nor explain gender differences in preferences and aspirations (Polavieja and Platt, 2014).

In contrast to institutional theories, neo-classical theories emphasise individual choices, and thus also incorporate supply-side factors. From a neo-classical perspective, occupational sex segregation is explained through the notion of *rational*

choice, assuming individuals in the labour market act as *homo oeconomicus*, seeking to maximise their personal benefits, a perspective closely linked to human capital theory (Steinmetz, 2012). Accordingly, workers are seen as choosing occupations that best align with their own skills and qualifications (human capital), constraints (such as family responsibilities), and preferences (for example, working conditions or flexibility) (Steinmetz, 2012). Within this framework, men and women are assumed to make different but rational decisions when investing in education and career paths, with women prioritising options that facilitate a balance between work and family life over maximising lifetime income, and men investing in human capital that enables them to access higher-paying positions. Hence, gendered occupational patterns are interpreted as reflecting men's and women's preferences rather than structural inequalities. However, this approach has been criticised for overlooking pre-labour market, societal forms of discrimination and for assuming that individual preferences and choices are entirely voluntary (Steinmetz, 2012). Moreover, in line with this approach gender inequalities should decrease with a reduction in gender differences in human capital, yet empirical evidence shows the opposite, with occupational sex segregation remaining high despite increasing gender equality in educational attainment, labour force participation, and declining fertility rates (Steinmetz, 2012).

Sociological theories, in contrast to neo-classical approaches, focus on the social and cultural dimensions underlying occupational sex segregation (Steinmetz, 2012). Children are viewed to develop gender-specific self-perceptions and preferences during childhood, which in turn influence their educational choices and future labour market behaviour (Malin, 2018; Steinmetz, 2012). The horizontal and vertical dimensions of occupational sex segregation are argued to derive from two deeply rooted ideological principles: *male primacy* and *gender essentialism* (Charles and Grusky, 2004; Steinmetz, 2012). The ideological belief in male primacy is viewed to shape vertical segregation by portraying men as more status worthy than women, while horizontal sex segregation particularly arises from perceptions of sex differences in skills and traits (gender essentialism), portraying women as more competent than men in areas such as service, nurturance, and social interaction (Charles & Grusky, 2004), feeding both into the demand-side and supply-side. Especially for the horizontal dimension, gender stereotypes are viewed to play a key role (Charles & Grusky, 2004). Building on the idea that sex segregation reflects the "indulgence of gendered selves" (Charles and Bradley, 2009a), scholars argue that occupational sex segregation is likely to persist even in contexts of rising gender egalitarianism (Charles

and Grusky, 2004). In cultural settings that emphasize individual choice, segregation resulting from gendered preferences is often perceived as a legitimate outcome rather than a form of inequality, thereby limiting pressures for structural change (Ochsenfeld, 2016). Accordingly, this theoretical perspective not only addresses potential causes for occupational sex segregation both on the demand-side and the supply-side but also contributes a possible explanation for its persistence.

Overall, the presented theoretical approaches indicate that individual selection processes are rarely independent. Instead, they are shaped by culturally embedded gender beliefs and structural and institutional constraints such as economic conditions and welfare policies within a given context. While these theories should be viewed as complementary for a more comprehensive explanation of occupational sex segregation and its persistence overall (Charles and Grusky, 2004; Steinmetz, 2012), the horizontal dimension—most relevant for understanding the high levels of segregation in higher education—is best understood through the tenet of gender essentialism, pointing to gender stereotypes as a central mechanism behind gender-typical behaviour in both educational and occupational decisions. The following section therefore examines the content, formation, and consequences of gender stereotypes in more detail, and explores how these stereotypes relate to gender role attitudes.

2.3. Gender, Gender Stereotypes and Gender Role Attitudes

Up to the present day, gender continues to serve as one of the most central categories "among the many classificatory systems that shape social relations and identities" (Charles and Bradley, 2009a). Despite increasing awareness and attempts to acknowledge the diversity of lived realities, the binary notion of gender continues to persist and impact the way gender is perceived and perpetuated (Sauer, 2016). While the sex assigned at birth serves mainly as a legal and administrative category (Butler, 2024), there is widespread consensus in gender studies, that gender identity, gender specific interests and skills do not stem from the sex assigned at birth and are rather understood as resulting from gender as a social construct, rejecting notions of biological essentialism (Butler, 2015, 2024; West and Zimmerman, 1987). The belonging to a gender as well as gender differences are constructed and reproduced in social interactions (Brake, 2012), influencing individuals in a constant and complex process, affecting their thinking, their self-image and self-perception, their interests and consequently, what they believe they are capable of (Rendtorff, Kleinau, and

Riegraf, 2016). In socialisation processes, which can be defined as "the process by which people acquire the behavior and beliefs of the social world [...] in which they live" (Arnett, 1995), *gender stereotypes* are considered a central lever for the perpetuation of gendered expectations and attributions.

Gender stereotypes refer to the link between a sex category and particular attributes and expectations, encompassing both "how women and men are perceived and what is expected of them (i.e., descriptive and prescriptive component of stereotypes)" (Eagly, 1987). According to Social Role Theory, these stereotypes are viewed to develop from "the distribution of men and women into social roles within their society" (Eagly and Wood, 2016) and are commonly structured along the dimensions of agency vs. communion or things vs. people: Women are more likely associated to activities involving interactions with people, care, and social responsibility (communal role), whereas men are typically associated with dealing with "things," providing financially (e.g., breadwinner), and assuming positions of authority (agentic role) (Eagly and Wood, 2016). These contents of gender stereotypes have shown "much consistency across time and space" (Charles and Bradley, 2009b). The most recent *SINUS Youth Study*[2] confirms these consistent binary gender attributions along the lines of agency vs. communion among young adults in Germany (see **Figure 2**), with almost all interviewees attesting continued gender-based attributions as well as role expectations (Calmbach et al., 2024). Though many of the young adults did not agree with these gender stereotypes and viewed them to be outdated, still, they had fully internalised these attributions and continue to be affected by them either consciously or unconsciously (Calmbach et al., 2024).

[2] The SINUS Youth Studies are a cross-sectional study series that analyse the diverse lifestyles, values and orientations of young people between the ages of 14 and 17 in Germany. Conducted approximately every four years, the qualitative study provides insights into shifting youth perspectives on key societal issues and explores how young people perceive traditional and modern gender roles, how these influence their aspirations and relationships, and the extent to which they challenge or reproduce gender stereotypes (SINUS, 2025).

The figure originally presented here cannot be made freely available via ORA because of copyright.

The figure was sourced at Calmbach, M.; Flaig, B.B.; Gaber, R.; Gensheimer, T.; Mler-Slawinski, H.; Schleer, C.; Wisniewski, N. 2024. *Wie ticken Jugendliche? 2024: Lebenswelten von Jugendlichen im Alter von 14 bis 17 Jahren in Deutschland*. Wie ticken Jugendliche, 5. Bonn: Bundeszentrale f politische Bildung.

Everyday observations of gender roles, such as the overrepresentation of men in computer science and mechanical engineering and women in education and veterinary medicine largely confirm and perpetuate these gender stereotypes and has led to consistent perceptions of occupations and study fields as being typically male or female (Cejka and Eagly, 1999; Gottfredson, 1981). These stereotypes, however, do not merely describe perceived differences; they actively shape how individuals see themselves and others, thereby influence behaviour across the life course. Through processes of socialisation, children internalise gender stereotypes about male and female characteristics. As cognitive schemata that are automatically activated and applied, they shape both self-perception and the perception of others (Elsen, 2020). "When girls internalize essentialist stereotypes that associate males with physical labor, they become less likely to prefer and aspire to physically strenuous work [...]. This mechanism accordingly presumes that gender-specific preferences are internalized early in life, affect subsequent investment decisions and aspirations, and form a stable component of the adult personality" (Charles and Grusky, 2004). In those terms, gender stereotypes can act as self-fulfilling prophecies: Through cognitive schemata they influence the perception of others, which in turn influences self-perception leading to corresponding behaviour. As they are based on rigid and overly simplistic assumptions, gender stereotypes limit children in their development, self-expression and life aspirations (Elsen, 2020).

Closely linked to gender stereotypes, and conceptualized as the "subjectively perceived degree of appropriateness" of such stereotypes (Taraszow, Gentrup, and Heppt, 2024),

are *gender role attitudes*[3]. Gender role attitudes are defined as "individual beliefs about the roles of men and women in family life and at the workplace" (Athenstaedt, 2000) and are commonly conceptualized as a continuum between traditional and egalitarian views (Taraszow, Gentrup, and Heppt, 2024). Traditional gender role attitudes are closely related to gender stereotypes and comprise both the ideas of gender essentialism and male primacy (Charles and Bradley, 2009b). Along the lines of agency vs. communion underlying gender stereotypes, individuals with traditional gender role attitudes tend to endorse a clear division of roles in family life, expecting women to focus on caregiving and domestic responsibilities, while men assume the breadwinner' role (Ehrtmann and Wolter, 2018). In contrast, individuals with egalitarian would "reject differences between the genders as described by gender stereotypes and disapprove of individuals being assigned to different tasks and resources based on their gender" (Wolter, Braun, and Hannover, 2015). Instead, they would "endorse an equal task division as well as equal occupation opportunities for women and men and would also associate the same abilities with women and men" (Ehrtmann and Wolter, 2018).

According to Athenstaedt (2000), men tend to hold more traditional views about gender roles than women, which is supported by recent findings confirming notable differences remain between girls and boys, with boys holding more traditional views than girls (Chesters, 2022). Although traditional gender role attitudes overall have weakened among both men and women over time they may still contribute to explaining persistent differences in educational and occupational choices (Dicke, Safavian, and Eccles, 2019).

Overall, understanding how gender stereotypes develop and operate and how they relate to operationalisable gender role attitudes, is essential for explaining persistent gendered patterns in educational and occupational choices, and ultimately for understanding the broader mechanisms driving occupational sex segregation.

[3] Besides gender role attitudes, the terms gender role orientation (e.g. Hadjar and Aeschlimann, 2015), gender role beliefs (e.g. Dicke, Safavian, and Eccles, 2019), or gender beliefs (e.g. Baird, 2012) are commonly used for the same concept.

3. Study Choice and Gender

University major choice not only depicts a crucial lever maintaining occupational sex segregation but also constitutes a key mechanism for researching root causes underlying this segregation, as the choice of a university major is less influenced by demand factors than later occupational choice (Philipp 2023). To understand why young women and men continue to select different fields of study, this chapter reviews the theoretical and empirical literature on key determinants of study choice, drawing on Expectancy-Value Theory and empirical findings on the role of gender stereotypes and gender role attitudes for study choice.

3.1. Expectancy-Value Theory

A widely used framework for explaining gender differences in educational and occupational choices is Wigfield and Eccle's (2000) Expectancy-Value Theory (EVT). The framework, initially developed to understand gender differences in educational choices, describes the mechanisms behind the development of interindividual differences in educational choices and integrates both psychological factors on the individual level as well as social and cultural influences (Eccles, 1987, 2011; Wigfield and Eccles, 2000; Wigfield, Rosenzweig, and Eccles, 2017). EVT has been widely applied in research on study choice (e.g. DeVries and Lauermann, 2025; Dicke, Safavian, and Eccles, 2019; Pikić-Jugović, Doolan, and Baranović, 2024; Wolter et al., 2019) and has proven to be a strong framework to predict career choices (Eccles and Wigfield, 2002).

According to EVT, educational and occupational choices are influenced most directly by motivational beliefs, namely *subjective task values* and *expectancies for success*, which, in turn, are influenced through social roles and socialisation processes (Eccles, 2011). Subjective task values are described as "the value the individual places on the array of choices perceived as appropriate" (Eccles, 1987), whereas expectations of success are defined as "the individual's estimate of the probability of success at these various options" (Eccles, 1987). Accordingly, young people are expected to prefer fields they personally value and expect to succeed in (Eccles, 1987).

Individual and group differences in subjective task values and expectancies for success are assumed to be influenced by social and contextual factors (Eccles, 2011). Gender differences in educational choices, such as study majors, are expected to be influenced by gender stereotypes and gender role belief systems in two ways, "through their

impact on individual's perceptions of the field of viable options, as well as through their impact on expectations and subjective task value" (Dicke, Safavian, and Eccles, 2019; Eccles, 1987). Accordingly, gender stereotypes influence not only influence motivational beliefs but also which educational and occupational pathways appear appropriate or desirable (Dicke, Safavian, and Eccles, 2019). Hence, subjective task values and expectancies are viewed to be influenced by contextual factors and serve as proximal predictors for domain-specific educational and occupational choices (DeVries and Lauermann, 2025).

In empirical applications, expectancy of success is most commonly operationalised as academic self-concept (Parker et al., 2020). While expectancy and academic self-concept are theoretically distinguished in Expectancy-Value Theory, empirically, the two constructs are so highly correlated that they can hardly be separated analytically (Eccles and Wigfield, 2002, 2020; Parker et al., 2020). The task value component of the theory incorporates four sub-constructs: intrinsic value, attainment value, utility value, and cost, wherein intrinsic values are frequently operationalised through intrinsic motivation and interests (Eccles and Wigfield, 2002, 2020).

3.2. Determinants of Study Choice

Considerable research has focused on understanding the mechanisms underlying the persistent sex segregation in study majors, yet there remains substantial debate about the root causes (Parker et al., 2012). While early explanations emphasized differences in abilities or academic achievement; recent studies have shifted attention toward psychological and motivational factors as key predictors of study choice (Parker et al., 2012). Much of the research, has primarily focused on students' interests and aspirations rather than their actual educational choices leading boys and girls into different career paths (Sinclair, Nilsson, and Cederskär, 2019). Furthermore, the literature has often maintained a narrow focus, concentrating mainly on explaining the underrepresentation of women in STEM[4] fields (Dicke, Safavian, and Eccles, 2019; e.g. Parker et al., 2014; Uunk, 2024; Wille et al., 2020; Wolter et al., 2019), while overlooking the overall gendered patterns of study choice, including the underrepresentation of men in traditionally female-dominated fields.

[4] Acronym for science, technology, engineering, and mathematics (see e.g. Rollins, 2011)

While in recent years more studies have shifted their focus, university major choice still is treated as "largely self-determined" (Philipp, 2023) in the literature, focusing individual level factors, focusing less on the underlying socialisation processes that influence these determinants. In the literature, *preferences* (e.g. Ochsenfeld, 2016; Patzina and Toussaint, 2023; Schmidt, 2020) and *academic self-concept*(e.g. Parker et al., 2014, 2012; Sinclair, Nilsson, and Cederskär, 2019) are studied as central determinants of gendered study choice, closely aligned with subjective task-values (preferences) and expectancy of success (academic self-concept) within the Expectancy-Value Theory framework.

Empirical evidence points to gender differences in preferences (i.e. vocational interests) as the major driver of sex segregation in higher education (Heine et al., 2008; Legewie and DiPrete, 2014a; Ochsenfeld, 2016; Patzina and Toussaint, 2023; Schmidt, 2020; Sinclair, Nilsson, and Cederskär, 2019; Wille et al., 2020). Vocational interests are commonly assessed through Hollands (1997) RIASEC model, that distinguishes between realistic, investigative, artistic, social, enterprising, and conventional domains of interest. In Ochsenfelds (2016) study on the role of preferences for major choice, 37.2% of the gender gap in major choice were attributable to gender differences in vocational interests, with men reporting much higher realistic and investigative interests, while women expressed substantially stronger social and artistic interests. The gender differences in vocational orientations translated directly into study choice: realistic and investigative interests markedly increased the likelihood of choosing math-intensive majors, whereas social and artistic interests were associated with avoiding such fields and gravitating toward care-related disciplines (Ochsenfeld, 2016). In a replication study, Patzina and Toussaint (2023) confirmed these findings. Consistent gender differences in vocational interests have been repeatedly shown in previous research (Su, Rounds, and Armstrong, 2009; Warwas et al., 2009). In a meta-analysis of gender differences in interests, men were shown to have higher interest in engineering, science and exhibit higher realistic and investigative interests, compared to women who exhibit higher social, artistic and conventional interests (Su, Rounds, and Armstrong, 2009). Taken together, these findings suggest that vocational interests are central predictors of students' study choice. Given their strong and persistent gendered pattern, vocational interests therefore play a central role in reproducing sex segregation in higher education.

Besides vocational interests, research also highlights academic achievement (Parker et al., 2012; Patzina and Toussaint, 2023; Uunk, 2024; Wolter et al., 2019) and academic self-concept (Heine et al., 2008; Kleinert and Schels, 2020; Parker et al., 2014; Pikić-Jugović, Doolan, and Baranović, 2024) as relevant factors for explaining gendered study choice, though findings vary with respect to their explanatory power. Academic achievement, particularly math performance, has traditionally been at the centre of research on university choice and robustly predicts entry to math-intensive fields (Parker et al., 2012; Patzina and Toussaint, 2023). In educational systems with pronounced gender differences in math and language performance, such as Germany, prior achievement can account for part of women's underrepresentation in STEM majors (Uunk, 2024). Yet other studies find that achievement contributes comparatively little once preferences are controlled for (Patzina and Toussaint, 2023), and overall, achievement alone is insufficient to fully explain gendered patterns in study choice overall, not only in STEM (Parker et al., 2012; Wolter et al., 2019). Instead of focusing on academic achievement, both theoretical and empirical literature increasingly emphasises importance of academic self-concepts for understanding sex segregation in study choice, suggesting a larger impact than academic achievement (Parker et al., 2014, 2012; Sinclair, Nilsson, and Cederskär, 2019). Academic self-concept, defined as domain-specific beliefs about one's capabilities (Wolter and Hannover, 2016), systematically guides whether students perceive certain fields as realistic options and whether they expect to succeed in them. As research argues, "individuals need to believe that they have the skills to persist on a path leading to a certain career. As long as girls continue to perceive their skills regarding 'male subjects' (e.g. STEM) or 'male occupations' as low, they will refrain from such vocational aspirations." (Hadjar and Aeschlimann, 2015). Longitudinal evidence shows that domain-specific self-concepts strongly predict study choice even after controlling for achievement: a high academic self-concept in math increases the likelihood of entering STEM, while a high verbal self-concept predicts entry into social sciences and humanities (Parker et al., 2012; PikićJugović Doolan, and Baranović 2024). Importantly, research consistently documents gender differences in academic self-concept, with boys reporting higher mathematical self-concepts and girls reporting higher verbal self-concepts (Jansen et al., 2019). Taken together, academic self-concept appears to exert a stronger and more proximal influence on gendered study choices than achievement itself, not least because it shapes how academic performance is interpreted and translated into vocational aspirations. Academic self-concept, and

the consistent gender differences in self-concepts, are viewed as another central driver for sex segregation in study choice (Parker et al., 2014, 2012; Sinclair, Nilsson, and Cederskär, 2019).

As further determinants of gendered study choice, the existence of role models, parents and peer approval, job values, anticipated discrimination and the expectation of future work–family conflicts have been considered in the literature. However, they have been shown to play a negligible role compared to preferences and academic self-concept. Exposure to role models can influence students' study choices by providing examples of gender-atypical success. For instance, female professors in STEM have been shown to increase women's participation in these fields (Carrell, Page, and West, 2010). Although role models can moderate gendered patterns, their impact tends to be context-specific and does not fully account for persistent gender segregation across study fields. In regard to social pressure, boys and girls may receive different levels of approval from friends for selecting gender-(a)typical majors, however, empirical evidence suggests that such differences explain only a very small portion of the gender gap in study choice (Ochsenfeld, 2016; Patzina and Toussaint, 2023). Studies testing whether parental approval or anticipated discrimination, job values or the expectation of future work–family conflicts explain gendered study choices have shown that these mechanisms have little to no explanatory power (Ochsenfeld, 2016; Patzina and Toussaint, 2023). Accordingly, peer and parental approval of major choice, job values, and perceived labour market discrimination fail almost entirely to account for the observed gender differences in study choice. Together, these findings suggest that role models can be relevant for study choice, while explicit social pressures or perceived barriers play only a limited role in shaping students' study choices, hence are not considered central mechanisms for horizontal segregation.

Overall, gender differences in vocational interests and academic self-concepts have been shown to central determinants of gendered study choice, in line with the Expectancy–Value Theory. Yet, while these factors explain gendered study choice, they do not explain *why* such systematic gender differences in interests and self-concepts persist. While the presented studies do not deny underlying socialisation processes impacting these central determinants for study choice, the causes for the consistent gender differences are rarely integrated in the research designs on study choice. Thus, to better understand the persistence of occupational sex segregation, not only the determinants for study choice, but also potential causes for consistent gender

differences in these determinants must be considered. The next section examines the role of gender stereotypes and gender role attitudes for the development of vocational interests, academic self-concept, and ultimately students' university major choice.

3.3. Role of Gender Stereotypes for Study Choice

Vocational preferences and academic self-concept, both central determinants of study choice, begin to develop in early childhood and are shaped in long-lasting socialization processes, with gender stereotypes and gender role attitudes viewed to play a central role (Gottfredson, 1981; Steinmetz, 2012). According to Gottfredson (1981), children's occupational preferences develop in different stages and are closely linked to gender stereotypes. Between the ages of six and eight, children begin to understand the concept of gender roles (Gottfredson, 1981). In turn, children's preferences "clearly reflect a concern with doing what is appropriate for one's sex" (Gottfredson, 1981). Gendered preferences for vocational domains can already be observed in children as young as nine and strengthen between third and fifth grade (von Maurice and Bäumer, 2015), without meaningful change through high school (Blažev, Popović, and Šverko, 2025; Gottfredson, 1981). These gendered vocational interests–with boys showing higher interests in the realistic and investigative domains and girls in social, artistic and conventional domains (Holland, 1997; Su, Rounds, and Armstrong, 2009)–correspond to persisting gender stereotypes about masculine or feminine connotations of occupational domains along the lines of agency vs. communion (Ehrtmann, Wolter, and Hannover, 2019). Furthermore, these gendered interests not only correspond to gender stereotypes, but, according to Blažev and colleagues (2025), are predicted by gender role attitudes, with different patterns for boys and girls. Findings showed that boys with more traditional gender role attitudes also exhibited higher interest in gender-typical domains (Blažev, Popović, and Šverko, 2025; Ehrtmann, Wolter, and Hannover, 2019; Hadjar and Aeschlimann, 2015; Tokar and Jome, 1998). For girls, studies have shown mixed results. Blažev and colleagues (2025) suggested that for girls, more traditional gender role attitudes lowered the probability to develop gender-atypical interests over time (Blažev, Popović and Šverko, 2025). In contrast, Ehrtmann and colleagues (2019) study indicated a general pattern across genders: Not only boys but also girls with more traditional gender role attitudes showed higher interest in typically male domains, while students with more egalitarian gender role attitudes showed higher interest in typically female interest domains, arguing

"endorsing egalitarian attitudes toward gender roles indicates a more liberal world view in general with more need for autonomy and the freedom to express oneself, such as in languages, arts, or social activities than endorsing traditional attitudes, which may be associated with a preference for stricter rules and highly structured environments as reflected in more clearly defined activities like mathematics, sciences, or manual activities" (Ehrtmann, Wolter, and Hannover, 2019). Hence, empirical evidence confirms the link between gender role attitudes and vocational interests, yet no consistent patterns have yet been shown among girls.

Academic self-concepts begin to form as soon as children start schooling and show significant gender differences that are closely interrelated with gender stereotypes (Hannover and Wolter, 2022; Wolter and Hannover, 2016). Girls lower academic self-concept in maths and boys lower academic self-concept in verbal domains correspond to boys being stereotyped as having stronger mathematical abilities and girls having stronger verbal abilities (Hannover and Wolter, 2022; Plante et al., 2013; Taraszow, Gentrup, and Heppt, 2024). Girls even show a lower academic self-concept in maths when they perform equally as well or better than their male peers (Hannover and Wolter, 2022; Jansen et al., 2019; Taraszow, Gentrup, and Heppt, 2024). These gender differences in academic self-concept are already observable in elementary school, as early as first grade (Wolter and Hannover, 2016). The prevailing explanation in recent empirical research, largely based on Expectancy-Value Theory, suggests that domain-specific academic self-concepts are influenced by gender stereotypes as well as teachers' and parents' expectations (Bonnot and Croizet, 2007; Hannover and Wolter, 2022; Henschel, Jansen, and Schneider, 2023; Wolter, Braun, and Hannover, 2015; Wolter and Hannover, 2016). Students' endorsement of gender stereotypes disfavouring girls and boys in respective domains has been shown to impact their academic self-concept as early as first grade, where a higher self-concept in reading/ math was linked to a higher female/male gender role concept (Bonnot and Croizet, 2007; Wolter and Hannover, 2016). In a recent representative, cross-sectional study in Germany, "boys' and girls' explicit beliefs in the stereotype favoring their own gender in-group (i.e., boys'/girls' belief that boys/girls do better at mathematics) were related to higher levels of self-concept" (Henschel, Jansen, and Schneider, 2023). Building on this evidence, further research is needed to examine whether broader belief systems, such as gender role attitudes, are similarly associated with domain- specific academic self-concepts. Investigating these links can reveal whether endorsement of traditional versus egalitarian gender roles affects academic self-

concept in a manner analogous to the influence of domain-specific gender stereotypes, thereby shaping subsequent study choices.

Both theory and empirical evidence point to gender stereotypes as a relevant factor explaining study choice, however, there remains a lack of empirical research explicitly examining how these stereotypes influence university major choice (Philipp, 2023). Vocational interests and academic self-concept have been shown to be central determinants for gendered study choice and have both been shown to be related to gender stereotypes. However, previous research on gendered study choice has largely focused on individual level factors, portraying study choice as largely self-determined without incorporating the root causes for the significant and consistent gender differences within the central determinants. Previous studies that incorporated the impact of gender stereotypes as measured with gender role attitudes have primarily analysed their role for occupational aspirations (Baird, 2012; Chesters, 2022, 2023; Ehrtmann, Wolter, and Hannover, 2019; Estévez-Abe, 2006; Hadjar and Aeschlimann, 2015; Pikić-Jugović, Doolan, and Baranović, 2024), which are closely linked with study choice (DeVries and Lauermann, 2025; Polavieja and Platt, 2014), but not for study choice itself. Other studies have focused on intergenerational transmission of gender stereotypes through parental attitudes and behaviours as a predictor for occupational aspirations (Chesters, 2022, 2023; Hadjar and Aeschlimann, 2015), and in few cases also for study choice (Georg and Bargel, 2017; Humlum, Nandrup, and Smith, 2019; Philipp, 2023). To my knowledge, only one study (Tokar and Jome, 1998) has incorporated the impact of students' gender role attitudes on university major choice and none have done so for the German context.

Empirical evidence confirms a relationship between gender role attitudes and occupational aspirations, however suggesting slightly different patterns for men and women, and has produced inconsistent results. While most of the studies suggest that both men and women with traditional gender role attitudes are more likely to aspire gender-typical occupations (Chesters, 2022, 2023; Estévez-Abe, 2006; Pikić-Jugović, Doolan, and Baranović, 2024), in Baird's (2012) study, this link was only significant for females, while in Hadjar and Aeschlimann's (2015) study, it was only significant for males, with small effect sizes. Traditional gender role attitudes further indicated weaker intentions for aspiring gender atypical occupations (Chesters, 2022, 2023; PikiéJugović Doolan, and Baranović 2024), whereas egalitarian gender role attitudes showed higher probability for more gender-neutral and even gender-atypical

occupational aspirations only for women (Baird, 2012; Chesters, 2022). While some of the studies (Baird, 2012; Chesters, 2022, 2023) have theorised and assessed the link between gender role attitudes and occupational aspirations directly, most studies employed an intermediary model, as suggested by EVT, suggesting that both interests and academic self-concept mediate the relationship between gender role attitudes and occupational aspirations (Hadjar and Aeschlimann, 2015; Pikić-Jugović, Doolan, and Baranović, 2024; Plante et al., 2013). Overall, the studies that have explored links between gender role attitudes and occupational aspirations have measured gender role attitudes either right before entering university or applied cross-sectional designs. As the literature points to long-lasting socialisation processes and the development of vocational interests and academic self-concept at a much younger age, longitudinal research incorporating both earlier assessments of gender role attitudes and later study choice, not only aspirations, are called for.

Studies on intergenerational transmission have suggested gender stereotypes to play a central role for gendered study choice (Humlum, Nandrup, and Smith, 2019; Philipp, 2023; Van Der Vleuten et al., 2018). Parents—as key agents of socialization (Bandura, 1977)—are expected to transmit their gender role attitudes to their children, with direct consequences for their later labour market behaviour (Busch, 2013; Platt and Polavieja, 2016). Empirically, the gender typicality of parents jobs has been shown to be significantly associated with their children's aspirations and study choice, which is regarded as "strong evidence for gender socialisation" (Philipp, 2023; Polavieja and Platt, 2014; Van Der Vleuten et al., 2018). Both boys and girls choose majors similar to their parents occupational field or majors that correspond to the gender typicality of their parents occupation (Humlum, Nandrup, and Smith, 2019; Philipp, 2023). Based on these findings, gender role attitudes are viewed to mediate the relationship between parental workforce participation and gendered study choice (Chesters, 2022, 2023; Hadjar and Aeschlimann, 2015; Philipp, 2023; Siembab and Wicht, 2020), hence, further suggest the relevance of gender stereotypes for study choice. Parents are, however, not the only agents for gender socialization, with other factors and socialization agents, such as teachers, school environment, friends, (social) media also contributing to gendered educational choices. For instance, a study in the US focusing on the role of school environment for study choice suggests that "the local environment in which adolescents spend their high school years plays an important role in the strengthening or weakening of gender stereotypes" (Legewie and DiPrete, 2014b). Accordingly, focusing on gender role attitudes on the student level allows a wider

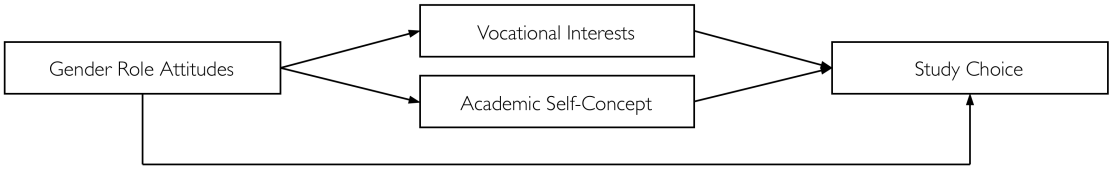
perspective on the role gender stereotypes play for study choice, as other factors and socialization agents are conceptually integrated as jointly and continuously shaping students' gender role attitudes.

While empirical evidence suggests a potential link between gender role attitudes and study choice, to my knowledge only one study has previously assessed this relationship. Working with a sample of male university students in the US, Tokar and Jome (1998) assessed indirect links between gender role attitudes and study choice via vocational interests and found that the relationship between gender role attitudes and study choice was fully mediated through occupational interests: Men with traditional gender role attitudes reported gender-typical vocational interests, which in turn were reflected in gender-typical career choices. Specifically, traditional gender role attitudes significantly predicted lower interests in social, artistic and higher interests in enterprising domains, whereas realistic interests and social interests significantly predicted gender typicality of study choice. The relation between gender role attitudes and study choice, however, was solely mediated through social interests, not the other interest domains. While this study provides a valuable methodological example by linking gender role attitudes, vocational interests, and study choice within the framework of Expectancy-Value Theory, its focus on a cross-sectional sample of male students in the US limits the generalisability of the findings. Given that gender role attitudes develop early, are expected to shape both interests and academic self-concepts, which in turn impact study choices, there is a clear need for research that examines these relationships longitudinally and across genders. Addressing this gap will allow a more comprehensive understanding of the role of gender stereotypes for the persistence of occupational sex segregation.

3.4. Study Aim and Research Questions

The distribution of young women and men across university majors continues to be highly segregated in Germany, with no meaningful change over the past decades, a constitutes a central lever for persisting gender inequalities in the labour market. Overall, the literature consistently shows that vocational interests and academic self-concepts are key determinants of study choice. Both vocational interests and academic self-concepts have been shown to exhibit gender differences, which, in line with Social Role Theory, are viewed to be shaped in socialisation processes from early childhood onwards along the lines of gender stereotypical notions of what is considered typically male or female. However, empirically, these links have not been fully understood. Previous research has established links between gender role attitudes and interests, indicating different patterns among boys and girls, however, with inconsistent results. Gender differences in academic self-concept have been shown to be related to the endorsement of gender stereotypes disfavouring girls and boys in respective domains, whereas links with broader belief systems, such as gender role attitudes, have not yet been fully established. Furthermore, only few studies have explored potential links between gender role attitudes and gender typical study choice. While research focusing on intergenerational transmission point to the role of gender stereotypes for study choice, research incorporating gender role attitudes assessing the student's individual beliefs has been scarce. Hence, the theorised mechanisms, building on Expectancy-Value Theory, that early gendered socialisation and the endorsement of traditional versus egalitarian gender roles predict vocational interests and academic self-concept, which in turn impact study choice, remain insufficiently understood. Consequently, the present research aims to address this gap by examining if gender role attitudes influence study choice through their impact on vocational interests and academic self-concept. Specifically, the study investigates these mechanisms for male and female students in the German context, applying a longitudinal perspective to allow for a more comprehensive understanding of the developmental and motivational processes that underpin the persistent occupational sex segregation. **Figure 3** provides a visual overview of the proposed model, summarizing the hypothesized relationships.

Figure 3. Hypothesized Model



Note: In line with Expectancy-Value Theory (Wigfield and Eccles 2000), vocational interests are included as a measure for intrinsic value, a subconstruct of subjective task values and academic self-concept as measure for the expectancy of success. Source: Author's illustration.

Based on the theoretical considerations outlined above, the following research questions were derived:

- RQ1: Do boys and girls differ in their gender role attitudes vocational interests, academic self-concept and gender typicality of study choice?
- RQ2: Do gender role attitudes predict the gender typicality of study choice?
- RQ3: Do gender role attitudes predict vocational interests and academic self-concept?
- RQ4: Do gender role attitudes indirectly predict study choice via vocational interests and academic self-concept?

4. Methodology

The following chapter gives an overview of the methodology of the current study, including the data base, ethical considerations, sample, used measures and analytic procedures.

4.1. Database

Addressing the research questions outlined above required longitudinal data that allowed the examination of children's gender role attitudes, their vocational interests and academic self-concept later in adolescence as well as their subsequent study choice. Furthermore, quality of measures and sample size were considered when choosing the data base, as both are essential for robust results (Kline, 2016).

This study uses data from the National Educational Panel Study (NEPS) (Blossfeld and Roßbach, 2019), as it fulfils the key requirements for addressing the present research questions, namely the availability of longitudinal data across adolescence on the concepts of interests, well established measures, and a sufficiently large sample size. The NEPS, carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network, is Germany's largest longitudinal study on educational trajectories. NEPS collects longitudinal data on skills development, educational decisions, educational returns, educational processes, their conditions, outcomes and consequences over the entire life course in formal, non-formal and informal contexts across the entire lifespan (Blossfeld and Roßbach, 2019). Using a multi-cohort sequence design, seven starting cohorts are arranged in such a way that they cover all educational phases over the life course (see Appendix, **Figure A.1**). Across the starting cohorts, the skills development and educational trajectories of a total of over 70,000 participants are being monitored from early childhood to adulthood. In addition, around 50,000 people from their environment, such as parents and educational professionals are surveyed (Blossfeld and Roßbach, 2019).

4.2. Ethics

The participation in the study was voluntary for all participants (students, parents, teachers and principals). Participants were able to withdraw from the study at any time. Only children with written consent from their parents were allowed to participate in the study (FDZ-LIfBi, 2024). In later waves, some federal states additionally

required the students own consent to continue their participation in the study when they reached the age of 14 (FDZ-LIfBi, 2024).

All analyses of this paper are secondary data analyses of previously published data. Analyses were performed via remote access (RemoteNEPS) over an encrypted connection in a controlled server environment using a virtual desktop (LIfBi, 2025a). Access to the data required a data use agreement between the researcher[5] and the LifBi and a supplementary form to access the remote access environment (see Appendix, **A.5**). Further, the present study is conducted under the regulation of the University of Oxford's Central University Research Ethics Committee (CUREC). The CUREC does not see the need for a renewed approval if the data is completely anonymous, which applied to the NEPS-data used in the present analysis. Hence, nor ethics application to the CUREC was made.

This paper uses the Scientific Use File (SUF) version SC3:13.1.0 (NEPS Network, 2025).

4.3. The Sample

The current study drew upon data from NEPS starting cohort three (SC3), which is the youngest cohort that has completed the transition into higher education. Furthermore, gender role attitudes were assessed as early as grade 6. Participants for the cohort were drawn from all children in Germany attending secondary school in grade five in the 2010/11 school year, using stratified multistage cluster sampling. Children were sampled within their institutional context (school). In the first survey wave, N=5,774 fifth-grade students from 291 schools participated (FDZ-LIfBi, 2024). As in two federal states, Berlin and Brandenburg, children transition into lower secondary school after grade 6, a substantial share of respondents left the institutional context in which they were originally sampled and surveyed (FDZ-LIfBi, 2024). To account for this, the initial sample was extended by a refreshment sample (n= 2,146 students), due to the loss of students in their institutional context (FDZ-LIfBi, 2024). Students were assessed within their institutional context in paper-and-pencil interviews (PAPI) and individually tracked after leaving compulsory education (see **Table 1**) (FDZ-LIfBi, 2024).

[5] In this case, both the dissertation supervisor as well as the student needed to sign the agreement.

Table 1. Measurement points, respondents and survey mode

	t_0	t_1	t_2	t_3	t_4
Date	09/2010-09/2011	10/2011-06/2012	10/2014-03/2015	01/2015-12/2015	09/2018-09/2022
Respondents	parents	students (grade 6)	students (grade 9)	students (grade 10)	individually tracked school-leavers
Survey Mode	CATI	PAPI	PAPI	PAPI	CATI/CAWI
Assessed variables	ISCED, Mig	GRA	ASC-M, ASC-G	RIASEC	1st Study Major

Note. CATI = computer-assisted telephone interviews. PAPI = paper-and-pencil interviews. CAPI = computer-assisted web interviews. ISCED = parents educational level. Mig = migration background. GRA = gender role attitudes. ASC-M = academic self-concept mathematics. ASC-G = academic self-concept German. RIASEC = vocational interests.

For the analysis, only individuals who started a degree in a tertiary institution with valid data on gender role attitudes in grade 6 were included. As the SUF provided by NEPS includes separate data files for cohort information, competences, vocational educational history of students as well as student, teacher, and parent questionnaires in different formats, I merged them into a new data set, keeping only measures and waves relevant to the present study**.** After careful data preparation (see Appendix **A.4**), the analytic sample consisted of N = 1,337 students (51.3% female[6]), with a mean age of M = 11.5 years (SD = 0.4) in grade 6.

4.4. Measures

The NEPS includes measures on a wide range of concepts. For the purpose of the present analysis, I selected a set of measures that are central to the theorized model: gender role attitudes, vocational interests, and domain-specific academic self-concepts and students' study choice. These variables capture the core constructs of the proposed path model testing indirect paths between gender role attitudes and study choice via vocational interests and academic self-concept. Additionally, socio-demographic variables such as parents' highest educational level and migration background were included as controls. The data used in the current study were assessed over a timeframe of twelve years (2010 - 2022).

[6] Sex was assessed as a binary measure (1 = *male*, 2 = *female*) in NEPS.

Study Choice

Much of previous research on study choice has focused on the underrepresentation of women in STEM and thus applied binary measures for study choice (STEM/non-STEM major), assessing factors associated with a higher/lower probability of entering a STEM field. In the current study, I widen the focus by measuring study choice through the gender typicality of study majors, as represented by the respective share of (wo)men in each major. Previous studies that have used gender composition of both study majors and occupations as a measure for gender typicality frequently applied a categorial measure (female-dominated (70% women or more), male-dominated (less than 30% women) and neutral for all other majors/occupations) (e.g. Chesters, 2022, 2023; Dämmrich and Blossfeld, 2017; Kleinert and Schels, 2020; Malin, 2018). As this approach has been criticised for discarding meaningful variation due to fixed cut-offs, and thereby limiting content validity (De Vaus, 2013), recent studies have operationalised gender typicality using the continuous gender proportion of each field (e.g. DeVries and Lauermann, 2025; Humlum, Nandrup, and Smith, 2019; Van Der Vleuten et al., 2018). Accordingly, I measure the gender-typicality of study choice as the average share of females (males) within each study programme in Germany. In line with Social Role Theory, the sex composition of study majors is closely linked to the public perception of gender typicality of a study field, with more gender-imbalanced fields being more strongly associated with gender stereotypical images (Cejka and Eagly, 1999). Hence, this operationalisation aligns well with theoretical expectations regarding the relationship between gender composition of study fields and public perceptions of their gender typicality, supporting the measures construct validity (De Vaus, 2013). At the same time, by retaining the full distribution of gender composition across study areas, the measure covers the content domain of gender typicality comprehensively, supporting content validity.

In NEPS, study majors are categorized into 60 study areas and ten subject groups based on the 2010/11 classification of the Federal Statistical Office of Germany (Federal Statistical Office of Germany, 2011). In my sample, I considered the first study major each student enrolled in for study choice, representing the initial study choice. To indicate the gender typicality of study majors, I used supplementary data from the Federal Statistical Office of Germany and calculated the gender composition based on the average female share in each of the 60 study areas within the last 15 years (2010-2025), drawing on publicly available population statistics (Federal Statistical Office of

Germany, 2025c) (see Appendix, **Table A.4**). I linked the respective ratio to the assessed study area for all participants of my sample.[7] As population data was only available on the three-digit level study subjects (e.g. Water management, Food Chemistry), I matched them to the corresponding two-digit study area (e.g. Civil engineering, Chemistry) based on classification information provided by the Federal Statistical Office (Federal Statistical Office of Germany, 2011). The constructed outcome measure indicated the average (fe)male share (ranging from 0.00-1.00) within each study area. For example, for female students a value of 0.73 means that 73% of the students enrolled in their study area in German universities over the past 15 years were women. A higher score thus indicates a more gender-typical study choice for both girls and boys. As the measure is based on official administrative statistics on student enrolment, classical psychometric reliability indicators (e.g. internal consistency) are not applicable. The use of population-level data ensured high measurement reliability and minimizes random measurement error. Averaging sex ratios over a 15-year period further increased measurement stability by smoothing short-term fluctuations in enrolment patterns and better reflecting enduring patterns of sex segregation in higher education, while aggregation at the level of study areas may introduce imprecision and mask heterogeneity across study majors.

Gender Role Attitudes

The NEPS items on gender role attitudes are based on the *questionnaire of normative gender role attitudes* (NGRO) developed by Athenstaedt (2000). The original instrument measures normative beliefs about the appropriateness of gendered roles in family and work contexts (traditional vs. egalitarian) has been extensively validated and has since been widely used in research (Athenstaedt, 2000). In the NEPS, gender role attitudes were measured with four items at t_1 = grade 6 (wave 2).

Students were asked about their "opinion on the duties of girls and boys in the family and in life in general" and rated their agreement with the four following statements:

(1) Boys and girls should do the same chores in the household.

(2) For some professions, men are better suited than women.

(3) Girls use technical devices as well as boys do.

[7] Based on the gender of the respondent, each study area was assigned either the average female or male (1-female share) share.

(4) Girls should be able to learn the same professions as boys.

Answer options ranged from *completely agree* to *completely disagree* on a 4-point Likert scale. I reverse coded items 1, 3, and 4 so that higher values reflected more traditional attitudes. I calculated a gender role attitude index, using mean scores across the four items, with higher scores indicating more traditional gender role attitudes and lower scores indicating more egalitarian gender role attitudes. The index (M = 2.06, SD = 0.733) showed good internal consistency (Cronbach's α = 0.748) (Johnson and Christensen, 2020). It should be noted that the measure primarily captures explicit attitudes toward gender equality in occupational and technical domains, while other aspects of gender role attitudes—such as boys' social roles or implicit beliefs—were not assessed, which may limit the content validity of the measure (De Vaus, 2013).

Vocational Interests

Vocational interests were assessed using the Interest Inventory Life Span (IILS), an 18-item short scale developed by NEPS (Wohlkinger et al., 2019). The IILS is based on the German version of the *Inventory of Children's Activities-Revised* (ICA-R) and *Allgemeiner Interessen Struktur-Test* (AIST-R) [8] , two established, extensively validated and widely used inventories for measuring vocational interests (Wicht, Miyamoto, and Lechner, 2022; Wohlkinger et al., 2019). The IILS measures six domains of vocational interests based on Holland's (1997) RIASEC model: realistic (R), investigative (I), artistic (A), social (S), enterprising (E), and conventional (C) (Wohlkinger et al., 2019).[9]These domains capture main patterns of vocational preferences, which can be combined to form individual interest profiles arranged in a hexagon structure (Wohlkinger et al., 2019).

In NEPS in SC3, vocational interests were assessed at t_3 = grade 10 (wave 6). Students were asked to rate how interested they are in particular tasks. Answer options ranged from 1 to 5 on a 5-point Likert scale (1 = *I have little interest in that/I do not like to do that at all*; 2 = *I have little interest in that*, 3 = *I am somewhat interested in that*, 4 =

[8] General Interest Structure Test established in the German-speaking countries (Wicht, Miyamoto, and Lechner, 2022)

[9] Realistic interests involve tasks with systematic manipulation of objects, tools, machines, or animals; investigative interests focus on observing, analysing, and exploring phenomena; artistic interests include creative manipulation of materials to produce artistic forms; social interests involve educating, advising, or helping others; enterprising interests involve influencing people to achieve goals or economic outcomes and conventional interests focus on structured data handling and organization (Wohlkinger et al., 2019).

I am rather interested in that, 5 = *I am very interested in that/I like to do that a lot*). Three items were measured for each interest domain and average scores computed for each interest domain by the NEPS team. Internal consistency varied between the measured constructs, was above the recommended threshold for realistic (Cronbach's $\alpha = 0.712$) and social interests (Cronbach's $\alpha = 0.769$) or just below, for investigative (Cronbach's $\alpha = 0.682$) and artistic interests (Cronbach's $\alpha = 0.685$), while enterprising (Cronbach's $\alpha = 0.480$) and conventional (Cronbach's $\alpha = 0.564$) interests fell well below the recommended cut-off ($\alpha \geq 0.7$, Johnson and Christensen, 2020).

Academic Self-Concept

Academic self-concept was measured through the short German version of *the Self Description Questionnaire II* (SDQ), replicated as used in PISA, a widely applied and extensively validated measure for self-concept (Kunter et al., 2002; Wohlkinger, Bayer, and Ditton, 2016). The Self Description Questionnaire contains three items for each domain (Math/German), where students were asked to rate their performance at school.

German:

In the subject German I am a hopeless case
I learn fast in German
I get good grades in German

Math:

I get good grades in Math
Math is one of my best subjects
I have always been good at math

Answer options range from 1 to 4 on a 4-point Likert scale (1 = Does not apply at all, 2 = Does not really apply, 3 = Applies to some extent, 4 = Applies completely). In NEPS SC3, academic self-concept was measured in t_2 = grade 9 (wave 5). For each domain, average scores for academic self-concept were computed by the NEPS-Team. The scores showed good internal consistency for both domains (Cronbach's $\alpha_{math} = 0.893$, Cronbach's $\alpha_{German} = 0.828$) (Johnson and Christensen, 2020).

Control Variables

Besides the core variables described above, parents' highest educational level and migration background were included as controls. Higher educational level has been linked to less gender-typical study choices among both boys and girls (Van Der Vleuten et al., 2018) and migration background is related to potential differences in socialisation experiences and has been shown to influence gender-typical occupational aspirations (Wicht and Siembab, 2022). Because gendered connotations of occupations vary across cultural contexts, young people with a migration background may draw on different cultural reference frames when forming ideas about appropriate careers for men and women (Wicht and Siembab, 2022).

Parents highest educational level was measured with the International Standard Classification of Education (ISCED) (UNESCO, 1997). The measure classifies all educational levels from early childhood education to doctoral level. The scale ranged from 0 = *no qualification* to 10 = *doctorate/habilitation* in NEPS. Data was provided by the NEPS for the interviewed parent and their partner. In the current analysis, I considered the highest level within the household (M= 6.68, SD=2.49).

Students' migration background was assessed based on their parents' answers. Along the commonly used definition of migration background (Federal Statistical Office of Germany, 2025d), I considered students to have a migration background if they, one of their parents or both parents were born abroad (0 = *non-immigrant background*, 1 = *immigrant background*). This applied to 12.7% of the sample.

4.5. Analytic Procedures

To answer the first research question, whether boys and girls differed in their gender role attitudes, vocational interests, academic self-concept and gender typicality of study choice (RQ1), I conducted independent samples t-tests (Field, 2024). For each variable, mean scores and standard deviations were calculated separately for boys and girls. Independent samples t-tests were then performed to assess whether the mean differences were statistically significant, applying a significance level of $\alpha = 0.05$ (Field, 2024). Effect sizes (*Cohen's d*) were calculated to quantify the magnitude of observed differences (Cohen, 1988).[10]

To answer the remaining research questions (RQs 2-4), structural equation modeling (SEM) for an observed variables model (path analysis) was employed as it enables the simultaneous estimation of multiple direct and indirect effects within a single, theoretically informed model (Kline, 2016). This approach is particularly suited to the present research questions, as it enabled me to incorporate gender role attitudes, the six RIASEC interest domains, academic self-concept and control variables while controlling for their interrelations. Compared to a series of separate regression analyses, this approach provides a coherent and statistically consistent representation of the structural relationships underlying study choice and allowed me to assess the unique contribution of each predictor and both direct and indirect effects while controlling for the effects of all other variables in the model. As both theoretical and empirical literature suggests different patterns for boys and girls, I estimated two path models for boys and girls separately. First, a baseline path model (model I) was specified in which gender role attitudes predicted gender-typical study choice, controlling for parents' highest level of education and migration background. In a second path model (model II), the six RIASEC vocational interest domains and academic self-concept in mathematics and German were included to examine indirect pathways linking gender role attitudes to gender-typical study choice. Direct paths were specified from gender role attitudes to vocational interests, academic self-concept, and gender-typical study choice. In addition, indirect paths from gender role attitudes to study choice via vocational interests and academic self-concept were specified. Parents' highest level of education and migration background were included

[10] Effect sizes between 0.0 and 0.19 were considered weak, between 0.2 and 0.39 moderate, between 0.4-0.59 strong and above 0.6 very strong (Cohen, 1988).

as control variables. In line with their conceptualisations, the endogenous vocational interest and academic self-concept variables were allowed to covary (Kline, 2016; Wohlkinger et al., 2011). The models were estimated sequentially to address different research questions and were not statistically compared. Both models were over-identified, allowing for the estimation of model fit indices and testing of specified paths.

Model fit was assessed using the chi-square (χ^2) statistic, the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Squared Residual (SRMR) (Hoyle, 2012). The evaluation of model fit followed commonly used cut-off criteria for good fit: CFI ≥ .95, RMSEA ≤ .06 and SRMR ≤ .08 (Hu and Bentler, 1999). The statistical significance of each specified path was evaluated applying a significance level of $\alpha = 0.05$ (Kline, 2016). Standardized regression coefficients (β) are reported for direct effects. In addition, indirect effects of gender role attitudes on study choice via vocational interests and academic self-concept were tested. Indirect effects were considered present if (a) the independent variable significantly predicted the intervening variable, (b) the intervening variable significantly predicted the dependent variable, and (c) the product of coefficients representing the indirect pathways was significant (product-of-coefficients approach) (Cheong and MacKinnon, 2012).

Analyses were conducted in SPSS (31.0.0.0) and in R 4.4.2 (R Core Team, 2024) with {lavaan} (Rosseel, 2012), {haven} (Wickham, Miller, and Smith, 2025), {dplyr} (Wickham, François, et al., 2025), {tidyr} (Wickham, Vaughan, et al., 2025), {car} (Weisberg, 2019), {psych} (Revelle, 2025) and {naniar} (Tierney and Cook, 2023).

4.6. Preliminary Analyses

Prior to carrying out the statistical analyses, the required data assumptions were checked. Independent-samples t-tests require each of the dependent variables to be continuous, approximately normally distributed within each group and to show equal variances in both groups (boys vs. girls) (Field, 2024). Furthermore, observations needed to be independent (i.e., distinct groups). All variables (gender role attitudes, the six vocational interest domains, academic self-concept in mathematics and German, and gender typicality) were continuous. Normality was assessed by checking skewness and kurtosis values for each variable and inspecting histograms and normal probability (Q-Q) plots (see Appendix **A.2.1**), which indicated approximate normality

for the variables of interests. Homogeneity of variances was assessed using Levene's test ($p \geq .05$). When Levene's test was significant ($p < 0.05$), Welch's test with adjusted degrees of freedom was applied (Field, 2024).

Further assumptions were tested for the path analyses, including multicollinearity of predictors, multivariate normality of the endogenous variables, independence of observations and reliability of scores (Kline, 2016). Missing data were carefully inspected and accounted for. Model specification was guided by theory and prior empirical findings. Both models were overidentified and therefore estimable (Kline, 2016). Study choice, vocational interests and academic self-concept were treated as endogenous variables, while gender role attitudes, migration background and parental education were included as exogenous predictors. Vocational interests and academic self-concept served as intervening variables, transmitting the effects of gender role attitudes to study choice. Sample size was adequate for the estimation of the specified path models. With N = 650 (boys) and N = 687 (girls), sample sizes exceeded commonly cited minimum sample size considerations for SEM (Kline, 2016). Multicollinearity among predictors was assessed using variance inflation factors (VIFs). All VIF values were below 1.6, indicating no problematic multicollinearity (Pallant, 2020).

Multivariate Normality

While SEM does not pose assumptions for exogenous variables, maximum likelihood, the default estimation method in structural equation modeling, assumes multivariate normality of endogenous variables (Kline, 2012, 2016).Multivariate normality is commonly assessed through several tests, including the normality of univariate distributions, bivariate scatterplots, homoscedasticity, Mardia's test of multivariate normality and Q-Q plots of Mahalanobis distances (Kline, 2016). If multivariate normality is violated, robust ML estimation poses an option to account for non-normality in the data (estimated or standard errors and model tests statistics are corrected for the degree of non-normality in the data) (Kline, 2012).

All endogenous variables were continuous and approximately normally distributed, as previously shown. Bivariate scatterplots indicated linear relationships between the exogenous and endogenous variables (see Appendix **A.2.2**). Homoscedasticity was assessed by visual inspection of standardized residuals plotted against standardized predicted values (see Appendix **A.2.3**). No substantial deviations were observed.

Mardia's test of multivariate normality (Kline, 2016) indicated significant skewness ($b1$ = 288.83, p < .001) for boys, while kurtosis did not significantly deviate from normality ($b2$ = 1.82, p = .069). For girls, both skewness ($b1$ = 346.75, p < .001) and kurtosis ($b2$ = 3.87, p <.001) showed significant deviations from normality. As Mardia's test is sensitive to large samples, further inspections of multinormality were carried out (Kline, 2016). Q-Q Plots of Mahalanobis distances were also inspected for each group to assess multivariate normality (see Appendix **A.2.4**) (Kline, 2016). The plots suggested minor departures from normality, but overall did not indicate severe violations.

Furthermore, multivariate outliers that could potentially unduly influence the model were assessed using Mahalanobis distances (see Appendix **A.2.5**) (Kline, 2016). Mahalanobis distance represents the multivariate distance of each observation from the centroid of the distribution, taking into account the covariance structure of the variables (Kline, 2016). Observations exceeding the χ^2 critical value corresponding to the 97.5% quantile were considered potential multivariate outliers. Among boys, n=24 cases (3.7%) and among girls, n=20 cases (2.9%) exceeded this threshold ($D^2 > 19.02$).

As tests of multivariate normality indicated slight violations of the assumptions, the path models were estimated using robust maximum likelihood (MLR) instead of standard ML methods to account for non-normality (Kline, 2012). As MLR also accounts for potential outliers and given the relatively small proportion of flagged cases, I decided to retain all cases including the identified outliers (Kline, 2012).

Independent Observations

A further assumption for SEM is that observations are independent, with violations potentially resulting in underestimated standard error and inflated Type I error (Malone and Lubansky, 2012). Violations can be accommodated with SEM software (Malone and Lubansky, 2012). Since the data of my sample are hierarchically structured (students were nested within schools), observations within the same school could not be assumed to be independent (Kline, 2012, 2016), violating the assumptions of independent observations. To account for the nested structure of the data, standard errors were adjusted by clustering on the school level by school ID (n = 163).

Reliability

In path analysis, observed exogenous variables are assumed to be measured without error, meaning that their score reliabilities are treated as if they were 1.00 (Kline, 2012). While this assumption is rarely realistic in applied research, as measurement error is virtually unavoidable when working with manifest variables, it is important to consider score reliabilities of exogenous variables, as measurement error can bias path coefficients within the model (Kline, 2012). In the present study, internal consistency varied between the observed variables, potentially introducing bias to the analyses (see Appendix **Table A.2).**

Missing Data

Missing data were examined across all variables and were assumed to be missing at random (MAR) (see Appendix **A.3**) (Enders and Little, 2022; Graham, 2009). Applying the complete case method (listwise deletion) would not have only drastically reduced the sample size down to N=862 cases (64.5%), but also potentially introduced bias as data was not missing completely at random (MCAR) (Field, 2024; Pampaka, Hutcheson, and Williams, 2016). To prevent bias and loss of valuable data, full information maximum likelihood estimation (FIML) was used to account for data MAR. This method draws on all observed variables in the model to estimate means and covariances affected by item non-response (Kline, 2016). FIML generally outperforms listwise deletion because it uses all available information and produces less biased parameter estimates (Graham, 2009; Pampaka, Hutcheson, and Williams, 2016).

5. Results

This chapter presents the empirical results of the study. First, descriptive statistics and bivariate correlations among the main variables are presented. Second, gender differences in key variables are assessed using independent-samples t-tests. Finally, the results of the path models are reported, examining associations between gender role attitudes, vocational interests, academic self-concept, and the gender typicality of study choice.

5.1. Descriptive Statistics

Descriptive statistics (see **Table 2**) highlighted the explanandum of the study: a considerable degree of sex segregation in university majors. On average, both young men and women selected gender typical programmes in which their own sex was overrepresented (M = 0.59, SD=0.18).

Table 2. Descriptive Statistics

	Mean/ Percentage	Standard Deviation	Min.	Max.	*N*
Gender typicality of study major	0.59	0.18	0.13	0.88	1337
Age	11.53	0.41	10.00	15.17	1336
Gender					
Male	48.7%				650
Female	51.3%				687
Gender Role Attitudes	2.06	0.73	1	4	1337
Vocational interests					
Realistic	2.87	0.96	1	5	1175
Investigative	2.92	0.97	1	5	1171
Artistic	2.58	1.03	1	5	1175
Social	3.09	0.86	1	5	1173
Enterprising	2.98	0.77	1	5	1173
Conventional	2.51	0.82	1	5	1169
Academic self-concept					
German	3.14	0.59	1	4	1173
Mathematics	2.69	0.91	1	4	1166
Migration Background					
Non-migration background	86.3%				1160
Migration background	12.7%				168
Highest Parental ISCED	6.68	2.49	0	10	1126

Note: Sample restricted to students with valid information on study major and gender role attitudes. ISCED = International Standard Classification of Education. Higher scores in gender typicality of study major represents a higher share of the respective gender within a study major. Higher scores in gender role orientation indicate more traditional attitudes. Analyses were carried out in SPSS 31.0.0.0.

Among young men, computer science was the most common major, followed by economics, mechanical engineering, law and electrical engineering (see **Table 3),** whereas among women, economics, psychology, law, educational sciences and social services were the most common in the sample.

Table 3 Most common study majors

Study Area	Boys	∅ Share	Study Area	Girls	∅ Share
Computer science	15.4%	79.6%	Economics	16.0%	48.3%
Economics	14.9%	51.7%	Psychology	6.1%	75.3%
Mechanical engineering	11.1%	79.3%	Law	5.5%	56.1%
Law	6.5%	43.9%	Educational sciences	5.2%	78.4%
Electrical engineering	3.8%	87.0%	Social services	4.8%	77.7%

Note: Analyses were carried out in SPSS 31.0.0.0.

Gender differences were observable in gender role attitudes, vocational interests and academic self-concepts (see **Table 5)**. Boys reported more traditional gender role attitudes than girls. In the interest domains, girls showed reported higher interests in artistic, social and conventional activities, compared to boys who showed higher interests in the realistic, investigative and enterprising domains. Girls displayed a higher academic self-concept in German and boys had a higher academic self-concept in mathematics.

Bivariate correlations between gender role attitudes, the RIASEC interest domains, academic self-concept and gender typicality of study are presented in **Table 4**. For boys, traditional gender role attitudes in grade 6 were statistically significantly positively associated with the gender typicality of study choice and negatively associated with the artistic and social interest domains. No significant correlations between traditional gender role attitudes and realistic, investigative and conventional interests as well as academic self-concept were evident for boys. Interests in the realistic domain and academic self-concept in math were statistically significantly positively associated with gender typicality of university majors for boys. Furthermore, interests in the artistic, social and enterprising domains and academic self-concept in German were statistically significantly negatively associated with gender typicality of university majors. Interests in the investigative and the conventional domain were not statistically significantly correlated with the gender typicality of university majors among boys.

Table 4. Bivariate correlations between gender typicality of study major and predictor variables

	1	2	3	4	5	6	7	8	9	10
1. Gender role orientation	–	-0.04	-0.05	-0.09*	-0.16**	-0.02	-0.02	-0.05	0.05	0.08*
2. Realistic	-0.02	–	0.39**	0.26**	0.13**	0.13**	0.25**	-0.04	0.15**	0.18**
3. Investigative	-0.09*	0.41**	–	0.23**	0.19**	0.12**	0.21**	0.08	0.11*	0.01
4. Artistic	-0.03	0.32**	0.27**	–	0.17**	0.15**	0.17**	0.08	-0.11*	-0.17**
5. Social	0.04	0.06	0.12**	0.08	–	0.33**	0.21**	0.04	-0.09*	-0.10*
6. Enterprising	-0.06	0.09*	0.13**	0.03	0.18**	–	0.35**	0.11*	-0.06	-0.12**
7. Conventional	0.11**	0.35**	0.20**	0.05	0.12**	0.29**	–	0.05	0.07	0.02
8. Academic Self-Concept (German)	0.09*	-0.06	0.05	0.21**	0.06	0.10*	0.04	–	0.02	-0.17**
9. Academic Self-Concept (Math)	0.03	0.22**	0.15**	-0.15**	-0.02	0.00	0.19**	-0.04	–	0.32**
10. Gender typicality of study major	-0.02	-0.09*	-0.06	0.10**	0.22**	-0.04	-0.08	0.12**	-0.21**	–

Note: Coefficients for females below diagonal/coefficients for males above diagonal. *p<0.05; **p<0.01. Analyses were carried out in SPSS 31.0.0.0.

Among girls, traditional gender role attitudes were statistically significantly negatively correlated with the investigative interest domain and academic self-concept in German and positively correlated with the conventional interest domain but not significantly correlated with realistic, artistic, social or enterprising interests, academic self-concept in math nor gender typicality of study major. Interest in the artistic and social interest domain and academic self-concept in German were statistically significantly positively correlated with gender typicality of study choice, while realistic and conventional interests and academic self-concept in math showed statistically significant negative associations with gender typicality of study choice. Interests in the investigative and enterprising domain were not statistically significantly correlated with the gender typicality of study choice.

5.2. Inferential Statistics

In the following section, inferential statistical analyses are presented to examine gender differences and to test the hypothesized direct and indirect effects of gender role attitudes on study choice, in the order of the four research questions.

Gender differences in vocational interests, academic self-concept, gender role attitudes and gender typicality of study major

To address the first research question, gender differences in gender role attitudes, vocational interests, academic self-concept, and the gender typicality of study choice were examined with independent-samples t-tests. Overall, significant gender differences emerged for gender role attitudes, all vocational interest domains and academic self-concept in both of the assessed domains, whereas gender typicality of study choice showed no statistically significant difference between boys and girls (see **Table 5**).

Boys and girls did not differ significantly in the gender typicality of their study major. Both groups were enrolled in similarly segregated fields of study (boys: M=0.59, SD=0.19; girls: M= 0.58, SD=0.16), indicating that young adults predominantly choose study programs in which their own gender was substantially overrepresented.

Analyses revealed significant gender differences in gender role attitudes. Boys (M=2.44, SD=0.73) reported more traditional gender role attitudes than girls (M=1.69, SD=0.53). The effect size was very large (d = 1.18), indicating a pronounced

difference between boys and girls. Boys and girls also differed in their vocational interests, with mean differences reaching statistical significance in all the six RIASEC interest domains. Girls reported higher interests in the artistic (girls: *M*=2.92, *SD*=1.01; boys: *M*=2.20, *SD*=0.79; *d*=-0.74), social (girls: *M*=3.40, *SD*=0.81; boys: *M*=2.76, *SD*=0.79; *d*=-0.79) and conventional (girls: *M*=2.55, *SD*=0.82; boys: *M*=2.46, *SD*=0.82; *d*=-0.12) interest domains. In contrast, boys showed higher interests in realistic (boys: *M*=3.17, *SD*=0.95; girls: *M*=2.61, *SD*=0.89; *d*=0.61), investigative (boys: *M*=3.08, *SD*=0.92; girls: *M*=2.77, *SD*=0.98; *d* = 0.32) and enterprising (boys: *M*=3.03, *SD*=0.76; girls: *M*=2.94, *SD*=0.77; *d* = 0.12) interest domains. Effect sizes were very strong for artistic, social and realistic interests, moderate for investigative interests, and weak for conventional and enterprising (Cohen, 1988).

Further, boys and girls also significantly differed in their domain specific academic self-concepts. Girls displayed a higher academic self-concept in German (girls: *M*=3.22, *SD*=0.55; boys: *M*=3.04, *SD*=0.62; *d* = –0.31), whereas boys had a higher academic self-concept in mathematics (boys: *M*=2.89, *SD*=0.88; girls: *M*=2.50, *SD*=0.90; *d* = 0.44). These differences were statistically significant, with moderate (German) and strong (mathematics) effects sizes. Notably, across both groups, students reported a lower academic self-concept in mathematics than in German.

With respect to the first research question, the results indicated pronounced gender differences in gender role attitudes, vocational interests, and domain-specific academic self-concepts, whereas no gender difference was observed in the gender typicality of study choice.

Table 5. Gender differences in gender role attitudes, vocational interests, academic self-concept and gender typicality of study major

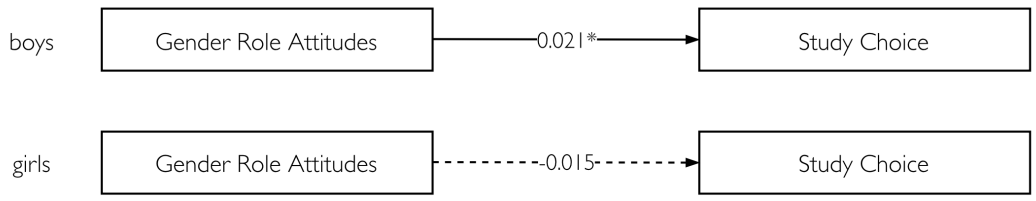
	Overall	Boys	Girls			Levene's Test		Effect size
	M(SD)	M(SD)	M(SD)	t	df	*F*	p	*d*
Gender role attitudes	2.05(0.73)	2.44(0.73)	1.69(0.53)	21.397***	1179.67	70.682	<0.001	1.18
Vocational interests								
Realistic	2.87(0.96)	3.17(0.95)	2.61(0.89)	10.481***	1173	3.564	0.059	0.61
Investigative	2.92(0.97)	3.08(0.92)	2.77(0.98)	5.534***	1179	3.030	0.082	0.32
Artistic	2.58(1.03)	2.20(0.92)	2.92(1.01)	-12.768***	1172.96	8.902	0.003	-0.74
Social	3.09(0.86)	2.76(0.79)	3.40(0.81)	-13.532***	1171	0.318	0.573	-0.79
Enterprising	2.98(0.77)	3.03(0.76)	2.94(0.77)	1.967*	1171	0.681	0.409	0.12
Conventional	2.51(0.82)	2.46(0.82)	2.55(0.82)	-2.100*	1167	0.035	0.851	-0.12
Academic self-concept								
German	3.14(0.59)	3.04(0.62)	3.22(0.55)	-5.248***	1171	3.298	0.070	-0.31
mathematics	2.69(0.91)	2.89(0.88)	2.50(0.90)	7.430***	1164	0.391	0.532	0.44
Gender typicality of study major	0.59(0.18)	0.59(0.19)	0.58(0.16)	1.134	1267.71	67.481	<0.001	0.062

Note: Higher scores in gender role orientation indicate more traditional attitudes. Higher scores in gender typicality of study major represents a higher share of the respective gender within a study major. When Levene's test was significant ($p < 0.05$), Welch's test with adjusted degrees of freedom was applied. *p<0.05; **p<0.01; ***p<0.001. Analyses were carried out in SPSS 31.0.0.0.

Direct effects of gender role attitudes on study choice

To answer the second research question, the first path model was tested (see **Figure 4**). As this baseline model (model I) included only a single endogenous variable with freely covarying predictors, model fit indices such as CFI, RMSEA, or χ^2 were not informative and are therefore not reported. Among boys, gender role attitudes significantly predicted gender-typical study choice (β = 0.021, *SE*= 0.011, p = .045). However, the model accounted for only 0.9% of the variance in study choice (R^2 = 0.009), indicating a weak predictive effect. Among girls, gender role attitudes did not significantly predict study choice (β = -0.015, *SE*=0.012 p = .692), and most of the variance remained unexplained (R^2 = 0.004). Thus, no evidence for a direct effect of gender role attitudes on study choice was found for girls in this first model. In sum, gender role attitudes showed a weak but significant effect on study choice among boys, while no evidence for a direct effect was found among girls.

Figure 4. Model I, direct effects of gender role attitudes on study choice



Note: Standardized path coefficients are displayed. *p<0.05; **p<0.01; ***p<0.001. Controls for highest parental education and migration background were included. Disturbances of the endogenous variables are not depicted. Cluster: schools. Estimator: MLR. Analyses were carried out in R 4.4.2.

Direct effects of gender role attitudes on vocational interests and academic self-concept

The second path model (model II) included direct and indirect effects of gender role attitudes on study choice and was tested to answer the two remaining research questions. The model showed good fit to the data, both for boys and girls (see **Table 6**). For boys, the fit indices indicated good model fit (Robust CFI = .983, RMSEA = .042, SRMR = .020), although the Chi-square test was significant ($\chi^2(7)$ = 15.01, p

=.036).[11] Similarly, for girls, the fit indices showed good model fit (Robust CFI = .985, RMSEA = .038, SRMR = .019) and the Chi-square value was only marginally significant ($\chi^2(7) = 14.11$, $p = .049$).

Table 6. Summary of Fit Statistics for Model II

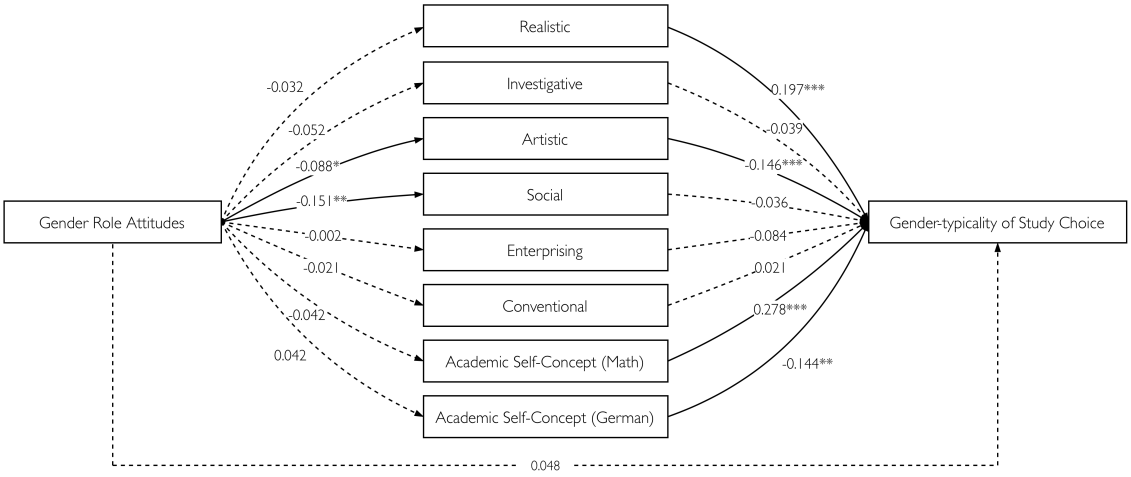
	Fit Statistics			
	χ^2	CFI	RMSEA	SRMR
Boys	15.00*** (df = 7)	.983	.042	.020
Girls	23.43* (df = 7)	.985	.038	.019

Note: N_{girls} = 685, N_{boys} = 650. CFI = Robust Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root-Mean-Square Residual. Analyses were carried out in R 4.4.2

Gender role attitudes significantly predicted vocational interests in the artistic and social domain among boys, while no significant effects were evident for the other domains or academic self-concept (see **Figure 5**). Traditional gender role attitudes were associated with lower artistic interests ($\beta = -.088$, $SE = .057$, $p = .048$), explaining 3.7% of the variance ($R^2 = 0.037$). Furthermore, traditional gender role attitudes were associated with lower social interests ($\beta = -.151$, $SE = .045$, $p < .001$, $R^2 = 0.001$). Gender role attitudes were neither significantly related to realistic ($\beta = -.032$, $SE = .055$, $p = .451$), investigative ($\beta = -.052$, $SE = .053$, $p = .209$), enterprising ($\beta = -.002$, $SE = .044$, $p = .962$) nor conventional interests ($\beta = -.021$, $SE = .049$, $p = .629$) among boys. Further, gender role attitudes did not show significant effects on academic self-concept, neither in math ($\beta = .042$, $SE = .052$, $p = .327$) nor in German ($\beta = -.042$, $SE = .043$, $p = .403$).

[11] Comparison of standard and robust fit indices and robust fit indices revealed only small differences, suggesting that potential violations of distributional assumptions (non-normality, outliers) did not substantially affect model estimation.

Figure 5. Model II, direct and indirect effects of gender role attitudes on study choice (boys)

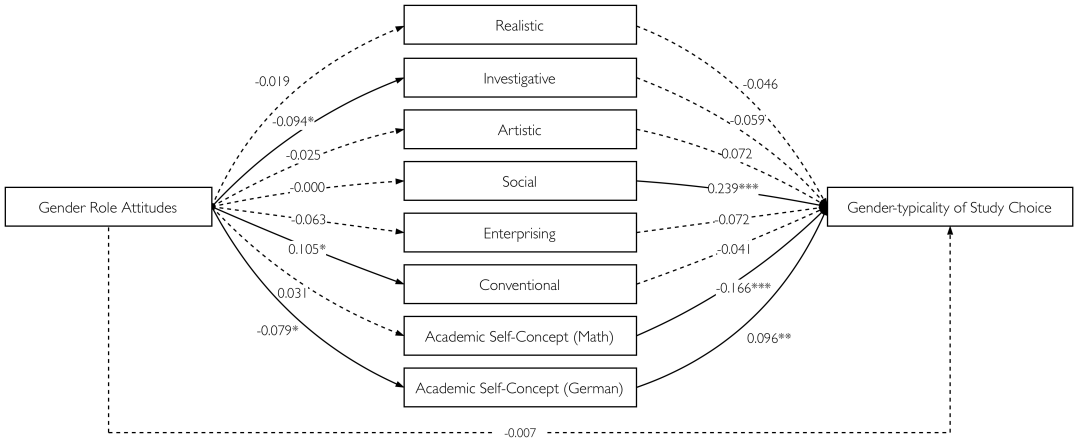


Note: Standardized path coefficients are displayed. *p<0.05; **p<0.01; ***p<0.001. Controls for highest parental education and migration background were included. Mediators were allowed to covary, but are not depicted.. Disturbances of the endogenous variables are not depicted. Cluster: schools. Estimator: MLR. Analyses were carried out in R 4.4.2.

Among girls (see **Figure 6**), gender role attitudes were significantly predictive of investigative and conventional interests as well as academic self-concept in German. Traditional gender role attitudes were associated with lower investigative interests (β = -.094, *SE* = .083, *p* = .033, R^2 = 0.015) and higher conventional interests (β = .105, *SE* = .063, *p* = .011, R^2 = 0.024) among girls. Gender role attitudes were neither significantly related to interests in the realistic (β = -.019, *SE* = .070, *p* = 0.639), artistic (β = -.025, *SE* = .084, *p* = .572), social (β = -.000, *SE* = .060, *p* = .999) nor the enterprising domain (β = -.063, *SE* = .056, *p* = .097). Direct effects of gender role attitudes on academic self-concept were only evident in German. Gender role attitudes significantly predicted academic self-concept in German and were associated with a lower academic self-concept in German (β = -.079, *SE* = .037, *p* = .024, R^2 = 0.023). Results showed no significant effect of gender role attitudes on academic self-concept in math for girls (β = .031, *SE* = .070, *p* = .450).

In summary, gender role attitudes showed small but significant direct effects on some of the vocational interest domains and academic self-concept, with boys exhibiting significant associations in the artistic and social domains, and girls in the investigative and conventional domains as well as in academic self-concept in German. Overall, most of the variance in these outcomes remained unexplained by gender role attitudes.

Figure 6. Model II, direct and indirect effects of gender role attitudes on study choice (girls)



Note: Standardized path coefficients are displayed. *p<0.05; **p<0.01; ***p<0.001. Controls for highest parental education and migration background were included. Mediators were allowed to covary, but are not depicted.. Disturbances of the endogenous variables are not depicted. Cluster: schools. Estimator: MLR. Analyses were carried out in R 4.4.2.

Indirect effects of gender role attitudes on study choice

Indirect effects of gender role attitudes on gender typical study choice via vocational interests and academic self-concept were examined for both boys and girls. Although gender role attitudes significantly predicted two of the intervening variables (e.g., artistic interest among boys, academic self-concept among girls), and these variables were also significantly related to gender-typical study choice, none of the computed indirect effects were statistically significant. This indicates that no significant indirect pathways were confirmed.

Among boys, traditional gender role attitudes were associated with lower artistic interests (see above), and artistic interests were significantly inversely related to gender typicality of study choice (β = -.146, SE = .008, p < .001). However, the corresponding indirect effect through artistic interests was not significant (β = -.013, SE = .002, p = .073). Gender role attitudes also significantly predicted social interests, but social interests did not significantly predict gender typical study choice (β = -.036, SE = .009, p = .326). Conversely, realistic interests, academic self-concept in mathematics and German significantly predicted study choice, but were not significantly predicted by gender role attitudes. Higher realistic interests (β = .197, SE = .009, p < .001) and academic self-concept in mathematics (β = .278, SE = .008, p <.001) were associated with a more gender typical study choice, whereas a higher

academic self-concept in German was associated with less gender typicality of study choice (β = -.144, *SE* = .012, p < .001). Interests in the investigative (β = -.039, *SE* = .009, p = .376), social (β = -.036, *SE* = .009, p = .326), enterprising (β = -.084, *SE* = .013, p = .091), and conventional (β = .021, *SE* = .011, p = .640) domains were not significantly related to gender typical study choice. Furthermore, the significant direct effects of gender role attitudes on study choice observed in the baseline model were no longer significant (β = .048, *SE* = .010, p = .183). Overall, the model explained 18.4% of the variance of gender typical study choice among boys (R^2 = 0.184). Significant effects were confirmed in six of the specified paths, however, no significant indirect effects were evident.

Among girls, gender role attitudes predicted academic self-concept in German (see above), which in turn was positively associated with more gender-typical study choice (β = .096, *SE* = .011, p = .009). The corresponding indirect effect was not significant (β = -.008, *SE* = .001, p = .078). Gender role attitudes significantly predicted investigative and conventional interests among girls, but neither investigative (β = -.059, *SE* = .007, p = .179) nor conventional interests (β = -.041, *SE* = .009, p = .365) significantly predicted study choice. And while social interests and academic self-concept in mathematics and German significantly predicted study choice, gender role attitudes did not significantly predict these variables. Social interests (β = .239, *SE* = .008, p <.001) and academic self-concept in German (β = .096, *SE* = .011, p = .009) were associated with more gender-typical study choice, whereas higher academic self-concept in mathematics predicted less gender-typical study choice (β = –.169, *SE* = .008, p <.001). Realistic (β = -.046, *SE* = .010, p = .415) and artistic (β = .072, *SE* = .006, p = .064) interests showed no statistically significant effects on gender typicality of study choice among girls. Overall, the model explained 12.1% of the variance in gender typicality of study choice among girls (R^2 = 0.121). The path analysis yielded significant direct effects in six of the specified paths, but statistically significant indirect effects were detected.

In summary, the analysis revealed significant direct effects of academic self-concept and some of the vocational interest domains on study choice, but no significant indirect effects of gender role attitude through these intervening variables were found for either boys or girls.

6. Discussion

The main aim of the current study was to understand the role of gender stereotypes, as measured through gender role attitudes, for gender typical study choice. Descriptive results confirmed the explanandum of the study: persisting high levels of segregation in study majors, with both young women and men, on average, choosing gender typical study majors. The most common majors among both young women and men largely corresponded to gender stereotypes of what is considered typically male or female (things vs. people): Young men were largely represented in study majors associated with things (e.g. computer science or mechanical engineering) and women in fields associated with people (e.g. psychology or educational sciences), supporting the theorised link with gender stereotypes.

While a large body of research has focused on understanding gender typical study choice, much of previous work is either centred around central determinants of study choice, without incorporating measures for underlying socialization processes, or focuses on intergenerational transmission. Only few studies have included the individual endorsement of gender stereotypes as a potential predictor of the persisting sex segregation. Recent research has confirmed a relationship between gender role attitudes and gender typical occupational aspirations (Chesters, 2022, 2023). Extending this line of inquiry, the present study focused on how these attitudes translate into concrete study choices. Notably, findings showed that boys and girls significantly differed in their gender role attitudes in grade 6. Boys showed more traditional gender role attitudes compared to girls, as expected from the literature. Results of the first path model, testing direct effects of gender role attitudes on study choice (**RQ2**), supported and extended Chester's (2022, 2023) findings, but only for boys. Among boys, traditional gender role attitudes in grade 6 significantly predicted gender typical study choice. Though the effects were weak, they support that there is a link between gender role attitudes and study choice, and further, that this link can be shown as early as grade 6. As much of the literature has either applied cross-sectional perspectives or focused on the years right before entering higher education when investigating gender typical study choice, these results can be understood as supporting evidence for the long-lasting socialisation processes that influence decisions such as study choice. Among girls, no significant direct effects were observed, which does not necessarily negate the influence of gender stereotypes but

may indicate that girls' study choices are shaped more by implicit gender beliefs than by consciously endorsed attitudes (see e.g. Cech, 2013; Plante et al., 2013).

Consistent with previous research (e.g. Ochsenfeld, 2016; Parker et al., 2014; Patzina and Toussaint, 2023; Pikić-Jugović, Doolan, and Baranović, 2024; Sinclair, Nilsson, and Cederskär, 2019; Wille et al., 2020), academic self-concept and vocational interests emerged as important predictors of gender typical study choice. Academic self-concept in math and German constituted a significant and moderate predictor for the gender typicality study choice for both young women and men, as suggested by previous research (Heine et al., 2008; Kleinert and Schels, 2020; Parker et al., 2014; Pikić-Jugović, Doolan, and Baranović, 2024). The relationship between academic self-concept and study choice was strongly gendered, with academic self-concept in math predicting gender-typical choice among boys and gender-atypical choice among girls, whereas self-concept in German showed the reverse pattern. Similar patterns were also visible in the vocational interest domains, though only few of the domains reached significance level. Among boys, realistic interests predicted more gender typical study choice, whereas artistic interests predicted more gender atypical study choice. For girls, social interests significantly predicted more gender typical study choice. This was in line with previous findings, that showed realistic and investigative interests among boys and social and artistic interests among girls to translate into gender typical study choice (see e.g. Ochsenfeld, 2016) and aligns with gender stereotypical notions along the things vs. people paradigm.

These results confirmed the consistent findings in the literature and raise the question of why vocational interests and academic self-concepts translate into such strongly gendered study choices. One key explanation lies in systematic gender differences in these underlying characteristics. Results of my analyses confirmed profound gender differences in these central determinants of study choice (**RQ1**). Gender differences in vocational interests reached significance in all six domains. Boys showed higher interests in activities involving things (realistic, investigative and enterprising interests) compared to girls, who reported higher interests in activities centred around people (social, artistic and conventional interests). Academic self-concepts also significantly differed between boys and girls: Boys showed a higher academic self-concept in mathematics and girls showed a higher academic self-concept in German, and vice versa. These differences in interests and self-concept are in line with a large body of research, consistently confirming profound gender differences in interests and

self-concepts along gender stereotypes (e.g. Hannover and Wolter, 2022; Plante et al., 2013; Su, Rounds, and Armstrong, 2009; Taraszow, Gentrup, and Heppt, 2024).

Moving beyond confirming established gender differences in these key determinants for study choice, a central aim of the present study lied in examining the role of gender role attitudes in shaping gendered vocational interests and academic self-concepts (**RQ3**), which has produced inconsistent patterns in previous research. Results of my analyses showed that the gender differences not only corresponded to gender stereotypes but were partially explained by gender role attitudes, however, with weak effects. Interestingly, most of the significant effects showed negative associations. Boys with more traditional gender role attitudes developed lower interests in stereotypically female interest domains (artistic and social) and girls with more traditional gender role attitudes showed lower academic self-concept in German. Only the effects on conventional interests among girls were positively associated, with more traditional gender role attitudes predicting higher conventional interests. While previous research has shown both positive associations with gender typical interests and negative associations with atypical interests for boys, this study's findings only confirmed the latter, highlighting primarily constraining effects of traditional gender role attitudes, as suggested by theory (e.g. Elsen, 2020; Hannover and Wolter, 2022).

Among girls, traditional gender role attitudes predicted higher gender typical interests (conventional domain) and lower gender atypical interests (investigative), but also lower academic self-concept in German, a typically female domain. At first glance, these findings among girls appeared inconsistent. The lower interests in the gender atypical interest domain are in line with Blažew and colleagues' (2025) findings, whereas the association of traditional gender role attitudes with higher gender typical interest (conventional) has not yet been shown among girls, and seems to contradict previous findings (Ehrtmann, Wolter, and Hannover, 2019). Ehrtmann, Wolter, and Hannover (2019) showed that among both boys and girls, traditional gender role attitudes were associated with typically male and egalitarian attitudes with typically female domains, arguing that egalitarian gender role attitudes reflect a liberal worldview aligned with expressive domains (e.g. languages, arts), whereas traditional attitudes are associated with structured, rule-based activities (e.g. science, manual activities). Building on this argument, the conventional interest domain potentially constitutes a special case: While typically female dominated (Su, Rounds, and Armstrong, 2009), the interest domain covers activities around structured data

handling and organization (Wohlkinger et al., 2019), which may align more closely with traditional worldviews than with egalitarian ones. From this perspective, higher conventional interests among girls with more traditional gender role attitudes appear theoretically consistent rather than contradictory. The same reasoning may also help explain the associaton of traditional gender role attitudes with lower academic self-concept in German among girls. Language-related domains emphasise interpretation, autonomy, and self-expression and may therefore be more closely linked to egalitarian attitudes and a liberal worldview. Consequently, traditional gender role attitudes may constrain girls' perceived competence in German, despite its status as a typically female domain. For boys, gender role attitudes did not significantly predict academic self-concept in either of the two domains. Though previous studies have confirmed direct links between explicit domain-related gender stereotypes and academic self-concept (Bonnot and Croizet, 2007; Henschel, Jansen, and Schneider, 2023; Wolter and Hannover, 2016), similar associations were not confirmed with broader belief systems, i.e. gender role attitudes for boys.

Overall, the findings can be interpreted as showing constraining effects of traditional gender role attitudes on the development of gender atypical interests for boys, and, more general, as pointing to limiting effects of traditional gender role attitudes in the development of self-expressive, typically female dominated, domains for both boys and girls, supporting Ehrtmann, Wolter, and Hannover's (2019) line of argument. While effects of gender role attitudes were weak and only shown in few of the domains, the results nonetheless indicate a significant relation, suggesting that traditional gender role attitudes partially explain gender differences in vocational interests. At the same time, the comparatively weak effects of gender role attitudes stand in contrast to the consistent evidence for the strong influence of domain-specific gender stereotypes on self-concepts. This suggests that gender role attitudes may capture only part of the mechanisms through which gender stereotypes influence interests and self-concepts.

Finally, full model incorporating direct and indirect effects, linking gender role attitudes to study choice via vocational interests and academic self-concept (**RQ4**), as suggested by Expectancy-Value Theory, did not reveal any significant indirect effects. While some of the specified links between gender role attitudes, intervening variables and study choice reached significance (artistic interests among boys and academic self-concept among girls), none of the potential indirect effects did. These findings and the relatively small effects in the significant links support the underlying expectation

that gender stereotypes play a role for study choice, however, suggest that gender role attitudes are not sufficient to fully grasp this mechanism.

Overall, I investigated whether gender role attitudes in grade 6 can contribute to an explanation of the development of gendered vocational interests and academic self-concept later in adolescence and the gender typicality of study major when entering higher education. Though statistical significance was only evident in some of the specified paths of the model and effect sizes were small, the results, taken together with previous findings, suggest that gender stereotypes play a role for gender typical study choice, as shown through the impact of gender role attitudes. Addressing the research gap calling for longitudinal approaches, one strength of the current study was the inclusion of gender role attitudes in grade 6, long before entering higher education. Results showed that gender role attitudes have an impact on the development of gender(a)typical interests and (among girls) on self-concept in German. The findings question the treatment of study choice as an independent, largely self-determined decision (rational choice perspective) and instead, support sociological perspectives of gendered study choice as resulting from long-lasting socialisation processes. Importantly, the direction of the observed effects points primarily to a limiting rather than an enabling role of traditional gender role attitudes. Across several domains, traditional attitudes were associated with lower interests in gender-atypical or self-expressive fields, suggesting that gender stereotypes function less by actively promoting gender-typical choices and more by constraining the development of alternative interests and self-concepts.

Limitations and Further Research

Several limitations should be considered when interpreting the findings. First, the explanatory power of gender role attitudes in this study was limited, highlighting a central challenge in measuring the impact of gender stereotypes on study choice. While the present study aimed to incorporate a wider perspective on gender stereotypes, measuring the impact of gender stereotypes on the individual level regardless of its source and thus indirectly including different socialisation agents and sources of influence (e.g. parents, teachers, peers, (social) media), the measure posed two potential limitations. The measure, although based on a validated instrument and showing good internal consistency, primarily captures attitudes toward gender roles in occupational and technical domains. Importantly, the items predominantly reflect assumptions about male-dominated or technical fields, which may partly explain why

girls appear highly egalitarian on this measure. Thus, the observed gender differences might, in part, be influenced by limited content validity of the measure. Furthermore, the measure only assessed the explicit endorsement of gender stereotypes. Previous research has pointed to the role of internalized gender stereotypes, that do not necessarily need to be explicitly endorsed to influence educational decisions (Cech, 2013; Plante et al., 2013), which could potentially explain why girls showed similar patterns in study choice as boys, even though they exhibited much more egalitarian gender role attitudes. Future research would therefore benefit from incorporating more differentiated measures of gender stereotypes, including implicit indicators such as Implicit Association Tests (IATs) (e.g. Kiefer and Sekaquaptewa, 2007) to better understand the psychological processes underlying gender differences in vocational interests and study choice.

Second, potential bias due to measurement error in the exogenous variables cannot be ruled out. Some of the interest measures, particularly the enterprising and conventional domains, showed reliability coefficients below the recommended threshold. This may have attenuated the estimated effects, and calls for caution when interpreting these specific results. Furthermore, it should be noted that most of the effect sizes in the path models were weak. As even relatively minor effects can reach statistical significance in large samples, this should be considered when interpreting the findings and their practical implications.

Third, the use of data from the NEPS, while providing large samples and the opportunity to analyse a wide range of constructs, also entails typical limitations of large-scale assessment and secondary data analysis, including restrictions to the available scales and participant attrition, as was evident in considerable missingness in the interests and self-concept variables. Nevertheless, the dataset was well-suited for addressing the research questions of the present study.

Finally, while the present study focused on study choices in higher education, it did not cover vocational education or other educational pathways, where gender-typical choices may be even more pronounced (Siembab and Wicht, 2020). Exploring these contexts constitutes a relevant area for future research to better understand gendered educational trajectories across the full spectrum of post-secondary options.

7. Conclusion

Occupational sex segregation remains a persisting feature of contemporary labour markets and constitutes a central mechanism in the reproduction of gender inequality. Study choice constitutes a central lever in maintaining this segregation, especially in the German labour market and its low occupational mobility. Considering the gendered patterns in study choice that remain insufficiently understood, with both young women and men consistently choosing gender typical study majors that largely correspond to gender stereotypes along the things vs. people paradigm, this study aimed to address this research gap by examining the role of gender stereotypes for study choice. As vocational interests and academic self-concepts have been shown to be central determinants of study choice, this study investigated effects of gender stereotypes on these central determinants and on study choice.

Using data from the National Educational Panel Study (NEPS) enabled the incorporation of gender role attitudes as early as grade 6 and its effects on later study choice, responding to calls for longitudinal perspectives. Findings confirmed highly segregated patterns in study choice and significant gender differences in gender role attitudes, vocational interests and academic self-concept, largely corresponding to gender stereotypes. Most notably, gender role attitudes in grade 6 significantly predicted some of the interest domains and academic self-concept among girls and were also significantly related to gender typical study choice among boys, however, with small effects that should be interpreted with caution. While limited in its explanatory power, these findings support the anticipated influence of gender stereotypes on study choice as suggested by Expectancy-Value Theory, as early as in grade 6, calling for future research to confirm these early influences of gender stereotypes for study choice with more thorough measures, integrating more differentiated conceptualisations of gender stereotypes that can better grasp the underlying mechanisms.

For educational practice, the findings suggest that overcoming occupational sex segregation requires both early educational interventions and a deeper understanding of the psychological mechanisms through which gendered inequalities are reproduced over time. Interventions targeting gender-typical study choices should begin much earlier than is currently the case. Measures implemented in late adolescence—such as career counselling at the upper secondary level—are likely to come too late to substantially alter educational pathways, if gender stereotypes shape interests and

self-concepts from childhood onwards. Educational interventions aimed at challenging gender stereotypes should therefore be integrated into early schooling, for example through gender-sensitive teaching practices and materials, exposure to counter-stereotypical role models, and curricula that actively encourage the exploration of a broad range of interests beyond the limits of what is considered typically male or female (Rendtorff, Kleinau, and Riegraf, 2016).

8. Sources

Aisenbrey, S.; Brückner, H. 2008. 'Occupational Aspirations and the Gender Gap in Wages'. In: *European Sociological Review*, 24(5), 633–649. https://doi.org/10.1093/esr/jcn024.

Arnett, J.J. 1995. 'Broad and Narrow Socialization: The Family in the Context of a Cultural Theory'. In: *Journal of Marriage and the Family*, 57(3), 617. https://doi.org/10.2307/353917.

Athenstaedt, U. 2000. 'Normative Geschlechtsrollenorientierung: Entwicklung und Validierung eines Fragebogens'. In: *Zeitschrift für Differentielle und Diagnostische Psychologie*, 21(1), 91–104. https://doi.org/10.1024//0170-1789.21.1.91.

Bächmann, A.-C.; Kleinert, C.; Schels, B. 2024. 'Anhaltende berufliche Geschlechtersegregation: In Ost wie West arbeiten Frauen und Männer häufig in unterschiedlichen Berufen'. In: *IAB-Kurzbericht*, 202403. Institut für Arbeitsmarkt- und Berufsforschung. https://doi.org/10.48720/IAB.KB.2403.

Baird, C.L. 2012. 'Going Against the Flow: A Longitudinal Study of the Effects of Cognitive Skills and Gender Beliefs on Occupational Aspirations and Outcomes[1]'. In: *Sociological Forum*, 27(4), 986–1009. https://doi.org/10.1111/j.1573-7861.2012.01365.x.

Bandura, A. 1977. *Social Learning Theory*. Prentice-Hall series in social learning theory. Englewood Cliffs, New Jersey: Prentice-Hall.

Blažev, M.; Popović, D.; Šverko, I. 2025. 'Longitudinal Patterns in Gender-Typed Career Interests and Career Stereotypes Among Boys and Girls in Middle Adolescence'. In: *Journal of Career Assessment*, 33(2), 383–404. https://doi.org/10.1177/10690727241267757.

Blossfeld, H.-P.; Roßbach, H.-G. (eds). 2019. *Education as a Lifelong Process: The German National Educational Panel Study (NEPS)*. Vol. 3. Edition ZfE. Wiesbaden: Springer VS. https://doi.org/10.1007/978-3-658-23162-0.

Bonnot, V.; Croizet, J.-C. 2007. 'Stereotype internalization and women's math performance: The role of interference in working memory'. In: *Journal of Experimental Social Psychology*, 43(6), 857–866. https://doi.org/10.1016/j.jesp.2006.10.006.

Braakmann, N. 2008. *Non Scholae, Sed Vitae Discimus!: The Importance of Fields of Study for the Gender Wage Gap among Germany University Graduates during Labor Market Entry and the First Years of Their Careers*. Vol. 85. Working Paper Series in Economics. Lüneburg: Leuphana Universität Lüneburg, Institut für Volkswirtschaftslehre.

Brake, A. 2012. *Bildung und Soziale Ungleichheit: Eine Einführung. Bildung und soziale Ungleichheit eine Einführung*. Grundriss der Pädagogik, Erziehungswissenschaft 35. Stuttgart: Kohlhammer.

Busch, A. 2013. *Die berufliche Geschlechtersegregation in Deutschland: Ursachen, Reproduktion, Folgen*. Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-01707-1.

Butler, J. 2015. *Gender Trouble: Feminism and the Subversion of Identity*. First issued in hardback. Routledge classics. New York London: Routledge, Taylor & Francis Group.

Butler, J. 2024. *Who's Afraid of Gender?* London: Allen lane.

Calmbach, M.; Flaig, B.B.; Gaber, R.; Gensheimer, T.; Möller-Slawinski, H.; Schleer, C.; Wisniewski, N. 2024. *Wie ticken Jugendliche? 2024: Lebenswelten von Jugendlichen im Alter von 14 bis 17 Jahren in Deutschland*. Wie ticken Jugendliche, 5. Bonn: Bundeszentrale für politische Bildung.

Carrell, S.E.; Page, M.E.; West, J.E. 2010. 'Sex and Sciecne: How Professor Gender Perpetuates the Gender Gap'. In: *Quarterly Jounral of Economics*, 125(3), 1101–1144.

Cech, E.A. 2013. 'The Self-Expressive Edge of Occupational Sex Segregation'. In: *American Journal of Sociology*, 119(3), 747–789. https://doi.org/10.1086/673969.

Cejka, M.A.; Eagly, A.H. 1999. 'Gender-Stereotypic Images of Occupations Correspond to the Sex Segregation of Employment'. In: *Personality and Social Psychology Bulletin*, 25(4), 413–423. SAGE Publications. https://doi.org/10.1177/0146167299025004002.

Charles, M.; Bradley, K. 2009a. 'Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries'. In: *American Journal of Sociology*, 114(4), 924–976. https://doi.org/10.1086/595942.

Charles, M.; Bradley, K. 2009b. 'Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries'. In: *American Journal of Sociology*, 114(4), 924–976. https://doi.org/10.1086/595942.

Charles, M.; Grusky, D.B. 2004. *Occupational Ghettos: The Worldwide Segregation of Women and Men*. Stanford University Press. https://doi.org/10.1515/9781503618183.

Cheong, J.; MacKinnon, D.P. 2012. 'Mediation/Indirect Effects in Structural Equation Modeling'. In: R.H. Hoyle (ed.), *Handbook of Structural Equation Modeling*First Edition. (pp. 417–435). S.l.: Guilford Press.

Chesters, J. 2022. 'Understanding the Persistence of Occupational Sex Segregation in German Labour Markets: How Gender Attitudes Shape Young Women's Occupational Aspirations'. In: *Journal of Applied Youth Studies*, 5(1), 55–73. https://doi.org/10.1007/s43151-021-00065-1.

Chesters, J. 2023. 'Gender Attitudes and Occupational Aspirations in Germany: Are Young Men Prepared for the Jobs of the Future?' In: *Work, Employment and Society*, 37(3), 571–587. SAGE Publications. https://doi.org/10.1177/09500170211017046.

Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. 2. ed. New York, NY: Psychology Press.

Dämmrich, J.; Blossfeld, H.-P. 2017. 'Women's disadvantage in holding supervisory positions. Variations among European countries and the role of horizontal gender segregation'. In: *Acta Sociologica*, 60(3), 262–282. SAGE Publications. https://doi.org/10.1177/0001699316675022.

De Vaus, D.A. 2013. *Surveys in Social Research*. Sixth Edition. Social research today. Abingdon, Oxon: Routledge.

DeVries, J.M.; Lauermann, F. 2025. 'Exploring the links between gender-(a)typical career aspirations and educational choices: Heterogeneous developmental pathways.' In: *Developmental Psychology*. https://doi.org/10.1037/dev0002015.

Dicke, A.-L.; Safavian, N.; Eccles, J.S. 2019. Traditional Gender Role Beliefs and Career Attainment in STEM: A Gendered Story?' In: *Frontiers in Psychology*, 10, 1053. https://doi.org/10.3389/fpsyg.2019.01053.

Eagly, A.H. 1987. *Sex Differences in Social Behavior: A Social-Role Interpretation*. Distinguished Lecture Series. Hoboken: Taylor and Francis.

Eagly, A.H.; Wood, W. 2016. 'Social Role Theory of Sex Differences'. In: A. Wong, R. Wickramasinghe, R. Hoogland, and N.A. Naples (eds), *The Wiley Blackwell Encyclopedia of Gender and Sexuality Studies*1st ed. (pp. 1–3). Wiley. https://doi.org/10.1002/9781118663219.wbegss183.

Eccles, J.S. 1987. 'Gender Roles and Women's Achievement-Related Decisions'. In: *Psychology of Women Quarterly*, 11(2), 135–172. https://doi.org/10.1111/j.1471-6402.1987.tb00781.x.

Eccles, J.S. 2011. 'Understanding Educational and Occupational Choices'. In: *Journal of Social Issues*, 67(3), 644–648. https://doi.org/10.1111/j.1540-4560.2011.01718.x.

Eccles, J.S.; Wigfield, A. 2002. 'Motivational Beliefs, Values, and Goals'. In: *Annual Review of Psychology*, 53(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153.

Eccles, J.S.; Wigfield, A. 2020. 'From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation'. In: *Contemporary Educational Psychology*, 61, 101859. https://doi.org/10.1016/j.cedpsych.2020.101859.

Ehrtmann, L.; Wolter, I. 2018. 'The impact of students' gender-role orientation on competence development in mathematics and reading in secondary school'. In: *Learning and Individual Differences*, 61, 256–264. Elsevier BV. https://doi.org/10.1016/j.lindif.2018.01.004.

Ehrtmann, L.; Wolter, I.; Hannover, B. 2019. 'The Interrelatedness of Gender-Stereotypical Interest Profiles and Students' Gender-Role Orientation, Gender, and Reasoning Abilities'. In: *Frontiers in Psychology*, 10, 1402. https://doi.org/10.3389/fpsyg.2019.01402.

Elsen, H. 2020. *Gender – Sprache – Stereotype: Geschlechtersensibilität in Alltag und Unterricht*. utb Sprachwissenschaft, 5302. Tübingen: Narr Francke Attempto Verlag.

Enders, C.K.; Little, T.D. 2022. *Applied Missing Data Analysis*. Second Edition. Methodology in the social sciences. New York London: The Guilford Press.

Estévez-Abe, M. 2006. 'Gendering the Varieties of Capitalism. A Study of Occupational Segregation by Sex in Advanced Industrial Societies'. In: *World Politics*, 59(1), 142–175. https://doi.org/10.1353/wp.2007.0016.

Eurostat. 2025. 'Students enrolled in tertiary education by education level, programme orientation, sex and field of education'. https://doi.org/10.2908/educ_uoe_enrt03.

FDZ-LIfBi. 2024. *Data Manual NEPS Starting Cohort 3-Grade 5, Paths Through Lower Secondary School, Scientific Use File Version 13.0.0*. Bamberg, Germany: Leibniz Institute for Educational Trajectories, National Educational Panel Study.

Federal Ministry of Education, Family Affairs, Senior Citizens, Women and Youth. 2020. 'Gleichstellungsstrategie der Bundesregierung'.

Federal Statistical Office of Germany. 2011. 'Bildung und Kultur'. Last accessed 8 June 2025: https://www.statistischebibliothek.de/mir/servlets/MCRFileNodeServlet/DEHeft_derivate_00006845/2110410117004.pdf.

Federal Statistical Office of Germany. 2023. 'Erwerbstätige in Führungspositionen nach Geschlecht'. Last accessed 10 October 2023: https://www.destatis.de/DE/Themen/Querschnitt/Gleichstellungsindikatoren/_inhalt.html#644540.

Federal Statistical Office of Germany. 2024. 'Gender Pay Gap: Germany remains among EU states with highest disparity'. Last accessed 1 March 2024: https://www.destatis.de/Europa/EN/Topic/Population-Labour-Social-Issues/Labour-market/gender_pay_gap.html.

Federal Statistical Office of Germany. 2025a. 'Statistics of schools of general education: School leavers (graduates and dropouts)'. Last accessed 5 May

2025: https://www-genesis.destatis.de/genesis/online?language=de&sequenz=tabelleErgebnis&selectionname=21111-0004#abreadcrumb.
Federal Statistical Office of Germany. 2025b. 'Participation of women in economic activity by occupations 2023'. Last accessed 5 May 2025: https://www.destatis.de/EN/Themes/Labour/Labour-Market/Quality-Employment/Dimension1/1_4_ParticipationWomenOccupation.html?utm_source=chatgpt.com.
Federal Statistical Office of Germany. 2025c. 'Students: Germany, semester, nationality, sex, subject'. Last accessed https://www-genesis.destatis.de/datenbank/online/statistic/21311/table/21311-0003.
Federal Statistical Office of Germany. 2025d. 'Migrationshintergrund', Migration und Integration. Last accessed 12 January 2025: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Migration-Integration/Glossar/migrationshintergrund.html.
Field, A. 2024. *Discovering Statistics Using IBM SPSS Statistics*. 6th edition. Los Angeles London New Delhi Singapore Washington DC Melbourne: Sage.
Georg, W.; Bargel, E. 2017. 'Parental qualifications as determinants of university entrance and choice of a field of study in Germany'. In: *European Journal of Higher Education*, 7(1), 78–95. https://doi.org/10.1080/21568235.2017.1265777.
Gottfredson, L.S. 1981. 'Circumscription and Compromise: A Developmental Theory of Occupational Aspirations'. In: *Journal of Counseling Psychology Monograph*, 28(6), 545–579. https://doi.org/10.1037/0022-0167.28.6.545.
Graham, J.W. 2009. 'Missing Data Analysis: Making It Work in the Real World'. In: *Annual Review of Psychology*, 60(1), 549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530.
Hadjar, A.; Aeschlimann, B. 2015. 'Gender stereotypes and gendered vocational aspirations among Swiss secondary school students'. In: *Educational Research*, 57(1), 22–42. https://doi.org/10.1080/00131881.2014.983719.
Hannover, B.; Wolter, I. 2022. 'Schule und Geschlecht'. In: T. Hascher, T.-S. Idel, and W. Helsper (eds), *Handbuch Schulforschung* (pp. 827–847). Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-24729-4.
Heine, C.; Willich, J.; Schneider, H.; Sommer, D. 2008. Studienanfänger im Wintersemester 2007/08'.
Henschel, S.; Jansen, M.; Schneider, R. 2023. 'How gender stereotypes of students and significant others are related to motivational and affective outcomes in mathematics at the end of secondary school'. In: *Contemporary Educational Psychology*, 73, 102161. https://doi.org/10.1016/j.cedpsych.2023.102161.
Holland, J.L. 1997. *Making Vocational Choices: A Theory of Vocational Personalities and Work Environments*. 3rd ed. Psychological Assessment Resources.
Hoyle, R.H. (ed.). 2012. *Handbook of Structural Equation Modeling*. First Edition. S.l.: Guilford Press.
Hu, L.; Bentler, P.M. 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives'. In: *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. https://doi.org/10.1080/10705519909540118.
Humlum, M.K.; Nandrup, A.B.; Smith, N. 2019. 'Closing or reproducing the gender gap? Parental transmission, social norms and education choice'. In: *Journal of*

Population Economics, 32(2), 455–500. https://doi.org/10.1007/s00148-018-0692-1.

Jansen, M.; Schneider, R.; Schipolowski, S.; Henschel, S. 2019. 'Motivationale Schülermerkmale im Fach Mathematik und in den naturwissenschaftlichen Fächern'. In: P. Stanat, S. Schipolowski, N. Mahler, S. Weirich, and H. Henschel Sofie (eds), *IQB-Bildungstrend 2018. Mathematische und naturwissenschaftliche Kompetenzen am Ende der Sekundarstufe I im zweiten Ländervergleich* (pp. 337–354). Münster: Waxmann. Last accessed 8 December 2025: https://www.pedocs.de/frontdoor.php?source_opus=18131.

Johnson, R.B.; Christensen, L.B. 2020. *Educational Research: Quantitative, Qualitative, and Mixed Approaches*. Seventh Edition. Los Angeles London New Delhi Singapore Washington DC Melbourne: SAGE.

Jusri, R. 2024. Student attrition in gender-atypical fields of study: acase of disapproval by parents and friends or lacking social integration?' In: *Zeitschrift Für Erziehungswissenschaft*. Springer Science and Business Media LLC. https://doi.org/10.1007/s11618-024-01285-w.

Kiefer, A.K.; Sekaquaptewa, D. 2007. Implicit stereotypes and women's math performance: How implicit gender-math stereotypes influence women's susceptibility to stereotype threat'. In: *Journal of Experimental Social Psychology*, 43(5), 825–832. https://doi.org/10.1016/j.jesp.2006.08.004.

Kleinert, C.; Schels, B. 2020. 'Zurück zur Norm? Kompromissbildung zwischen geschlechtstypischen und -untypischen Berufsaspirationen, Bewerbungs- und Ausbildungsberufen'. In: *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 72(S1), 229–260. https://doi.org/10.1007/s11577-020-00668-1.

Kline, R.B. 2012. 'Assumptions in Structural Equation Modeling'. In: R.H. Hoyle (ed.), *Handbook of Structural Equation Modeling*First Edition. (pp. 111–125). S.l.: Guilford Press.

Kline, R.B. 2016. *Principles and Practice of Structural Equation Modeling*. Fourth edition. Methodology in the social sciences. New York London: The Guilford Press.

Kunter, M.; Schümer, G.; Artelt, C.; Baumert, J.; Klieme, E.; Neubrand, M.; Prenzel, M.; Schiefele, U.; Schneider, W.; Stanat, P.; Tillmann, K.-J.; Weiß, M. (eds). 2002. *PISA 2000: Dokumentation der Erhebungsinstrumente*. Materialien aus der Bildungsforschung, Nr. 72. Berlin: Max-Planck-Inst. für Bildungsforschung. https://doi.org/10.48644/mpib_escidoc_33618.

Legewie, J.; DiPrete, T. 2014a. 'Pathways to Science and Engineering Bachelor's Degrees for Men and Women'. In: *Sociological Science*, 41–48. https://doi.org/10.15195/v1.a4.

Legewie, J.; DiPrete, T. 2014b. 'The High School Environment and the Gender Gap in Science and Engineering'. In: *Sociology of Education*, 87(4), 259–280. https://doi.org/10.1177/0038040714547770.

LIfBi. 2025a. 'Remote Access Technology: RemoteNEPS'. Last accessed 22 October 2025: https://www.neps-data.de/Data-Center/Data-Access/RemoteNEPS.

LIfBi. 2025b. Survey Design of the NEPS'. Last accessed https://www.neps- data.de/Project-Overview/Survey-Design.

Little, R.J.A. 1988. 'A Test of Missing Completely at Random for Multivariate Data with Missing Values'. In: *Journal of the American Statistical Association*, 83(404), 1198–1202. https://doi.org/10.1080/01621459.1988.10478722.

Malin, L. 2018. 'Occupational Gender Segregation in Germany'. University of Cologne.

Malone, P.S.; Lubansky, J.B. 2012. 'Preparing Data for Stuctural Equation Modeling'. In: R.H. Hoyle (ed.), *Handbook of Structural Equation Modeling*First Edition. (pp. 263–276). S.l.: Guilford Press.

von Maurice, J.; Bäumer, T. 2015. 'Entwicklung allgemeiner Interessenorientierungen beim Übergang von der Grundschule in den Sekundarbereich'. In: C. Tarnai and F.G. Hartmann (eds), *Berufliche Interessen: Beiträge zur Theorie von J. L. Holland* (pp. 63–85). Münster New York: Waxmann.

NEPS Network. 2025. 'Scientific Use File der NEPS-Startkohorte 3: Klasse 5Scientific Use File of NEPS Starting Cohort 3: Grade 5'. Leibniz Institute for Educational Trajectories. https://doi.org/10.5157/NEPS:SC3:13.1.0.

O'Brien, J. (ed.). 2009. *Encyclopedia of Gender and Society*. 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc. https://doi.org/10.4135/9781412964517.n315.

Ochsenfeld, F. 2016. 'Preferences, constraints, and the process of sex segregation in college majors: A choice analysis'. In: *Social Science Research*, 56, 117–132. https://doi.org/10.1016/j.ssresearch.2015.12.008.

Pallant, J. 2020. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. Seventh edition. Place of publication not identified: Routledge.

Pampaka, M.; Hutcheson, G.; Williams, J. 2016. 'Handling missing data: analysis of a challenging data set using multiple imputation'. In: *International Journal of Research & Method in Education*, 39(1), 19–37. https://doi.org/10.1080/1743727X.2014.979146.

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 and J.S. Eccles (eds), *Gender Differences in Aspirations and Attainment*1st ed. (pp. 224–246). Cambridge University Press. https://doi.org/10.1017/CBO9781139128933.015.

Parker, P.D.; Schoon, I.; Tsai, Y.-M.; Nagy, G.; Trautwein, U.; Eccles, J.S. 2012. 'Achievement, agency, gender, and socioeconomic background as predictors of postschool choices: A multicontext study.' In: *Developmental Psychology*, 48(6), 1629–1642. https://doi.org/10.1037/a0029167.

Parker, P.D.; Van Zanden, B.; Marsh, H.W.; Owen, K.; Duineveld, J.J.; Noetel, M. 2020. 'The Intersection of Gender, Social Class, and Cultural Context: a Meta-Analysis'. In: *Educational Psychology Review*, 32(1), 197–228. https://doi.org/10.1007/s10648-019-09493-1.

Patzina, A.; Toussaint, C. 2023. 'Assessing the Importance of Sample Choice and Selectivity for Sex Segregation in College Majors: A Replication of Ochsenfeld (2016)'. In: *Zeitschrift Für Soziologie*, 52(4), 425–439. https://doi.org/10.1515/zfsoz-2023-2029.

Philipp, J. 2023. 'Gendered university major choice: the role of intergenerational transmission'. In: *Journal of Population Economics*, 36(2), 1049–1097. Springer Science and Business Media LLC. https://doi.org/10.1007/s00148-022-00900-6.

Pikić-Jugović, I.; Doolan, K.; Baranović, B. 2024. 'Exploring situated expectancy-value theory: A study of gendered higher education choices'. In: *Psiholoska Istrazivanja*, 27(2), 197–222. https://doi.org/10.5937/PSISTRA27-49718.

Plante, I.; De La Sablonnière, R.; Aronson, J.M.; Théorêt, M. 2013. 'Gender stereotype endorsement and achievement-related outcomes: The role of competence beliefs and task values'. In: *Contemporary Educational Psychology*, 38(3), 225–235. https://doi.org/10.1016/j.cedpsych.2013.03.004.

Platt, L.; Polavieja, J. 2016. Saying and Doing Gender: Intergenerational Transmission of Attitudes towards the Sexual Division of Labour'. In: *European Sociological Review*, 32(6), 820–834. https://doi.org/10.1093/esr/jcw037.

Polavieja, J.G.; Platt, L. 2014. 'Nurse or Mechanic? The Role of Parental Socialization and Children's Personality in the Formation of Sex-Typed Occupational Aspirations'. In: *Social Forces*, 93(1), 31–61. https://doi.org/10.1093/sf/sou051.

R Core Team. 2024. 'R: A language and environment for statistical computing'. Vienna, Austria: R Foundation for Statistical Computing. Last accessed https://www.R-project.org/.

Rendtorff, B.; Kleinau, E.; Riegraf, B. 2016. *Bildung – Geschlecht – Gesellschaft: Eine Einführung*. Reihe Erziehung und Bildung: Wissen für pädagogisches Handeln. Weinheim Basel: Beltz.

Revelle, W. 2025. 'psych: Procedures for Psychocologica, Psychometric, and Personality Research'. Evanston, Illinois: Northwestern University. Last accessed https://CRAN.R-project.org/package=psych.

Rollins, J.C. 2011. *U.S. Science, Technology, Engineering and Math (STEM) Education*. Education in a Competitive and Globalizing World. Hauppauge: Nova Science Publishers, Incorporated.

Rosseel, Y. 2012. 'lavaan : An *R* Package for Structural Equation Modeling'. In: *Journal of Statistical Software*, 48(2). https://doi.org/10.18637/jss.v048.i02.

Sauer, B. 2016. 'Gender und Sex'. In: A. Scherr (ed.), *Soziologische Basics*3. Auflage. (pp. 81–87). Wiesbaden: Springer VS.

Schmidt, J. 2020. 'Die berufliche Geschlechtersegregation am Arbeitsmarkt Welche Rolle spielen persönliche Präferenzen?' In: *IW Trends*, (1). https://doi.org/10.2373/1864-810X.20-01-04.

Siembab, M.; Wicht, A. 2020. 'Schulformen und geschlechtstypische Berufsorientierungen: Jugendliche am Ende der neuntenKlasse zwischen Gelegenheitsstrukturen auf dem Arbeitsmarkt und schulspezifischen Berufsaspirationen'. In: *Zeitschrift für Soziologie*, 49(2–3), 183–199. Walter de Gruyter GmbH. https://doi.org/10.1515/zfsoz-2020-0017.

Sinclair, S.; Nilsson, A.; Cederskär, E. 2019. 'Explaining gender-typed educational choice in adolescence: The role of social identity, self-concept, goals, grades, and interests'. In: *Journal of Vocational Behavior*, 110, 54–71. https://doi.org/10.1016/j.jvb.2018.11.007.

SINUS. 2025. 'Sinus Youth Milieus'. Last accessed https://www.sinus-institut.de/en/sinus-milieus/sinus-youth-milieus.

Steinmetz, S. 2012. *The Contextual Challenges of Occupational Sex Segregation*. Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-93056-5.

Su, R.; Rounds, J.; Armstrong, P.I. 2009. 'Men and things, women and people: A meta-analysis of sex differences in interests.' In: *Psychological Bulletin*, 135(6), 859–884. https://doi.org/10.1037/a0017364.

Taraszow, T.; Gentrup, S.; Heppt, B. 2024. 'Egalitarian gender role attitudes give girls the edge: Exploring the role of students' gender role attitudes in reading and math'. In: *Social Psychology of Education*, 27(6), 3425–3452. https://doi.org/10.1007/s11218-024-09913-3.

Tierney, N.; Cook, D. 2023. 'Expanding Tidy Data Principles to Facilitate Missing Data Exploration, Visualization and Assessment of Imputations'. In: *Journal of Statistical Software*, 105(7). https://doi.org/10.18637/jss.v105.i07.

Tokar, D.M.; Jome, L.M. 1998. 'Masculinity, Vocational Interests, and Career Choice Traditionality: Evidence for a Fully Mediated Model'.
UNESCO. 1997. *International Standard Classification of Education (ISCED 1997)*. Paris: United Nationas Educational, Scientific and Cultural Organization.
Uunk, W. 2024. The Role of Math and Language Performance in Explaining the Gender Gap in STEM Major Choice. A Test for Germany'. In: *Zeitschrift Für Soziologie*, 53(4), 404–418. https://doi.org/10.1515/zfsoz-2024-2025.
Van Der Vleuten, M.; Jaspers, E.; Maas, I.; Van Der Lippe, T. 2018. 'Intergenerational transmission of gender segregation: How parents' occupational field affects gender differences in field of study choices'. In: *British Educational Research Journal*, 44(2), 294–318. https://doi.org/10.1002/berj.3329.
Warwas, J.; Nagy, G.; Watermann, R.; Hasselhorn, M. 2009. 'The Relations of Vocational Interests and Mathematical Literacy: On the Predictive Power of Interest Profiles'. In: *Journal of Career Assessment*, 17(4), 417–438. https://doi.org/10.1177/1069072709339284.
Weisberg, F.J. 2019. *An R Companion to Applied Regression*. 3rd edition. Thousand Oaks, CA: Sage. Last accessed https://www.john-fox.ca/Companion/.
West, C.; Zimmerman, D.H. 1987. 'Doing Gender'. In: *Gender & Society*, 1(2), 125–151. https://doi.org/10.1177/0891243287001002002.
Wicht, A.; Miyamoto, A.; Lechner, C.M. 2022. 'Are Girls More Ambitious Than Boys? Vocational Interests Partly Explain Gender Differences in Occupational Aspirations'. In: *Journal of Career Development*, 49(3), 551–568. SAGE Publications. https://doi.org/10.1177/0894845321991665.
Wicht, A.; Siembab, M. 2022. 'Ethnic Differences in Gender-Typical Occupational Orientations Among Adolescents in Germany'. In: *Social Inclusion*, 10(2). https://doi.org/10.17645/si.v10i2.5092.
Wickham, H.; François, R.; Henry, L.; Müller, K.; Vaughan, D. 2025. 'dplyr: A Grammar of Data Manipulation. R package version 1.1.4'. Last accessed https://dplyr.tidyverse.org.
Wickham, H.; Miller, E.; Smith, D. 2025. 'haven: Import and Export "SPSS", "Stata" and "SAS" Files. R package version 2.5.5'. Last accessed https://haven.tidyverse.org.
Wickham, H.; Vaughan, D.; Girlich, M.; Ushey, K. 2025. 'tidyr: Tidy Messy Data. R package version 1.3.1'. Last accessed https://tidyr.tidyverse.org.
Wigfield, A.; Eccles, J.S. 2000. 'Expectancy–Value Theory of Achievement Motivation'. In: *Contemporary Educational Psychology*, 25(1), 68–81. https://doi.org/10.1006/ceps.1999.1015.
Wigfield, A.; Rosenzweig, E.Q.; Eccles, J.S. 2017. 'Achievement Values. Interactions, Interventions, and Future Directions'. In: A.J. Elliot, C. Dweck, and D.S. Yeager (eds), *Handbook of Competence and Motivation: Theory and Application*Second edition. (pp. 116–134). New York London: The Guilford Press.
Wille, E.; Stoll, G.; Gfrörer, T.; Cambria, J.; Nagengast, B.; Trautwein, U. 2020. 'It Takes Two: Expectancy-Value Constructs and Vocational Interests Jointly Predict STEM Major Choices'. In: *Contemporary Educational Psychology*, 61, 101858. https://doi.org/10.1016/j.cedpsych.2020.101858.
Wohlkinger, F.; Bayer, M.; Ditton, H. 2016. 'Measuring Self-Concept in the NEPS'. In: H.-P. Blossfeld, J. Von Maurice, M. Bayer, and J. Skopek (eds), *Methodological Issues of Longitudinal Surveys* (pp. 181–193). Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-11994-2_11.
Wohlkinger, F.; Blumenfelder, A.R.; Bayer, M.; von Maurice, J.; Ditton, H.; Blossfeld, H.-P. 2019. 'Measuring motivational concepts and personality aspects in the

national educational panel study'. In: H.-P. Blossfeld and H.-G. Roßbach (eds), *Education as a Lifelong Process: The German National Educational Panel Study (NEPS)*Vol. 3 (pp. 155–169). Edition ZfE. Wiesbaden: Springer VS. https://doi.org/10.1007/978-3-658-23162-0.

Wohlkinger, F.; Ditton, H.; Von Maurice, J.; Haugwitz, M.; Blossfeld, H.-P. 2011. '10 Motivational concepts and personality aspects across the life course'. In: *Zeitschrift Für Erziehungswissenschaft*, 14(S2), 155–168. https://doi.org/10.1007/s11618-011-0184-5.

Wolter, I.; Braun, E.; Hannover, B. 2015. 'Reading is for girls!? The negative impact of preschool teachers' traditional gender role attitudes on boys' reading related motivation and skills'. In: *Frontiers in Psychology*, 6. https://doi.org/10.3389/fpsyg.2015.01267.

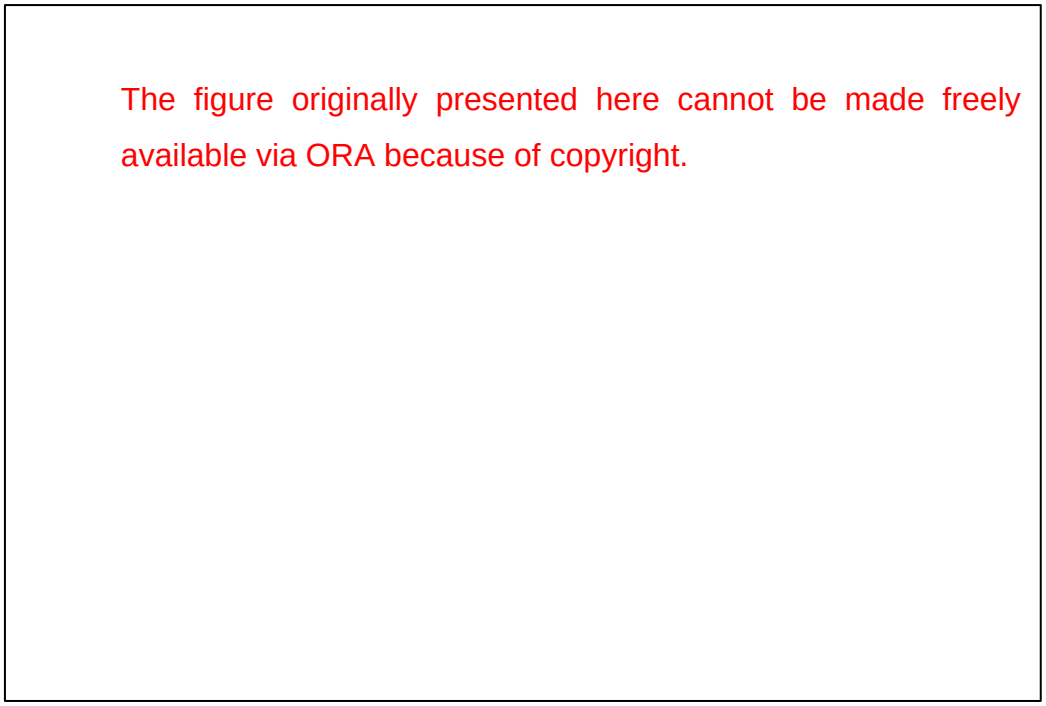
Wolter, I.; Ehrtmann, L.; Seidel, T.; Drechsel, B. 2019. 'Social or Economic Goals? The Professional Goal Orientation of Students Enrolled in STEM and Non-STEM Majors in University'. In: *Frontiers in Psychology*, 10. Frontiers Media SA. https://doi.org/10.3389/fpsyg.2019.02065.

Wolter, I.; Hannover, B. 2016. 'Gender role self-concept at school start and its impact on academic self-concept and performance in mathematics and reading'. In: *European Journal of Developmental Psychology*, 13(6), 681–703. https://doi.org/10.1080/17405629.2016.1175343.

A. Appendix

A.1 NEPS Study Design

Figure A.1 Multi Cohort Sequence Design of the NEPS



Source: Leibniz Institute for Educational Trajectories (LIfBi, 2025b)

A.2 Data Assumptions

A.2.1 Normality | Skewness and Kurtosis

Table A.1 Skewness and Kurtosis

	Skewness		Kurtosis	
	Boys	Girls	Boys	Girls
Gender Role Attitudes	0.225	0.710	-0.453	0.428
Realistic	-0.003	0.356	-0.544	-0.262
Investigative	0.017	0.216	-0.565	-0.656
Artistic	0.654	0.004	-0.159	-0.836
Social	0.141	-0.128	-0.332	0.339
Enterprising	0.035	0.319	-0.123	-0.280
Conventional	0.448	0.361	0.159	-0.165
ASC German	-0.599	-0.456	0.360	0.301
ASC Math	-0.317	0.087	-0.907	-1.017
Gender Typicality of Study Major	-0.270	-0.553	-1.169	0.173
Parents' ISCED	-0.473	-0.510	-1.115	-1.077

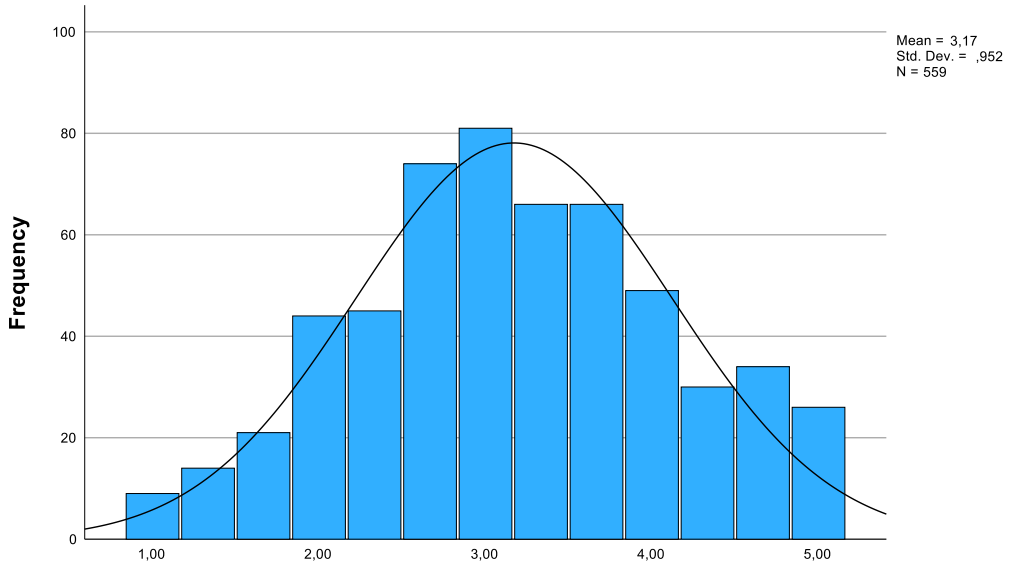
Note: ASC German = Academic Self-Concept German. ASC Math = Academic Self-Concpet Math. Analyses were carried out in SPSS 31.0.0.0.

Values were within the recommended range of ± 2 for skewness and ±3 for kurtosis (Field, 2024) for all variables across both boys and girls, indicating approximate normal distribution of the variables.

A.2.1 Normality | IILS-R (Realistic Interests)

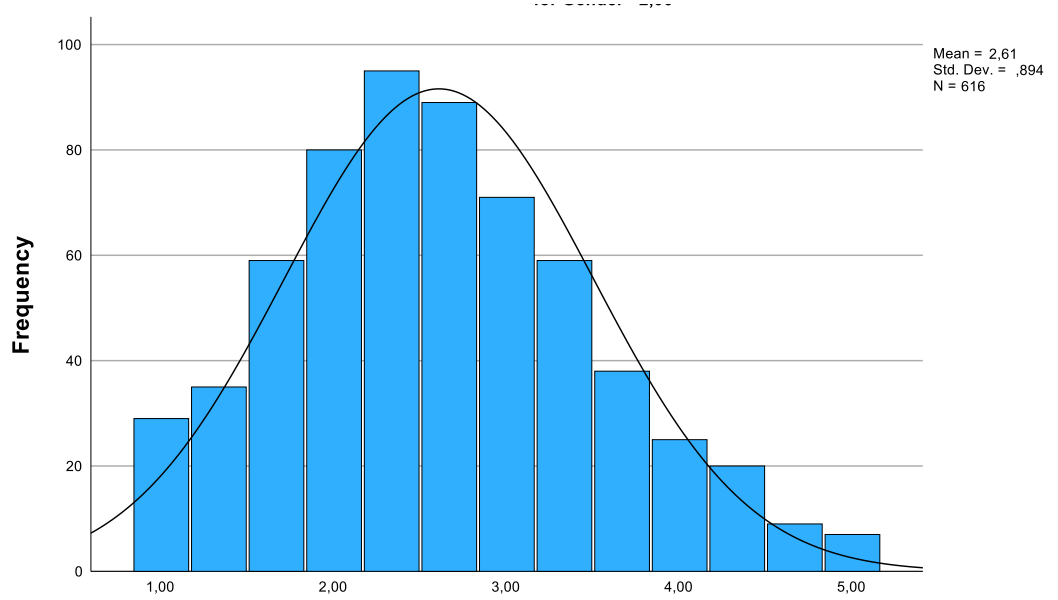
Approximate normal distribution of IILS-R (boys/girls) is indicated by the histograms (Figures A.2 and A.3) and the Q-Q-Plots (Figures A.4 and A.5).

Figure A.2 Histogram of IILS-R (realistic interests), boys



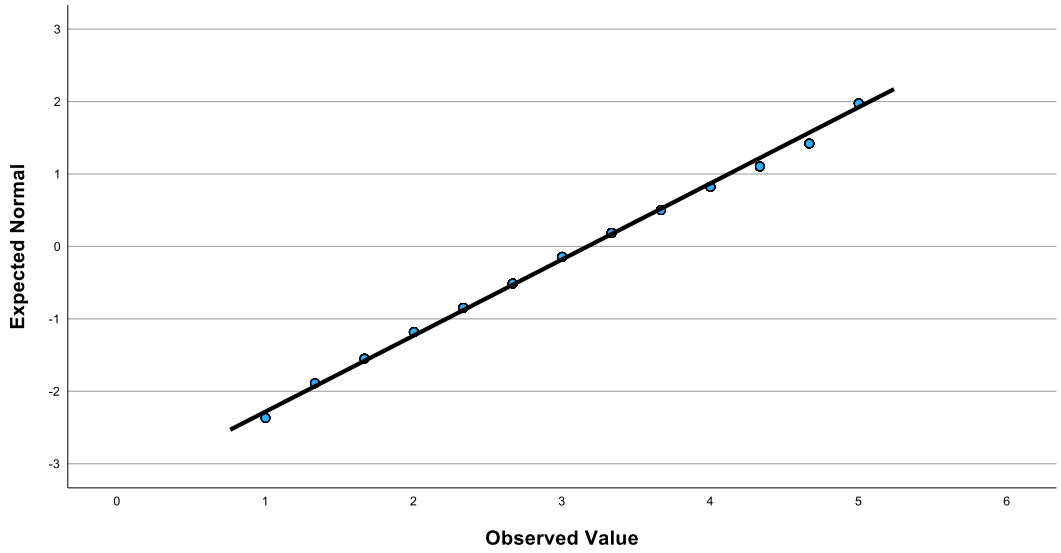
Note: The histogram visualises the distribution of the IILS-R (realistic interests). Outputs from SPSS 31.0.0.0.

Figure A.3 Histogram of IILS-R (realistic interests), girls



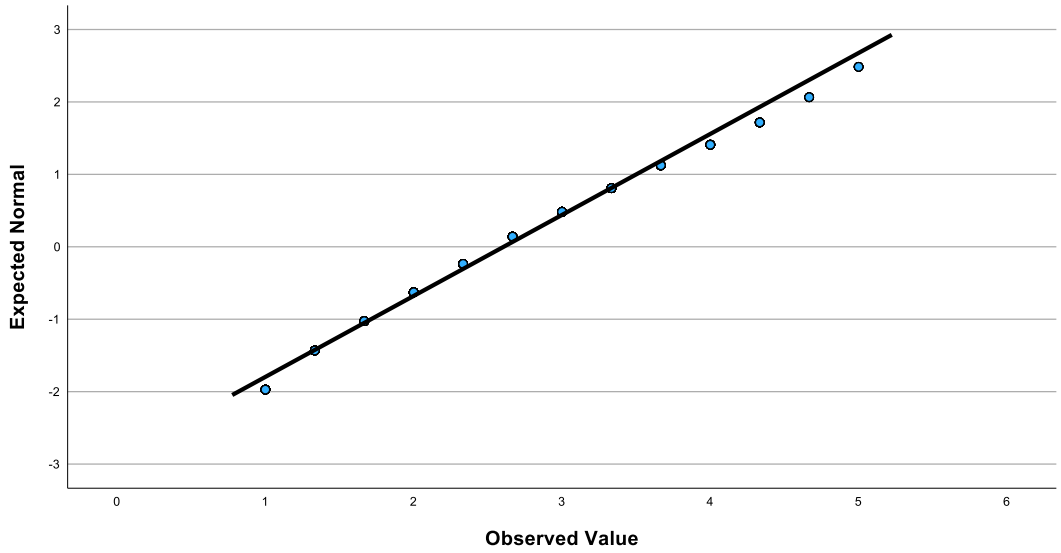
Note: The histogram visualises the distribution of the IILS-R (realistic interests). Outputs from SPSS 31.0.0.0.

Figure A.4 Normal Q-Q Plot of IILS-R (realistic interests), boys



Note: The normal probability plot visualises the distribution of the IILS-R (realistic interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0.

Figure A.5 Normal Q-Q Plot of IILS-R (realistic interests), girls

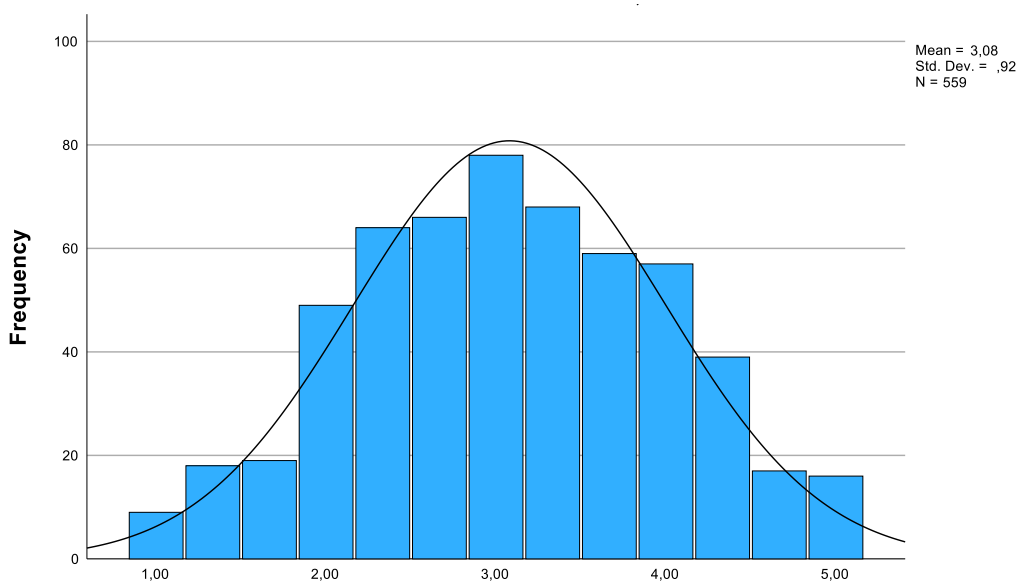


Note: The normal probability plot visualises the distribution of the IILS-R (realistic interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0.

A.2.1 Normality | IILS-I (Investigative Interests)

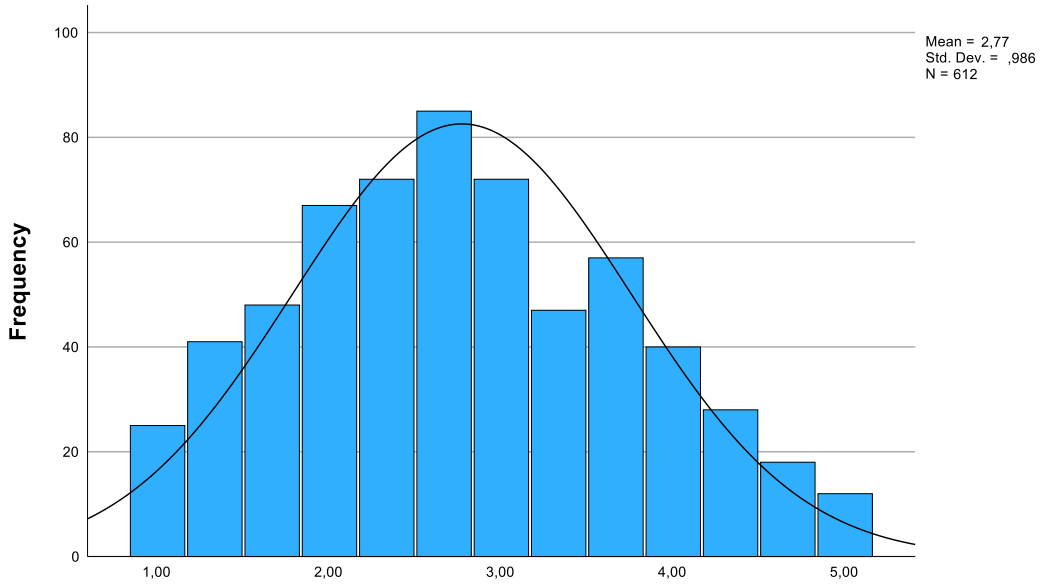
Approximate normal distribution of IILS-I (boys/girls) is indicated by the histograms (Figures A.6 and A.7) and the Q-Q-Plots (Figures A.8 and A.9).

Figure A.6 Histogram of IILS-I (investigative interests), boys



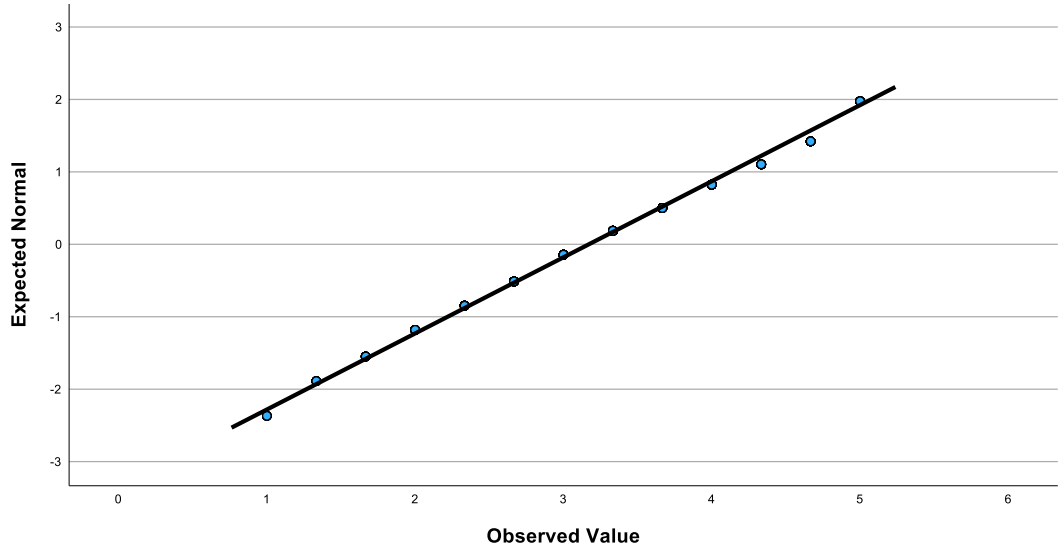
Note: The histogram visualises the distribution of the IILS-I (investigative interests). Outputs from SPSS 31.0.0.0.

Figure A.7 Histogram of IILS-I (investigative interests), girls



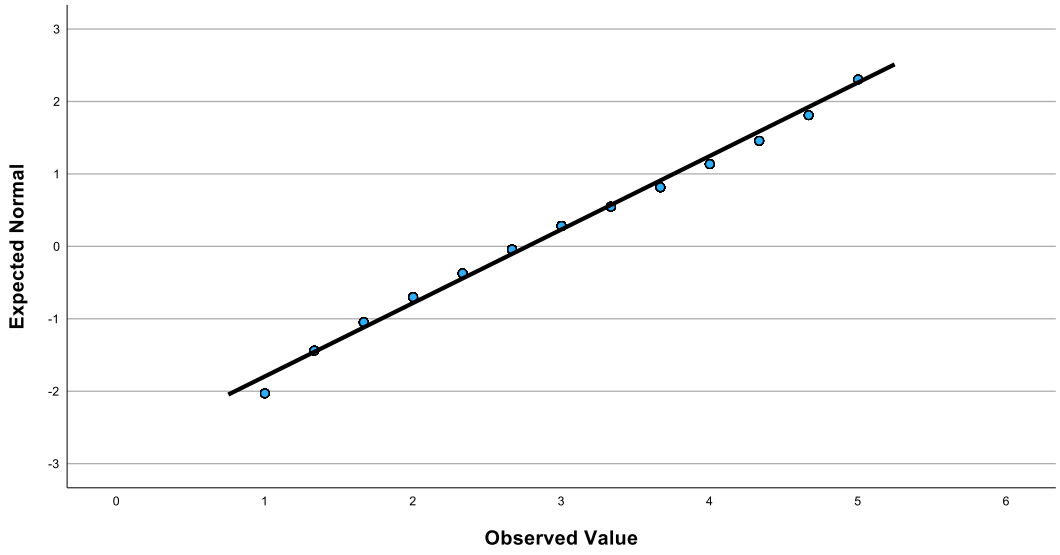
Note: The histogram visualises the distribution of the IILS-I (investigative interests). Outputs from SPSS 31.0.0.0.

Figure A.8 Normal Q-Q Plot of IILS-I (investigative interests), boys



Note: The normal probability plot visualises the distribution of the IILS-I (investigative interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.9 Normal Q-Q Plot of IILS-I (investigative interests), girls

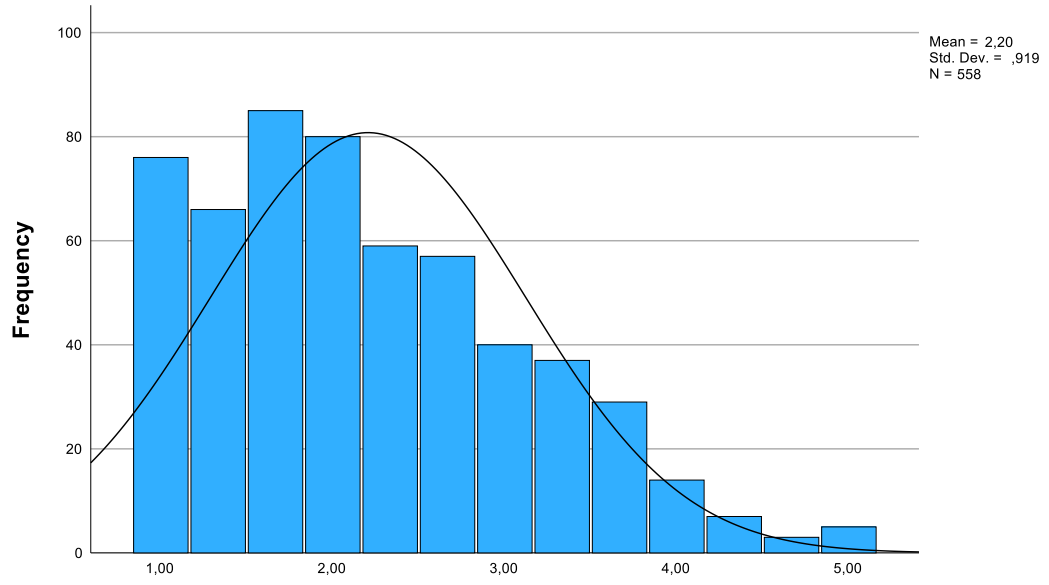


Note: The normal probability plot visualises the distribution of the IILS-I (investigative interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | IILS-A (Artistic Interests)

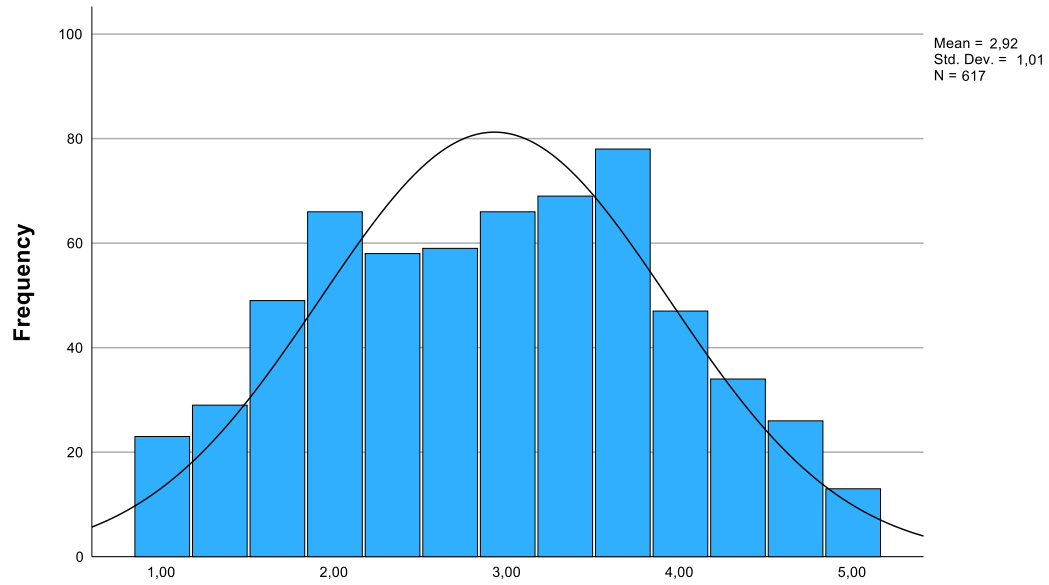
Approximate normal distribution of IILS-A (boys/girls) is indicated by the histograms (Figures A.10 and A.11) and the Q-Q-Plots (Figures A.12 and A.13).

Figure A.10 Histogram of IILS-A (artistic interests), boys



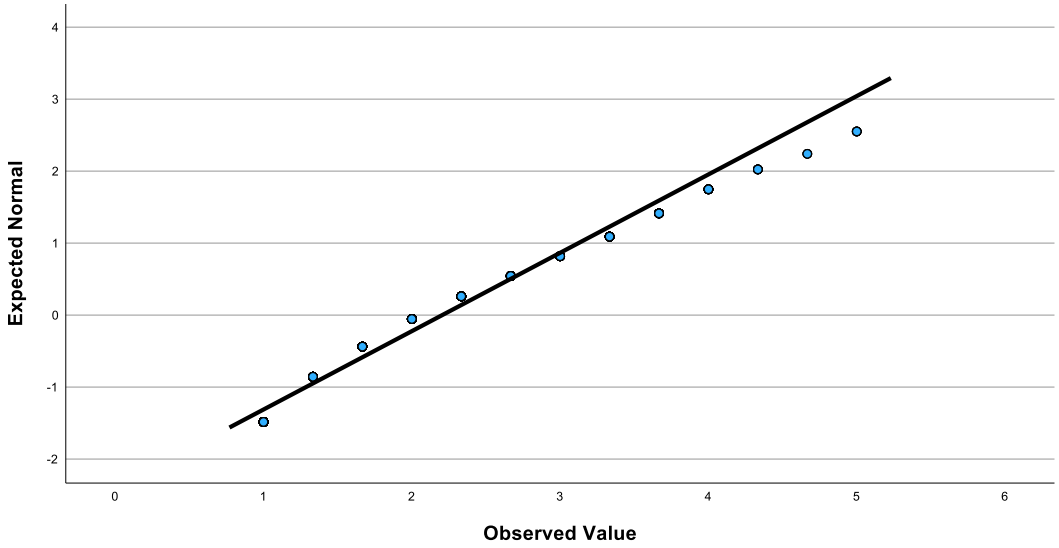
Note: The histogram visualises the distribution of the IILS-A (artistic interests). Outputs from SPSS 31.0.0.0.

Figure A.11 Histogram of IILS-A (artistic interests), girls



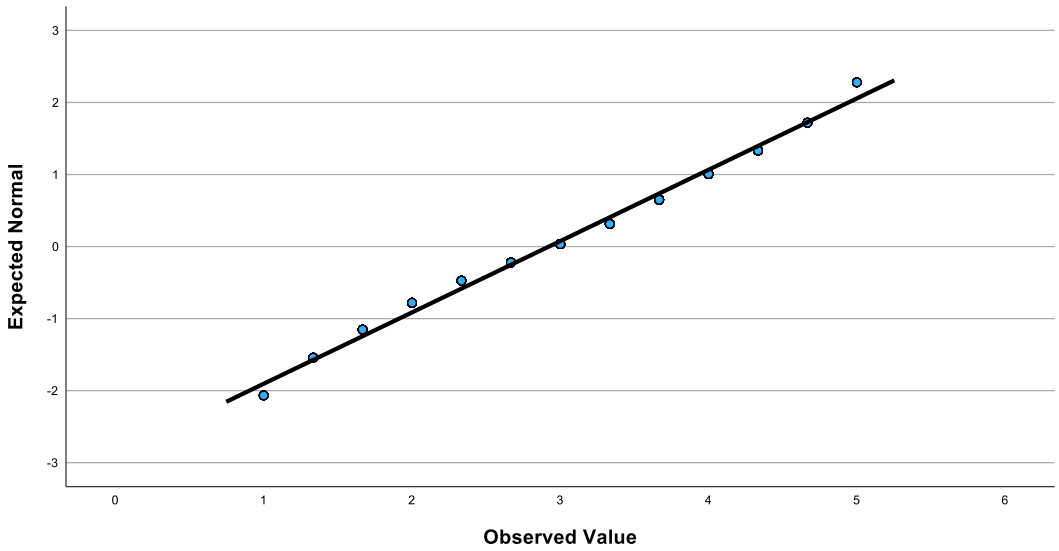
Note: The histogram visualises the distribution of the IILS-A (artistic interests). Outputs from SPSS 31.0.0.0.

Figure A.12 Normal Q-Q Plot of IILS-A (artistic interests), boys



Note: The normal probability plot visualises the distribution of the IILS-A (artistic interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.13 Normal Q-Q Plot of IILS-A (artistic interests), girls

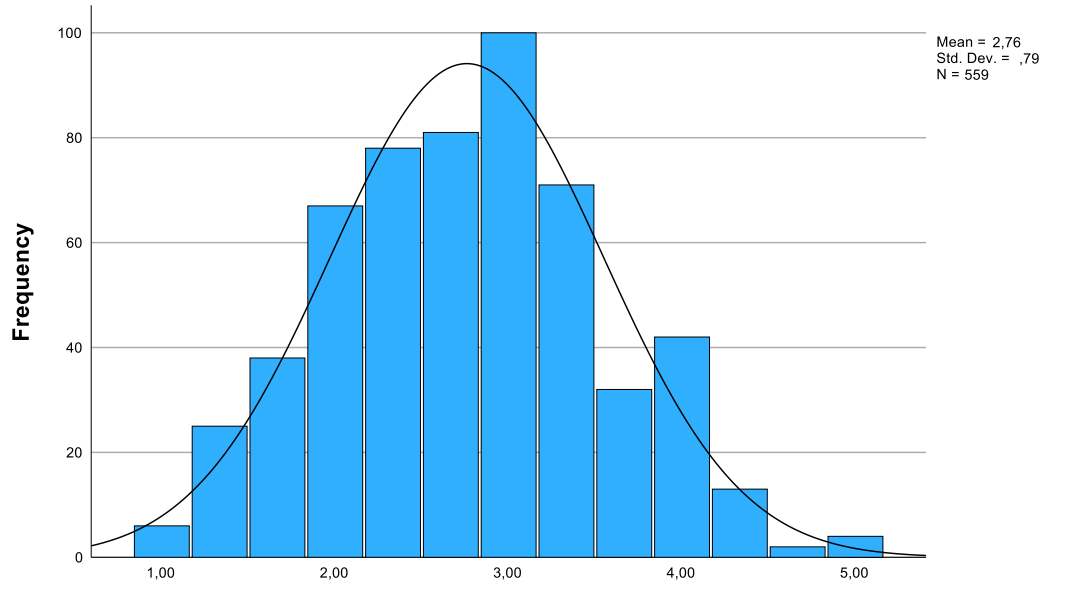


Note: The normal probability plot visualises the distribution of the IILS-A (artistic interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | IILS-S (Social Interests)

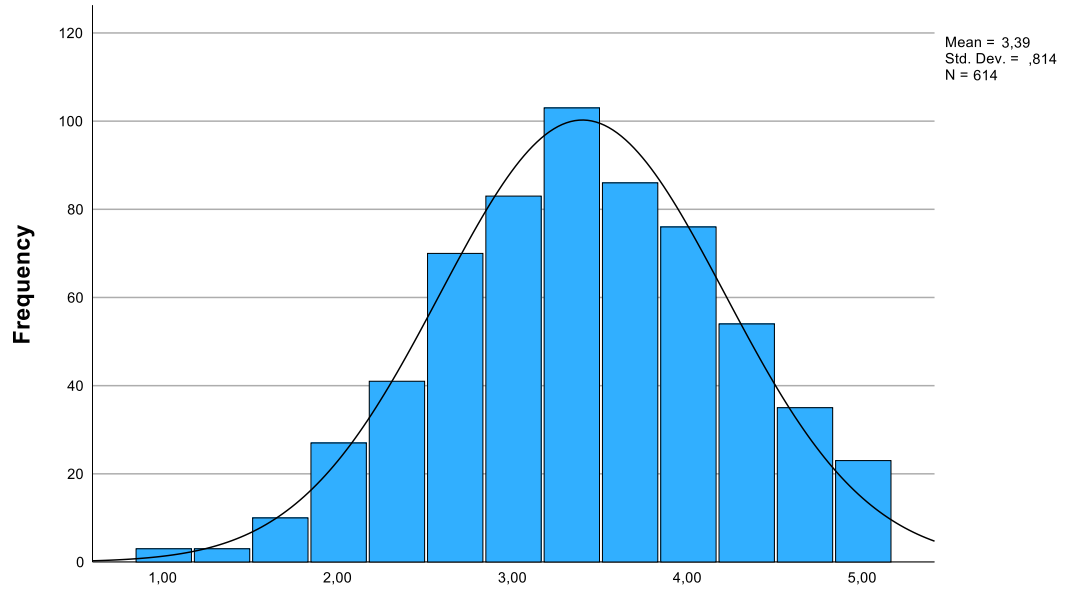
Approximate normal distribution of IILS-S (boys/girls) is indicated by the histograms (Figures A.14 and A.15) and the Q-Q-Plots (Figures A.16 and A.17).

Figure A.14 Histogram of IILS-S (social interests), boys



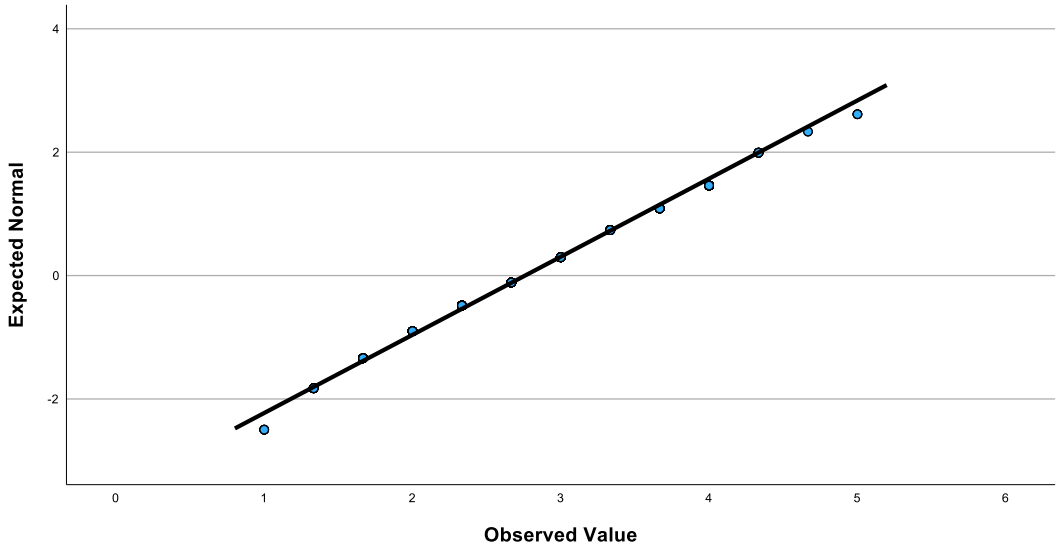
Note: The histogram visualises the distribution of the IILS-S (social interests). Outputs from SPSS 31.0.0.0.

Figure A.15 Histogram of IILS-S (social interests), girls



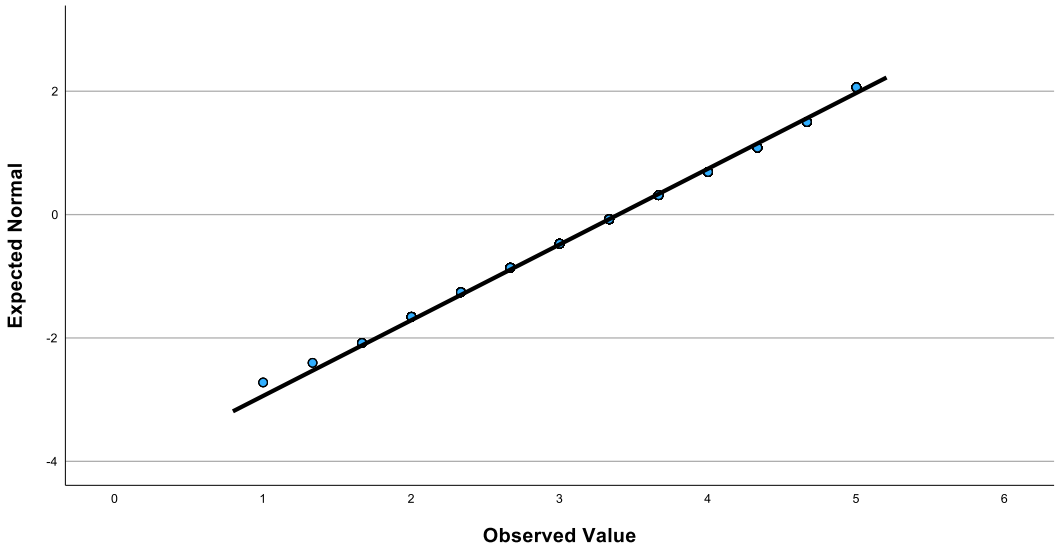
Note: The histogram visualises the distribution of the IILS-S (social interests). Outputs from SPSS 31.0.0.0.

Figure A.16 Normal Q-Q Plot of IILS-S (social interests), boys



Note: The normal probability plot visualises the distribution of the IILS-S (social interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.17 Normal Q-Q Plot of IILS-S (social interests), girls

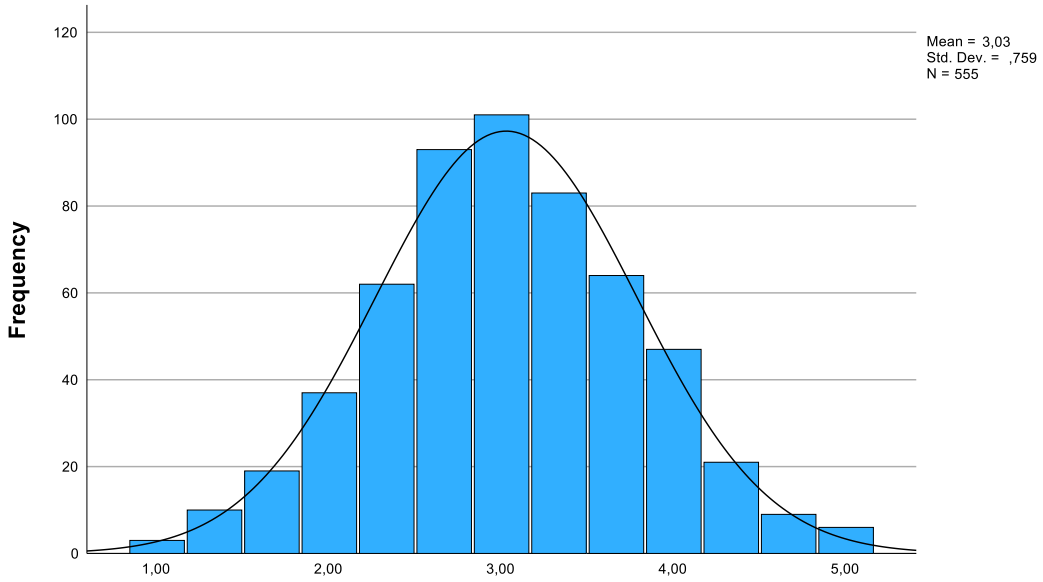


Note: The normal probability plot visualises the distribution of the IILS-S (social interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | IILS-E (Enterprising Interests)

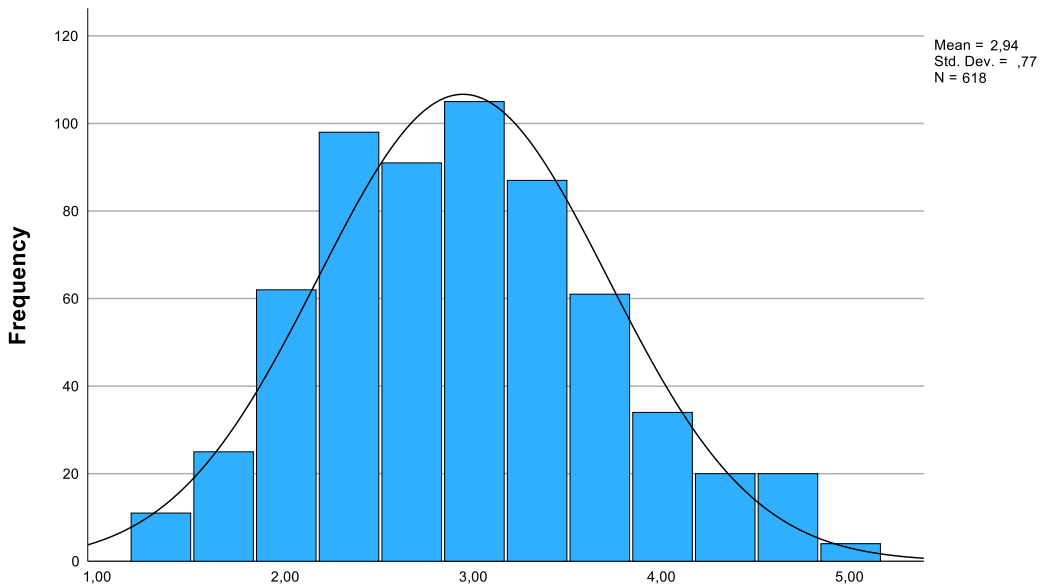
Approximate normal distribution of IILS-E (boys/girls) is indicated by the histograms (Figures A.18 and A.19) and the Q-Q-Plots (Figures A.20 and A.21).

Figure A.18 Histogram of IILS-E (enterprising interests), boys



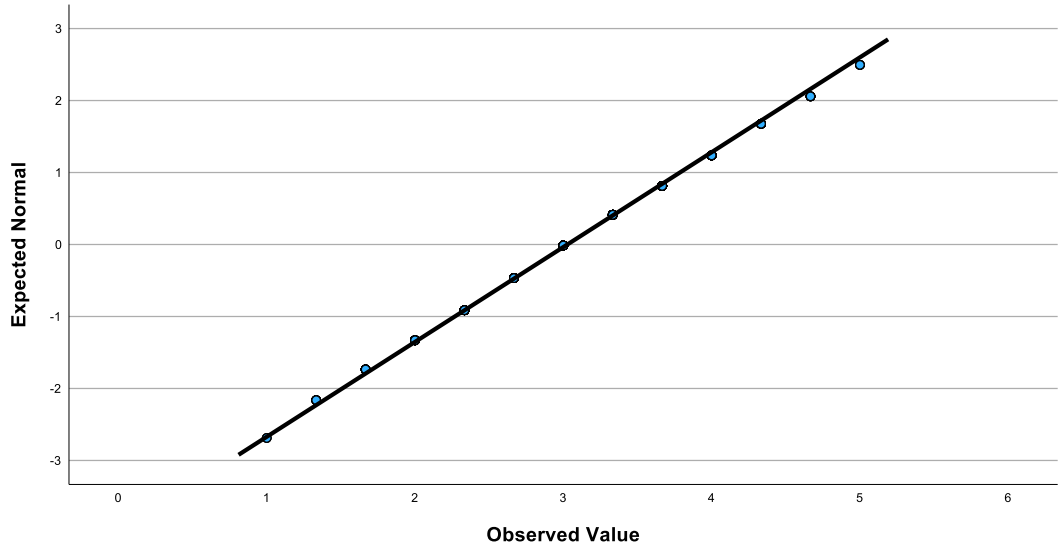
Note: The histogram visualises the distribution of the IILS-E (enterprising interests). Outputs from SPSS 31.0.0.0.

Figure A.19 Histogram of IILS-E (enterprising interests), girls



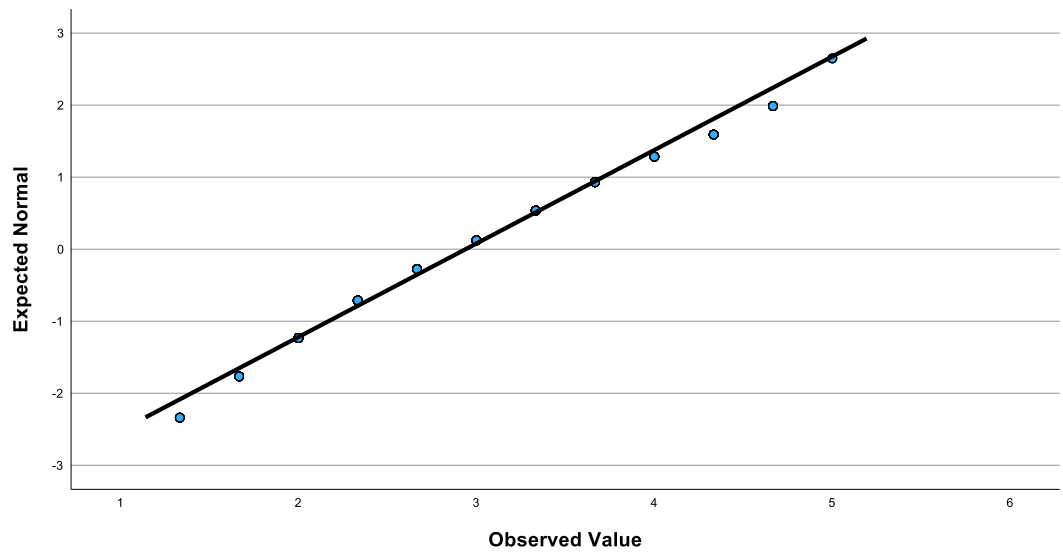
Note: The histogram visualises the distribution of the IILS-E (enterprising interests). Outputs from SPSS 31.0.0.0.

Figure A.20 Normal Q-Q Plot of IILS-E (enterprising interests), boys



Note: The normal probability plot visualises the distribution of the IILS-E (enterprising interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.21 Normal Q-Q Plot of IILS-E (enterprising interests), girls

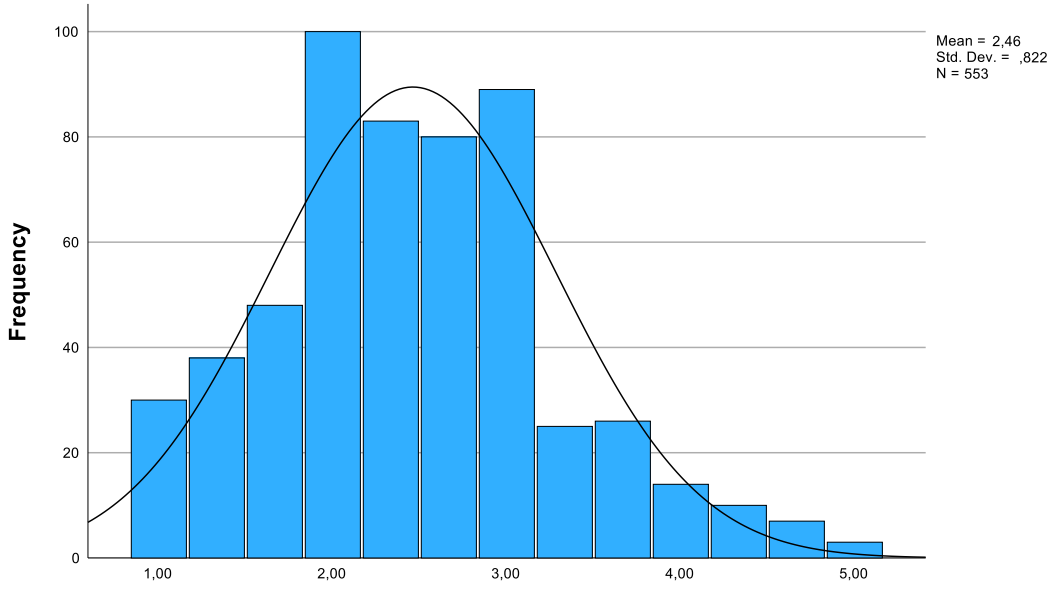


Note: The normal probability plot visualises the distribution of the IILS-E (enterprising interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | IILS-C (Conventional Interests)

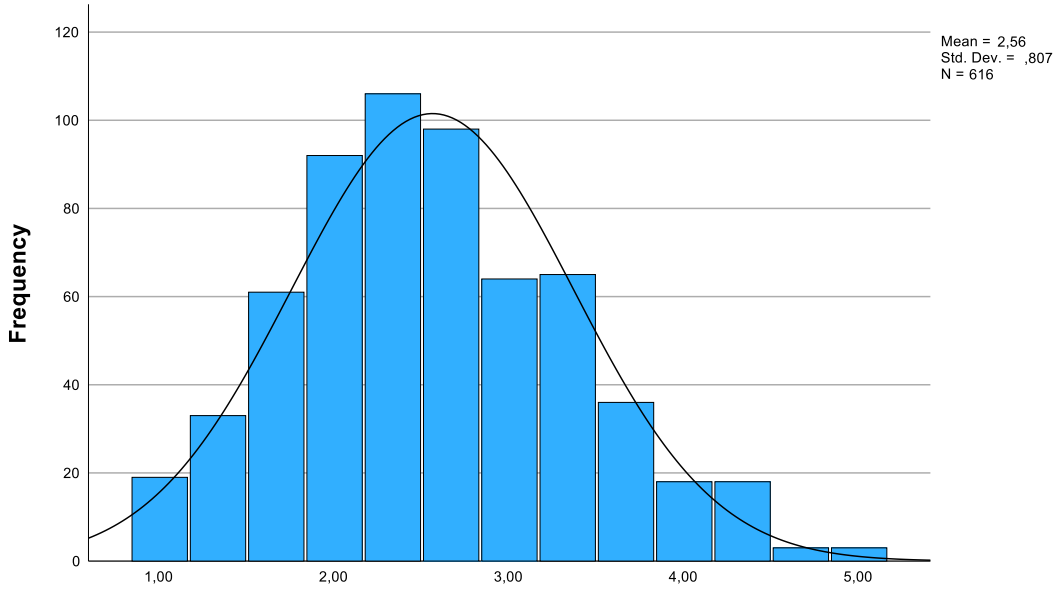
Approximate normal distribution of IILS-C (boys/girls) is indicated by the histograms (Figures A.22 and A.23) and the Q-Q-Plots (Figures A.24 and A.25).

Figure A.22 Histogram of IILS-C (conventional interests), boys



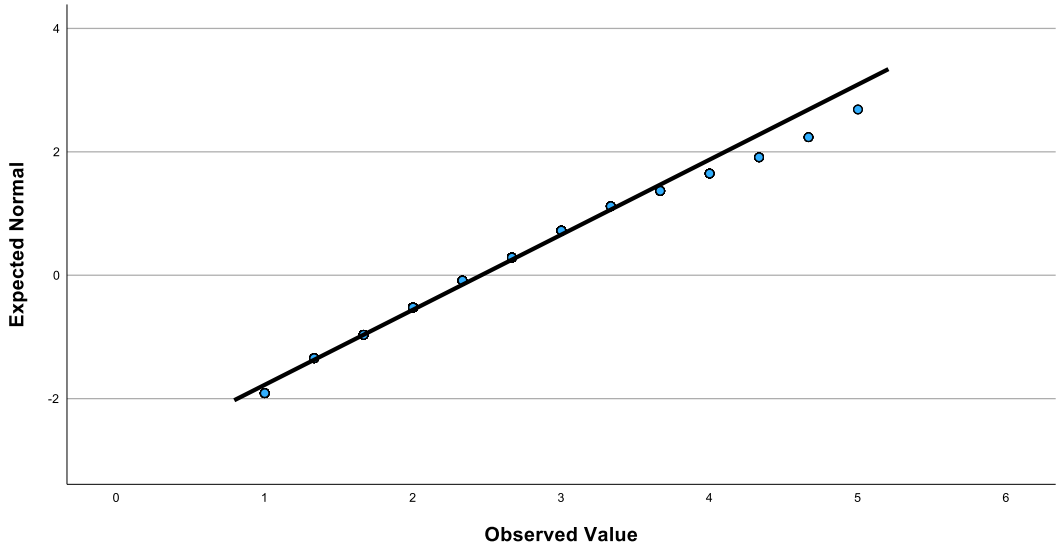
Note: The histogram visualises the distribution of the IILS-C (conventional interests). Outputs from SPSS 31.0.0.0.

Figure A.23 Histogram of IILS-C (conventional interests), girls



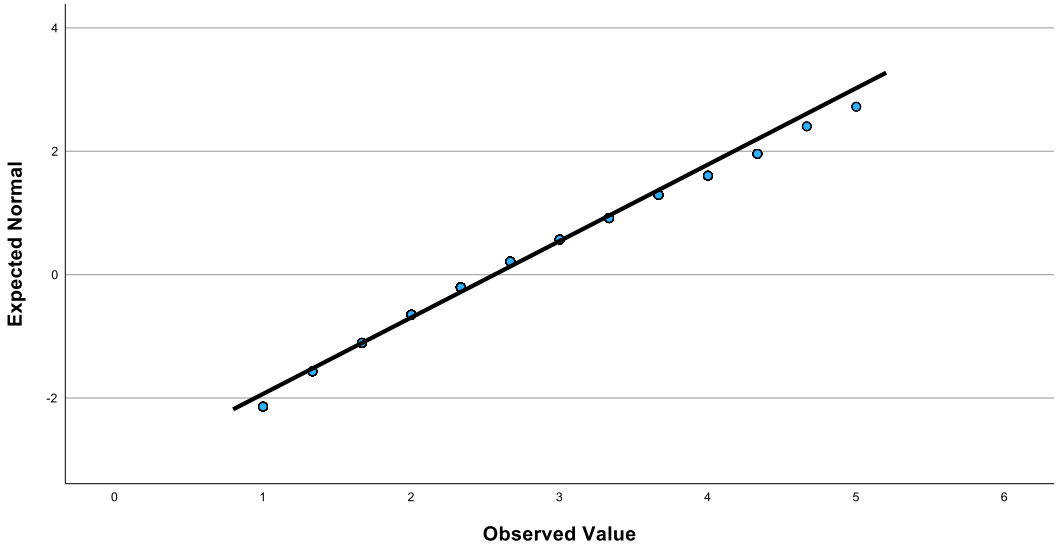
Note: The histogram visualises the distribution of the IILS-C (conventional interests). Outputs from SPSS 31.0.0.0.

Figure A.24 Normal Q-Q Plot of IILS-C (conventional interests), boys



Note: The normal probability plot visualises the distribution of the IILS-C (conventional interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.25 Normal Q-Q Plot of IILS-C (conventional interests), girls

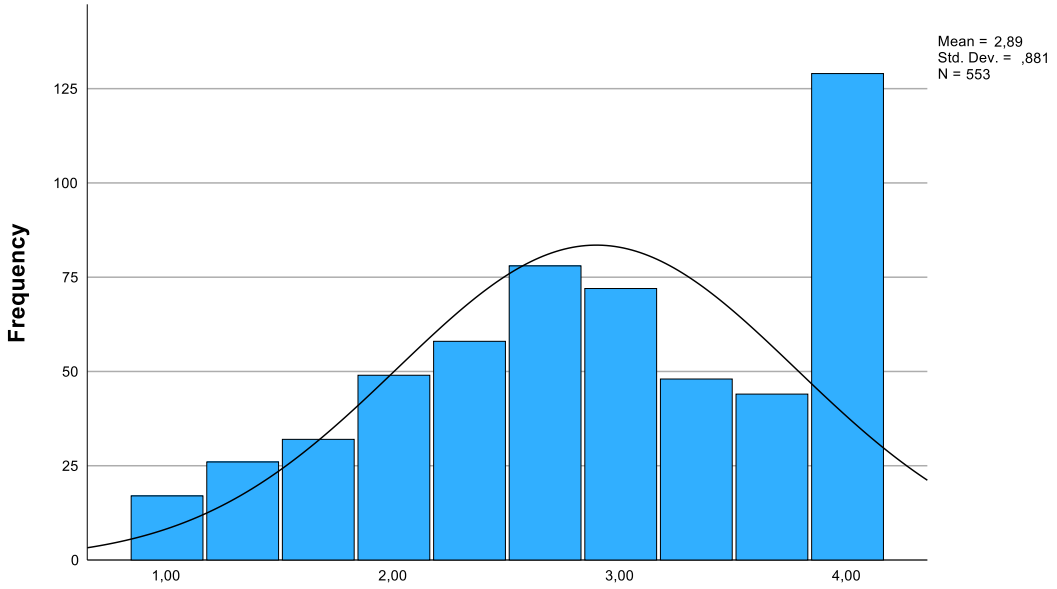


Note: The normal probability plot visualises the distribution of the IILS-C (conventional interests). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | ASC-M (Academic Self-Concept Math)

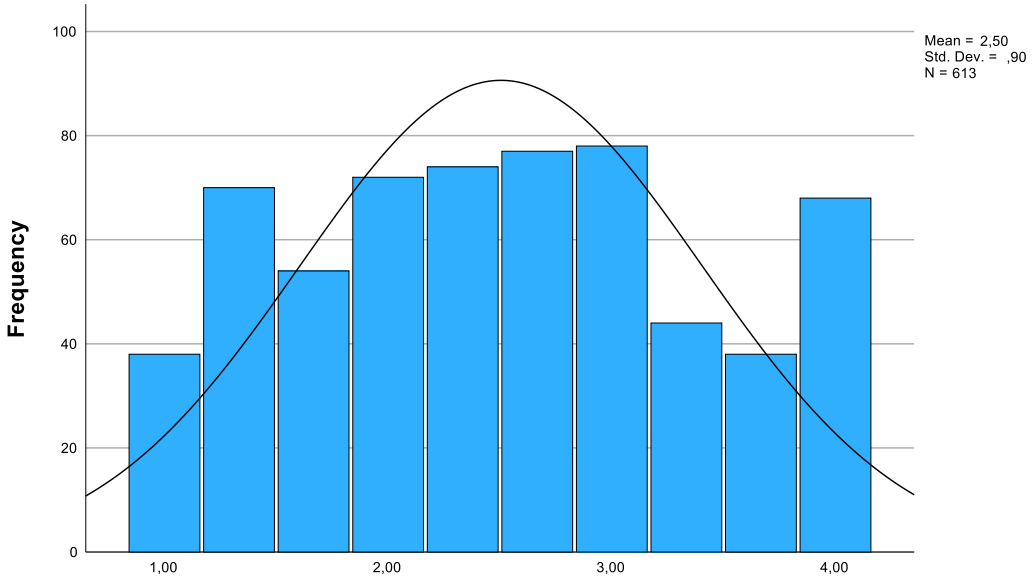
Approximate normal distribution of ASC-M (boys/girls) is indicated by the histograms (Figures A.26 and A.27) and the Q-Q-Plots (Figures A.28 and A.29).

Figure A.26 Histogram of ASC-M (Academic Self-Concept Math), boys



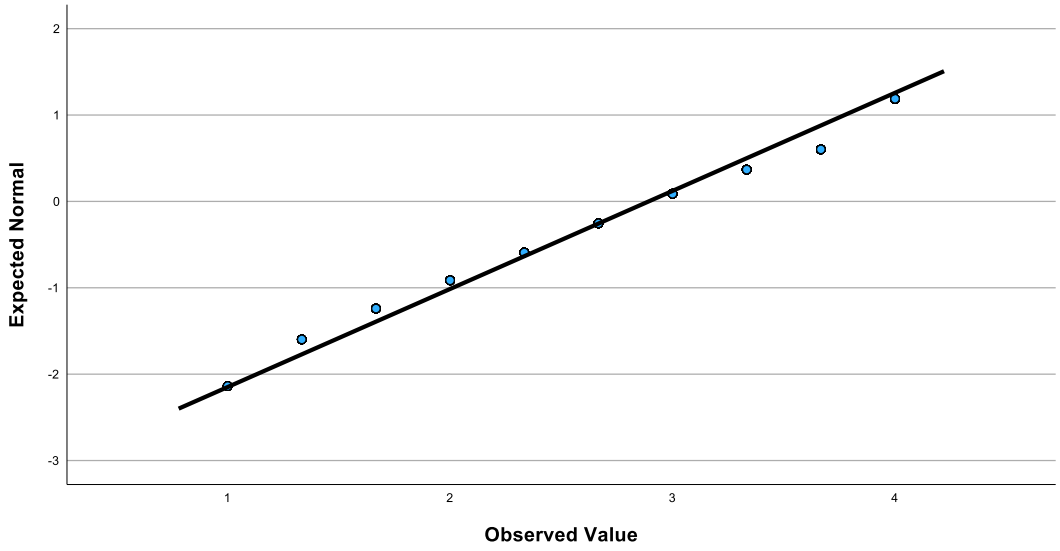
Note: The histogram visualises the distribution of the ASC-M (academic self-concept math). Outputs from SPSS 31.0.0.0.

Figure A.27 Histogram of ASC-M (Academic Self-Concept Math), girls



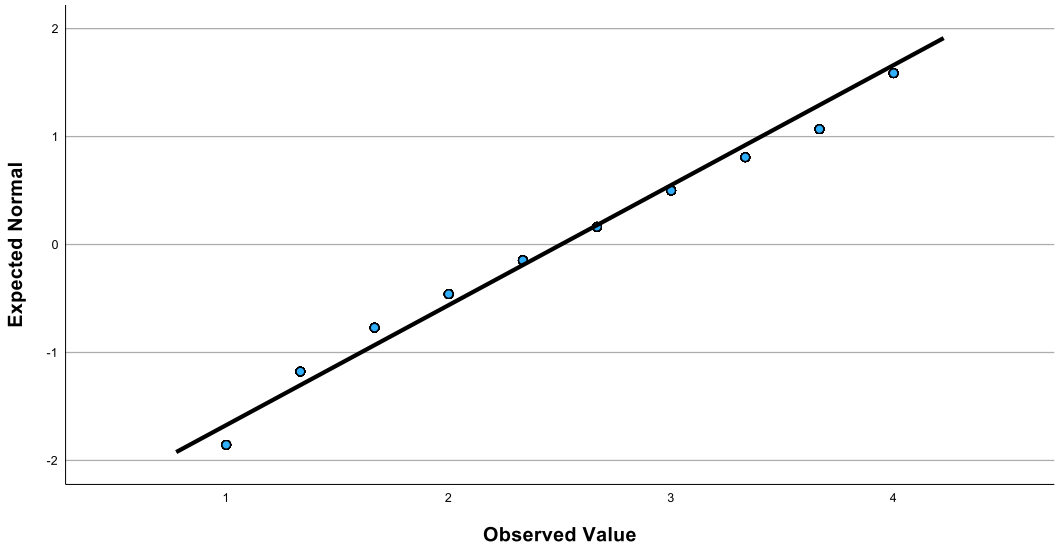
Note: The histogram visualises the distribution of the ASC-M (academic self-concept math). Outputs from SPSS 31.0.0.0.

Figure A.28 Normal Q-Q Plot of ASC-M (Academic Self-Concept Math), boys



Note: The normal probability plot visualises the distribution of the ASC-M (academic self-concept math). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.29 Normal Q-Q Plot of ASC-M (Academic Self-Concept Math), girls

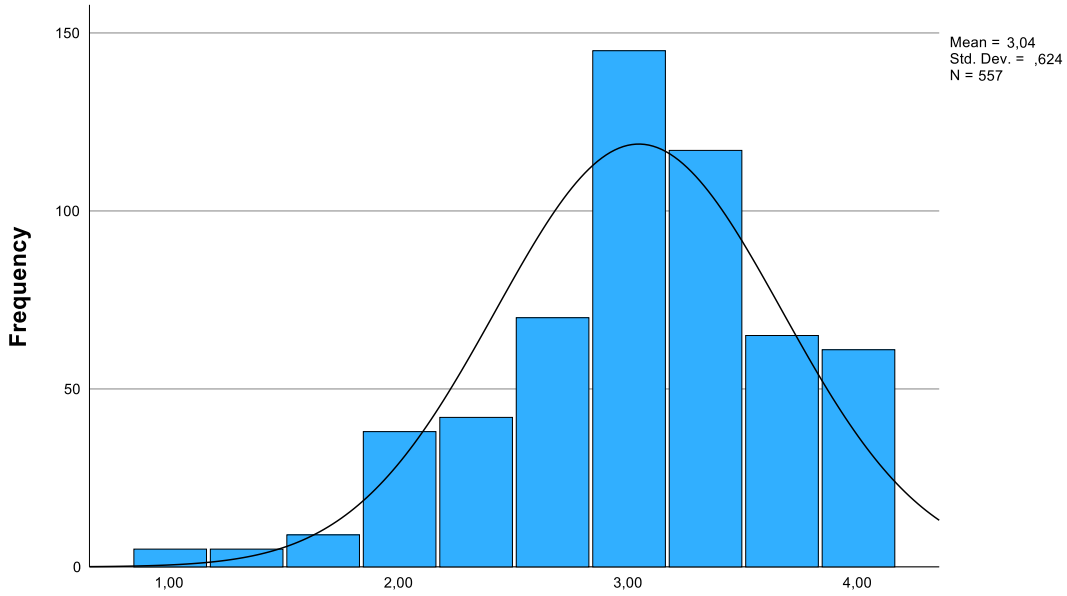


Note: The normal probability plot visualises the distribution of the ASC-M (academic self-concept math). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | ASC-G (Academic Self-Concept German)

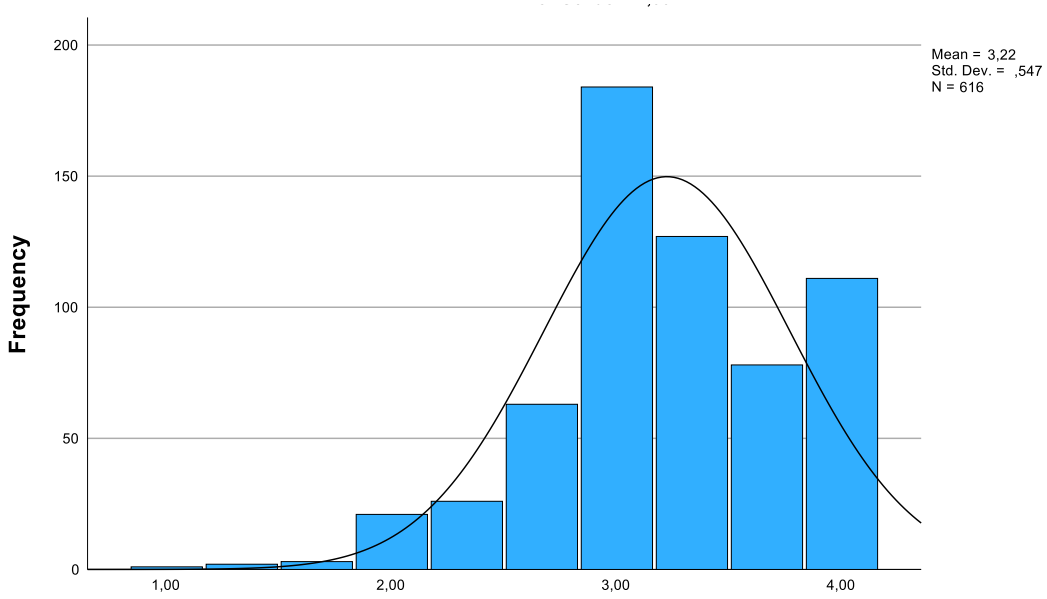
Approximate normal distribution of ASC-G (boys/girls) is indicated by the histograms (Figures A.30 and A.31) and the Q-Q-Plots (Figures A.32 and A.33).

Figure A.30 Histogram of ASC-G (Academic Self-Concept German), boys



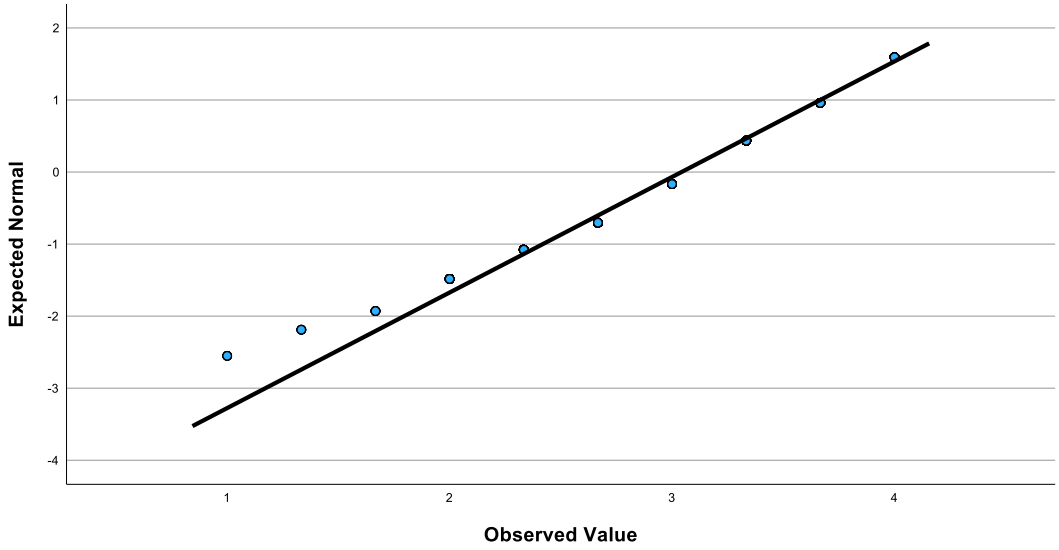
Note: The histogram visualises the distribution of the ASC-G (academic self-concept German). Outputs from SPSS 31.0.0.0.

Figure A.31 Histogram of ASC-G (Academic Self-Concept German), girls



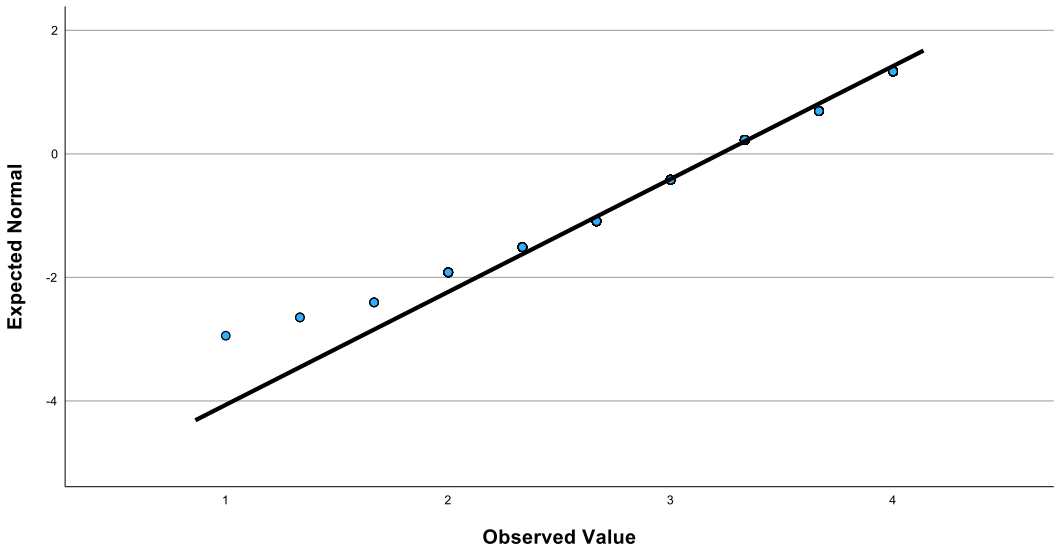
Note: The histogram visualises the distribution of the ASC-G (academic self-concept German). Outputs from SPSS 31.0.0.0.

Figure A.32 Normal Q-Q Plot of ASC-G (Academic Self-Concept German), boys



Note: The normal probability plot visualises the distribution of the ASC-G (academic self-concept German). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.33 Normal Q-Q Plot of ASC-G (Academic Self-Concept German), girls

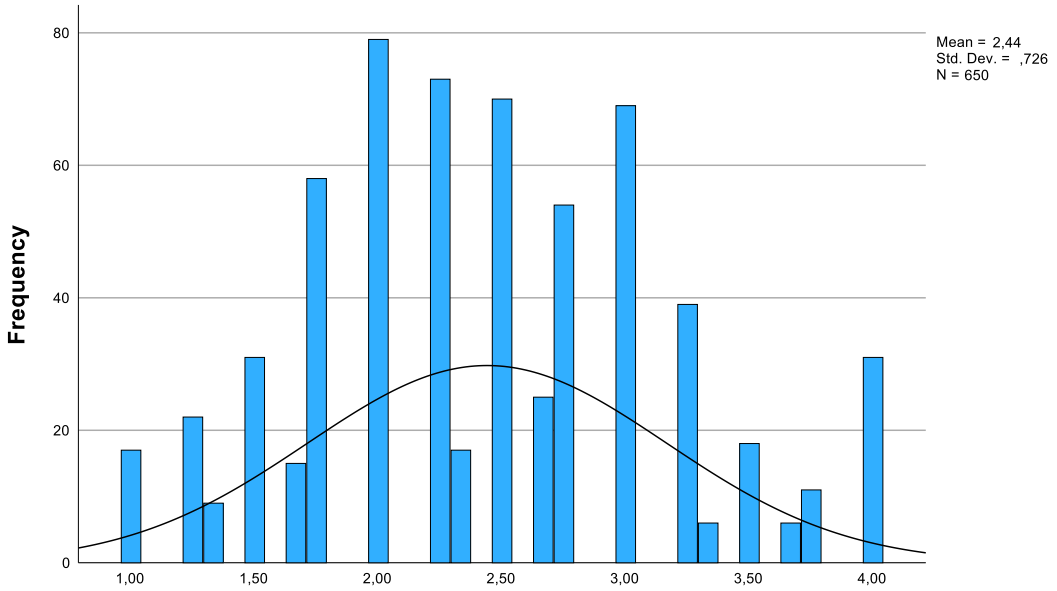


Note: The normal probability plot visualises the distribution of the ASC-G (academic self-concept German). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | GRA (Gender Role Attitudes)

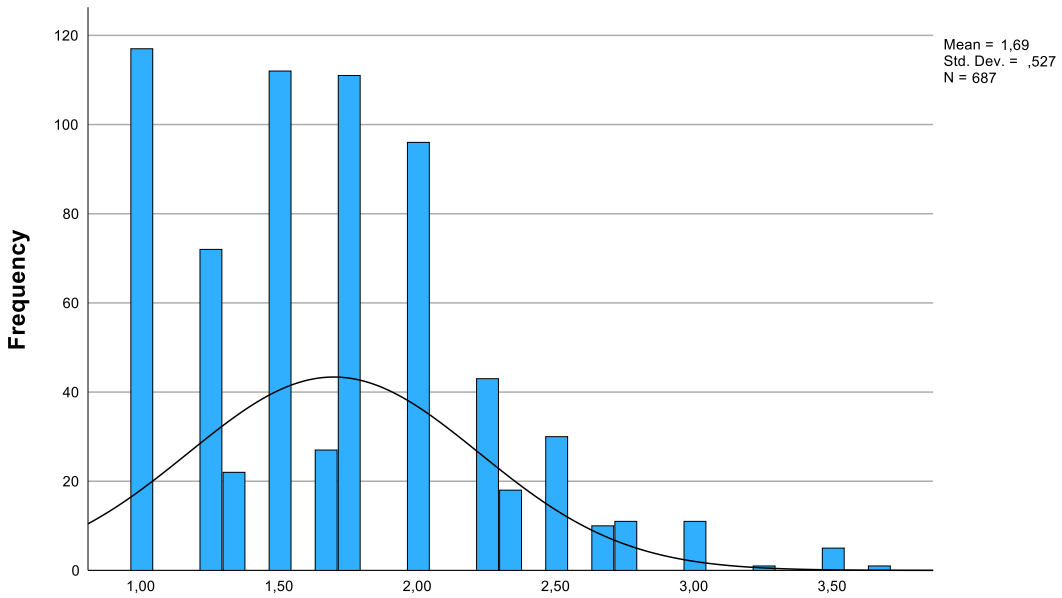
Approximate normal distribution of GRA (boys/girls) is indicated by the histograms (Figures A.34 and A.35) and the Q-Q-Plots (Figures A.36 and A.37).

Figure A.34 Histogram of GRA (Gender Role Attitudes), boys



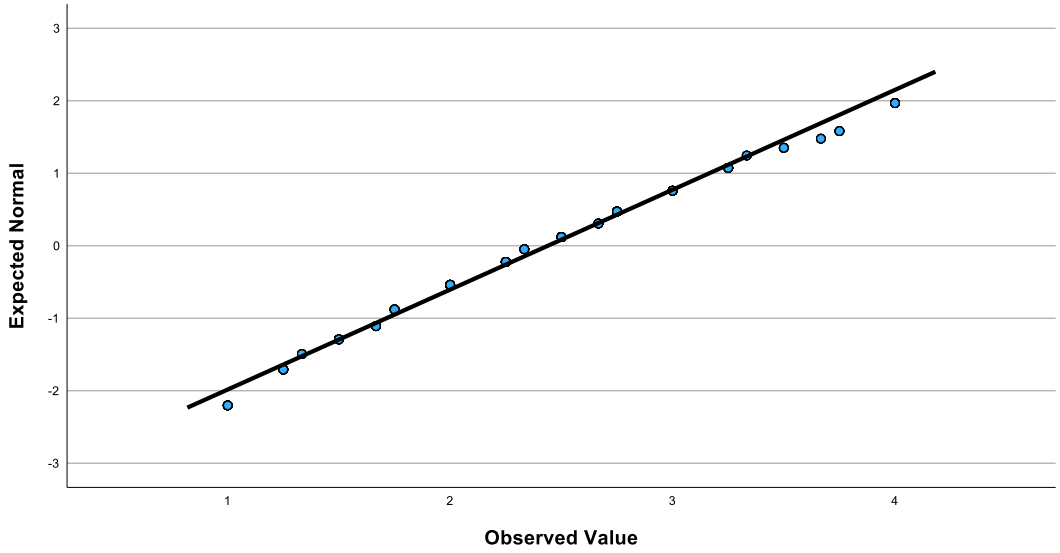
Note: The histogram visualises the distribution of the GRA (gender role attitudes). Outputs from SPSS 31.0.0.0.

Figure A.35 Histogram of GRA (Gender Role Attitudes), girls



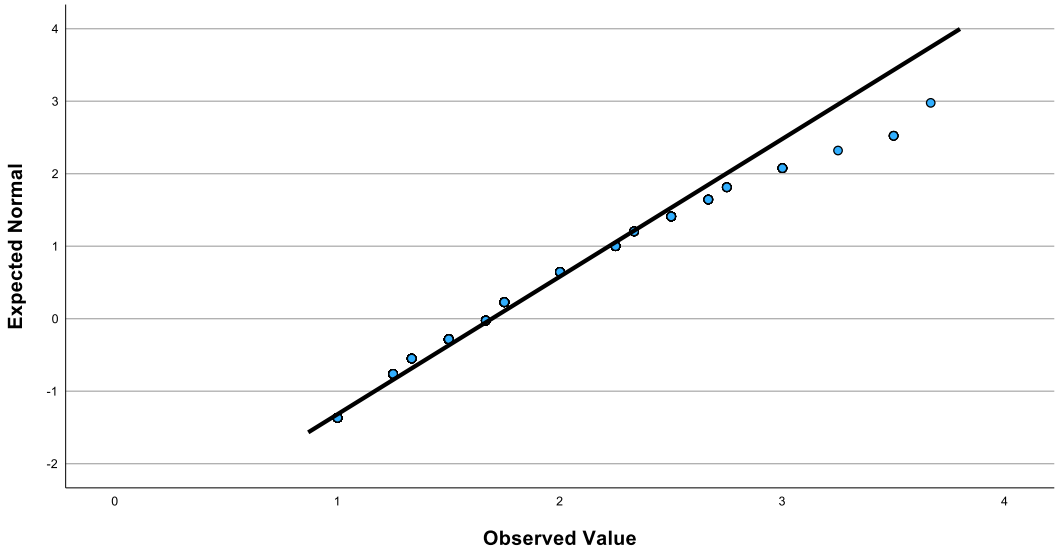
Note: The histogram visualises the distribution of the GRA (gender role attitudes). Outputs from SPSS 31.0.0.0.

Figure A.36 Normal Q-Q Plot of GRA (Gender Role Attitudes), boys



Note: The normal probability plot visualises the distribution of the GRA (gender role attitudes). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

Figure A.37 Normal Q-Q Plot of GRA (Gender Role Attitudes), girls

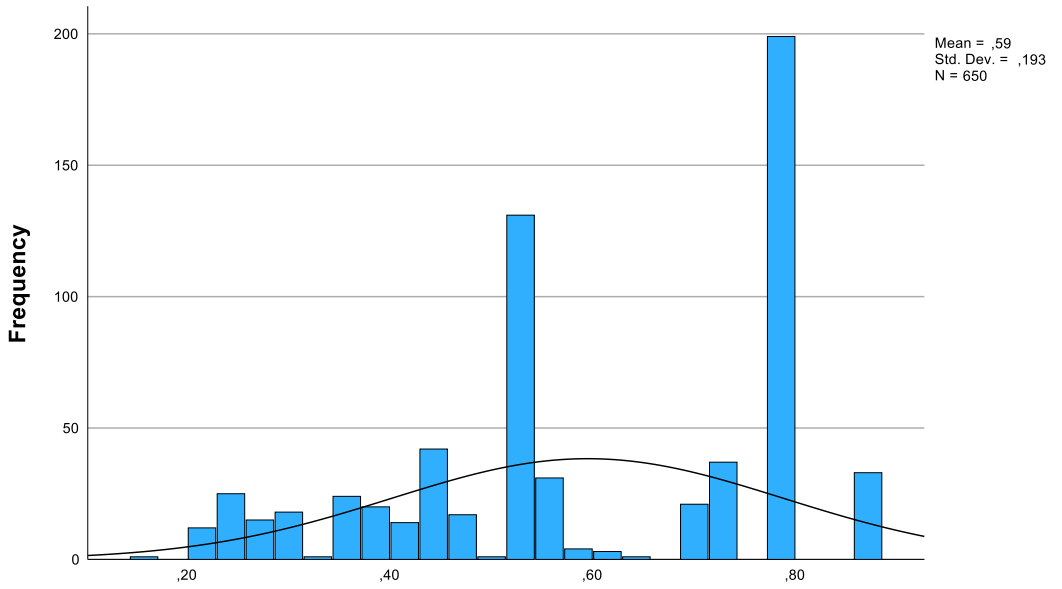


Note: The normal probability plot visualises the distribution of the GRA (gender role attitudes). The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

A.2.1 Normality | Gender Typicality of Study Major

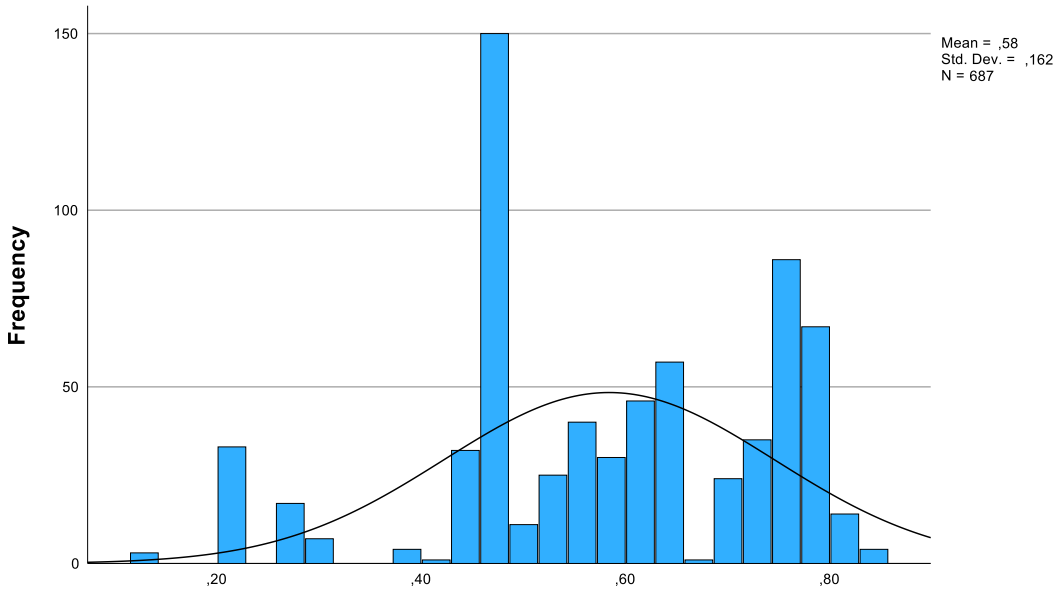
Approximate normal distribution of Gender Typicality of Study Major (boys/girls) is indicated by the histograms (Figures A.38 and A.39) and the Q-Q-Plots (Figures A.40 and A.41).

Figure A.38 Histogram of Gender Typicality of Study Major, boys



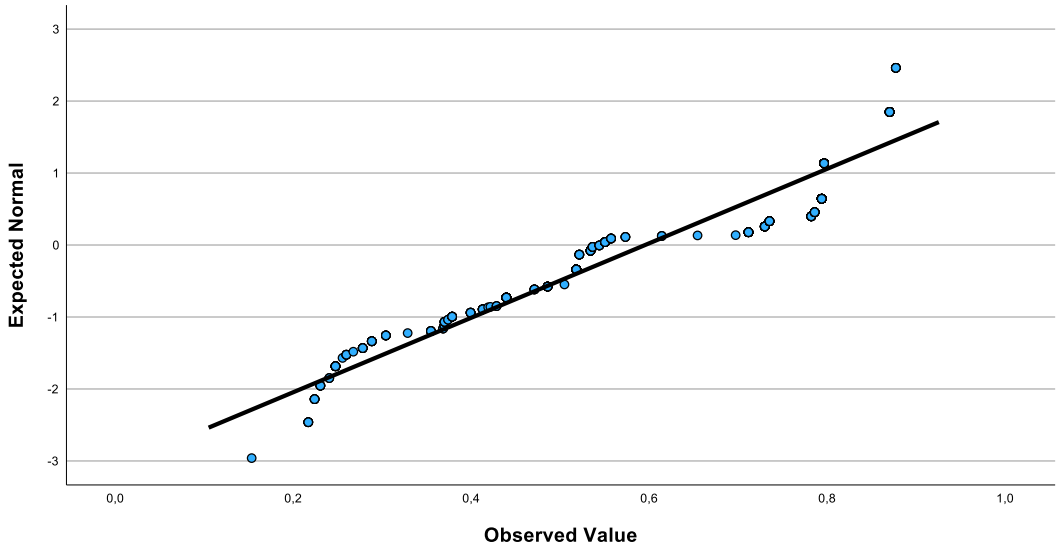
Note: The histogram visualises the distribution of the gender typicality of study major. Outputs from SPSS 31.0.0.0.

Figure A.39 Histogram of Gender Typicality of Study Major, girls



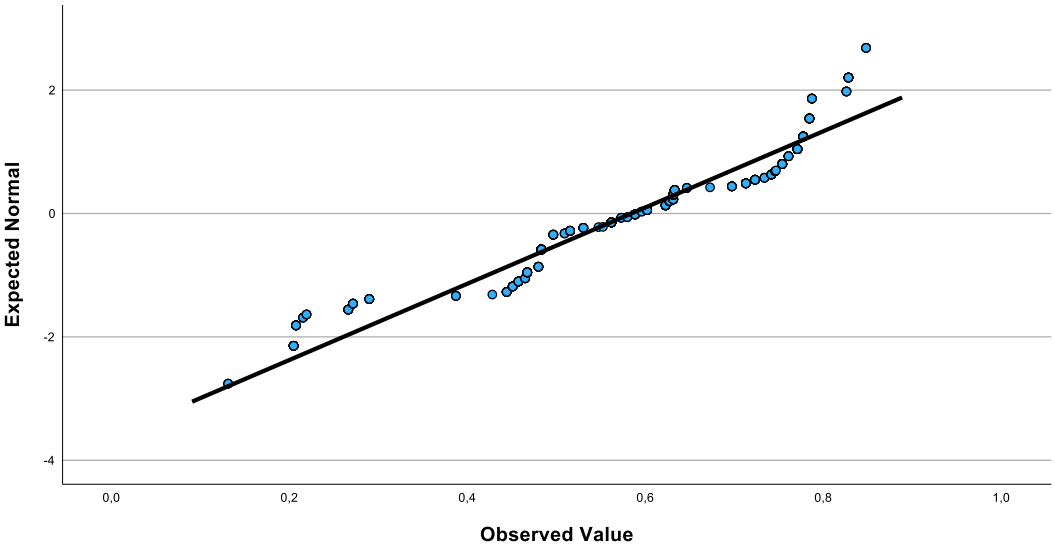
Note: The histogram visualises the distribution of the gender typicality of study major. Outputs from SPSS 31.0.0.0.

Figure A.40 Normal Q-Q Plot of Gender Typicality of Study Major, boys



Note: The normal probability plot visualises the distribution of the gender typicality of study major. The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

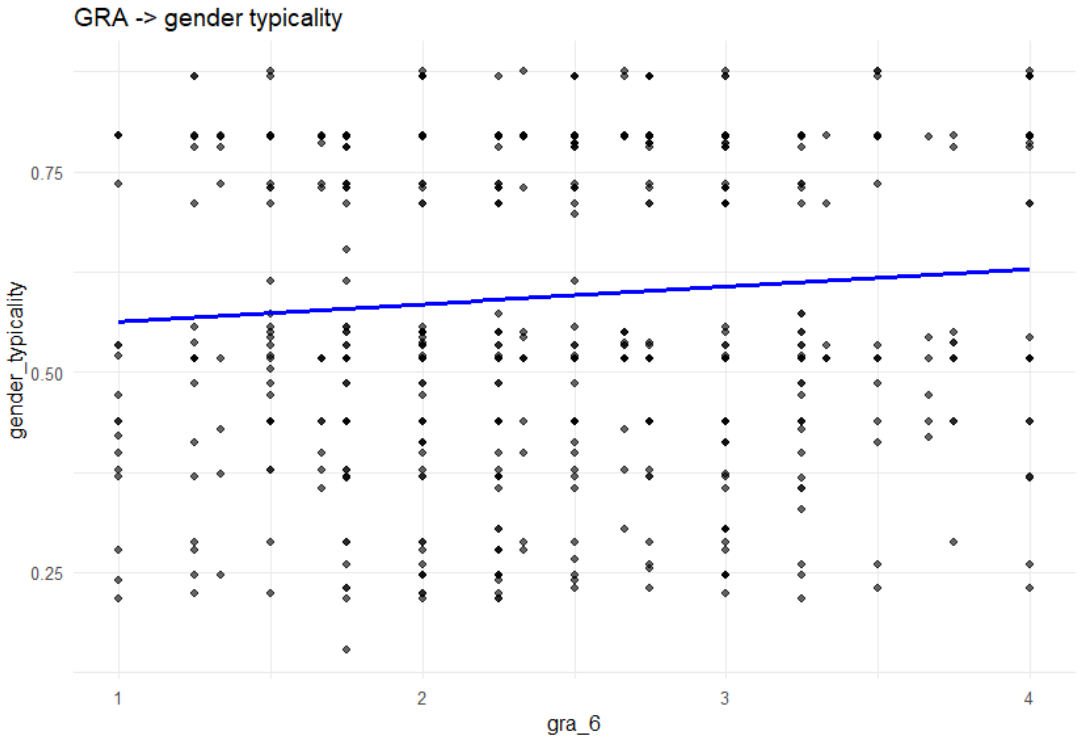
Figure A.41 Normal Q-Q Plot of Gender Typicality of Study Major, girls



Note: The normal probability plot visualises the distribution of the gender typicality of study major. The observed value for each score is plotted against the expected value from the normal distribution. The reasonably straight line suggests approxiamte normal distribution. Output from SPSS 31.0.0.0

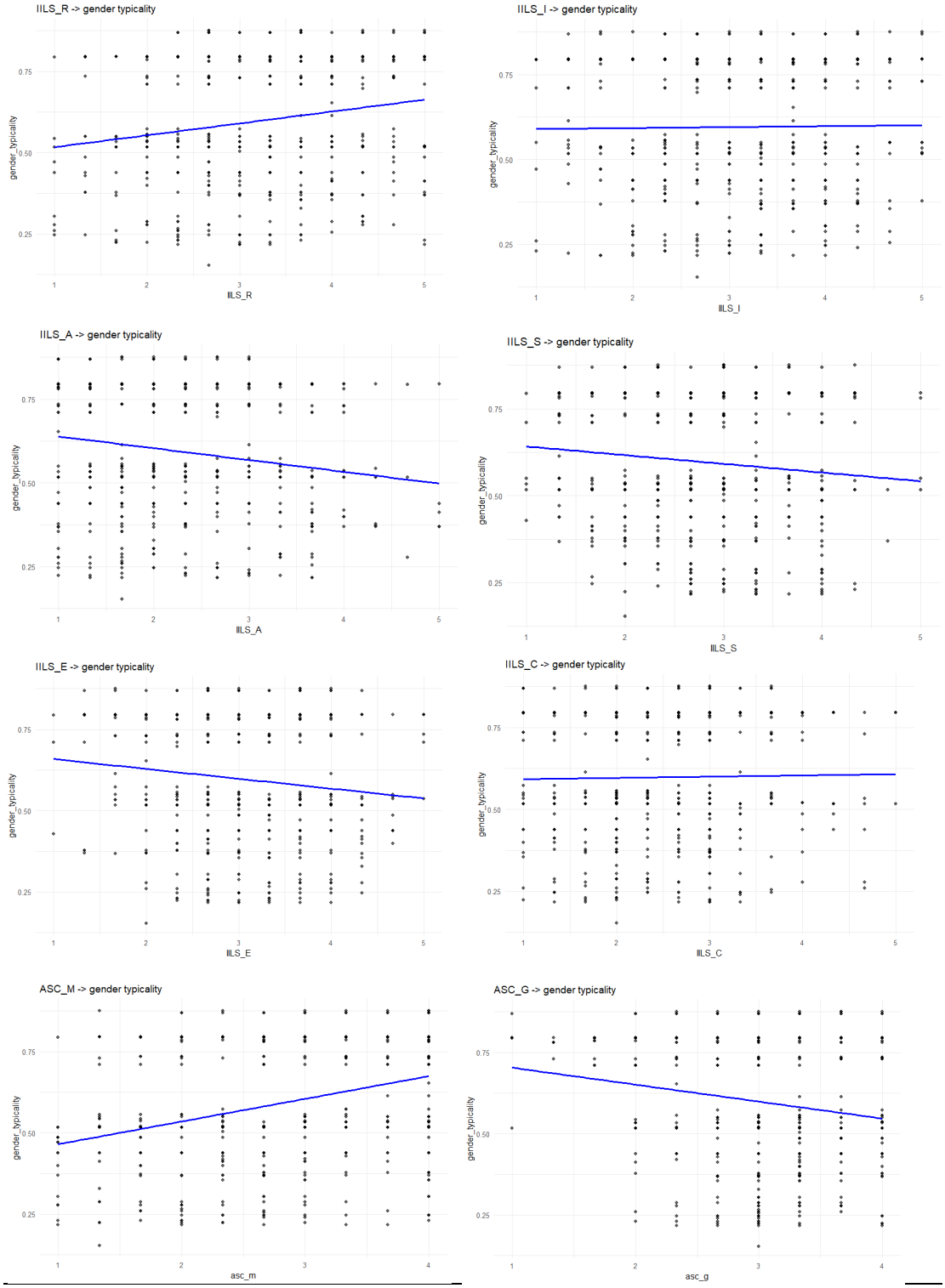
A.2.2 Bivariate Scatterplots

Figure A.42 Bivariate Scatterplots, GRA à Study Choice, boys



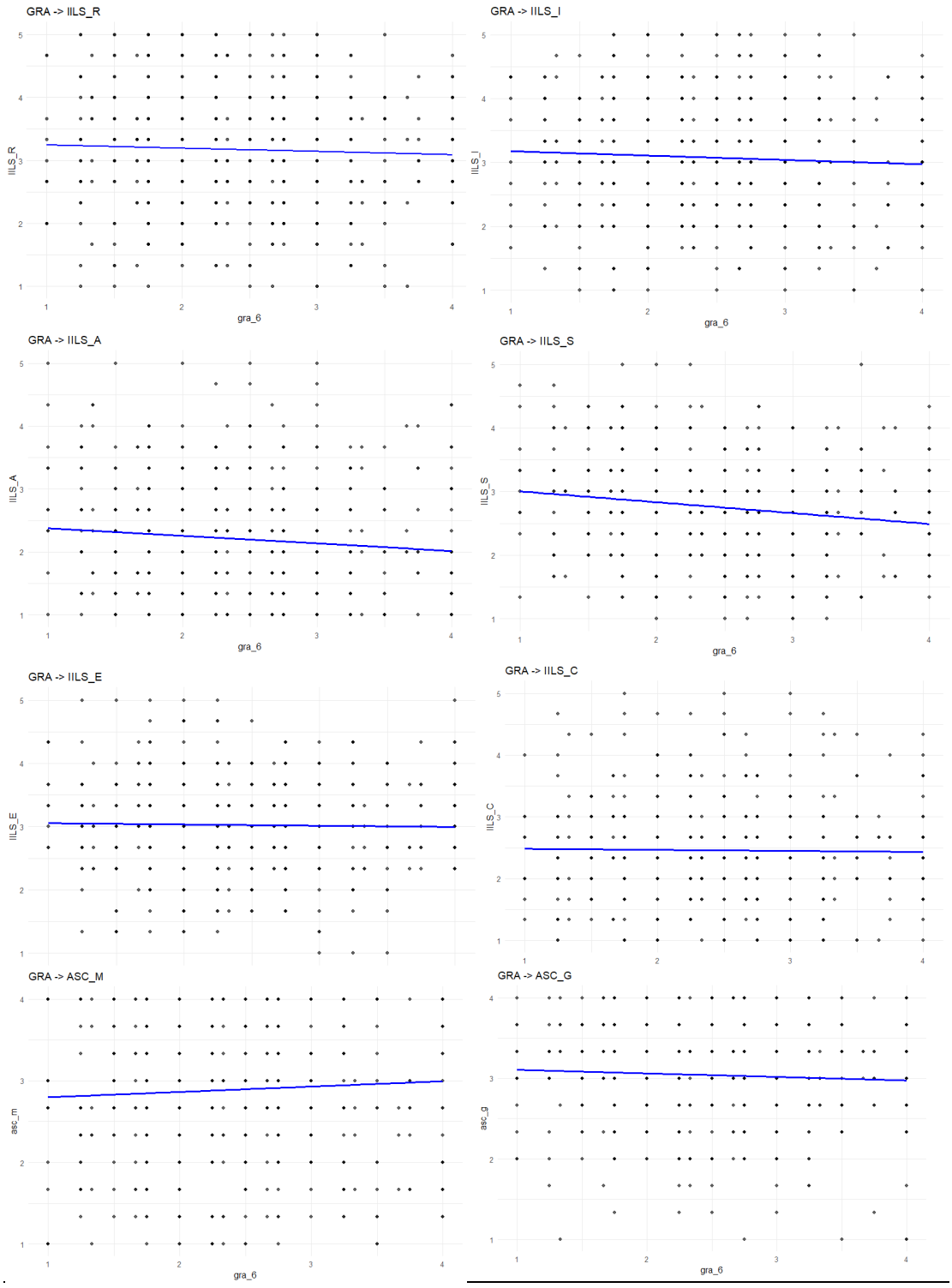
Note: Output from R 4.2.2.

Figure A.43 Bivariate Scatterplots, RIASEC/ASC à Study Choice, boys



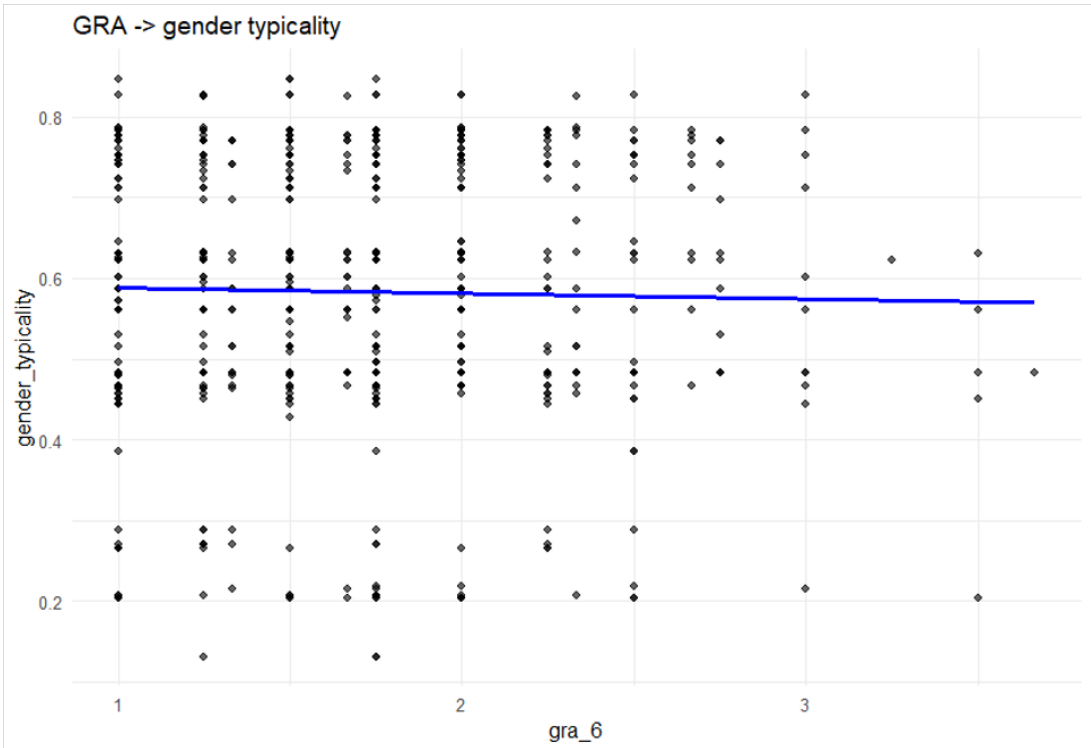
Note: Output from R 4.2.2.

Figure A.44 Bivariate Scatterplots, GRA à RIASEC/ASC, boys



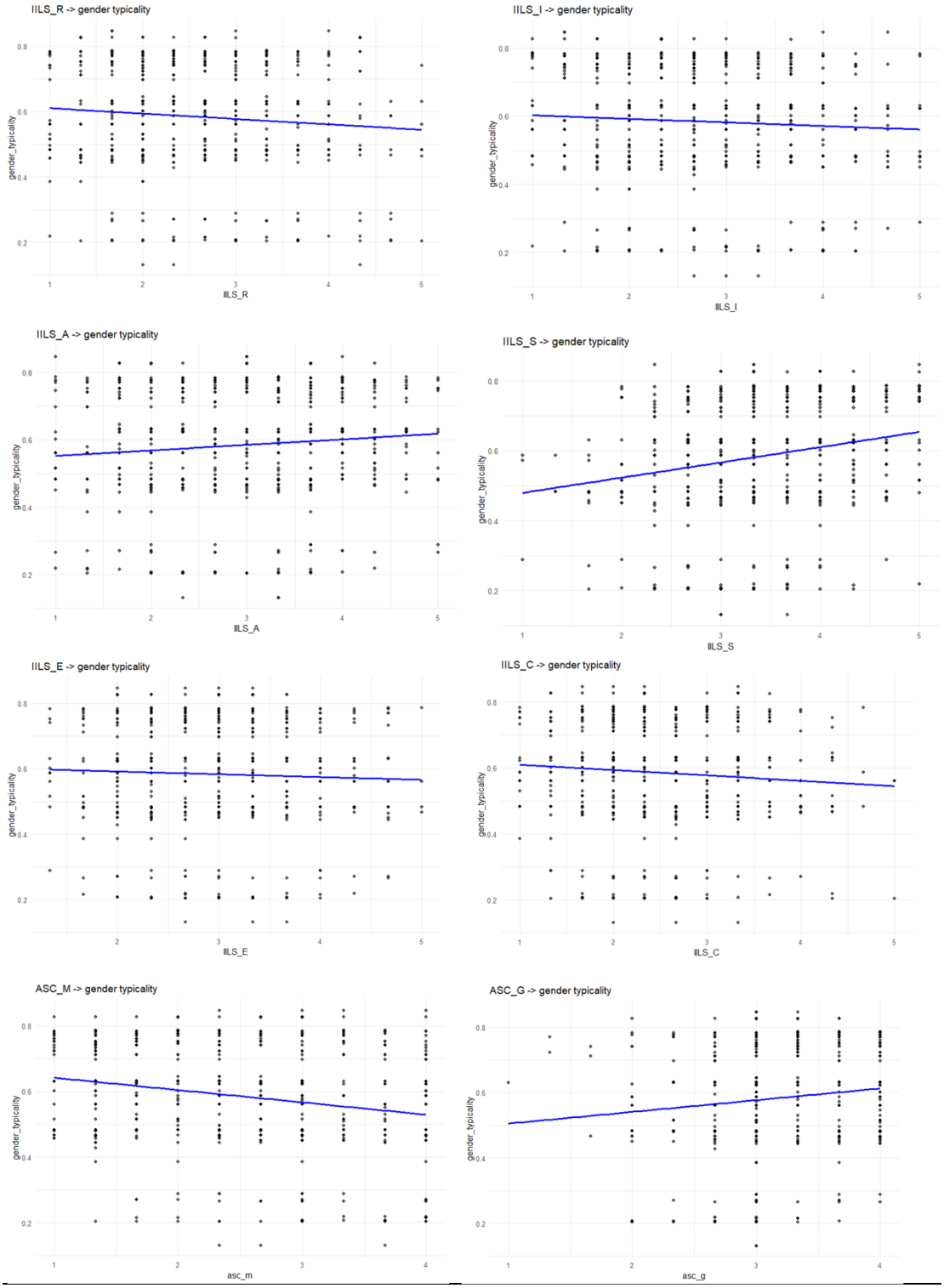
Note: Output from R 4.2.2.

Figure A.45 Bivariate Scatterplots, GRA à Study Choice, girls



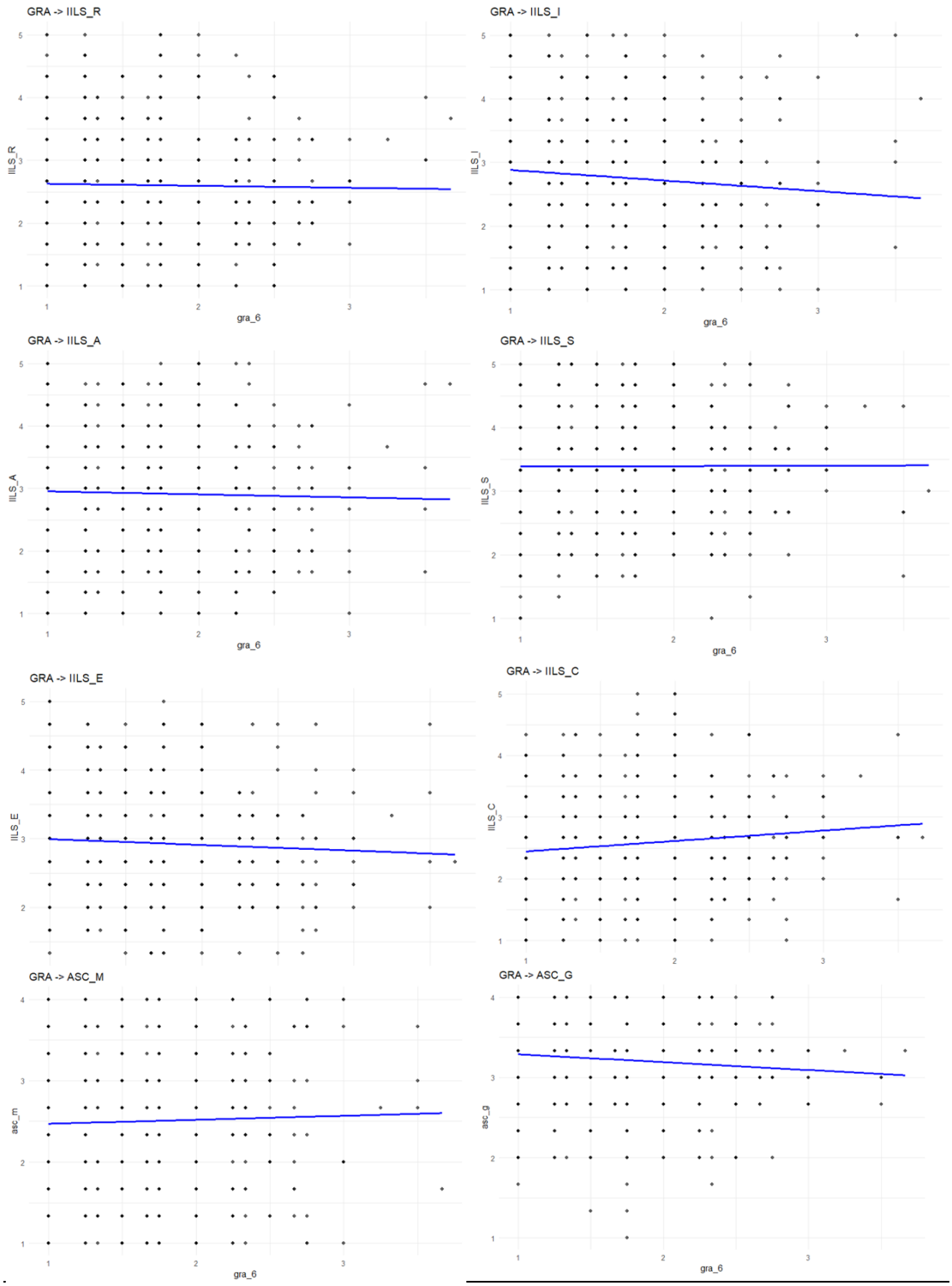
Note: Output from R 4.2.2.

Figure A.46 Bivariate Scatterplots, RIASEC/ASC à Study Choice, girls



Note: Output from R 4.2.2.

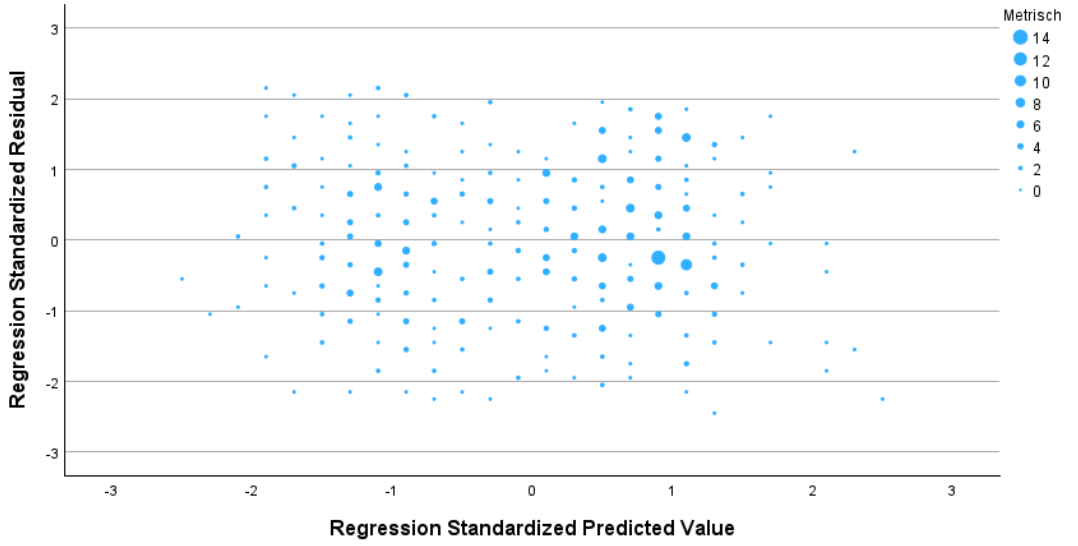
Figure A.47 Bivariate Scatterplots, GRA à RIASEC/ASC, girls



Note: Output from R 4.2.2.

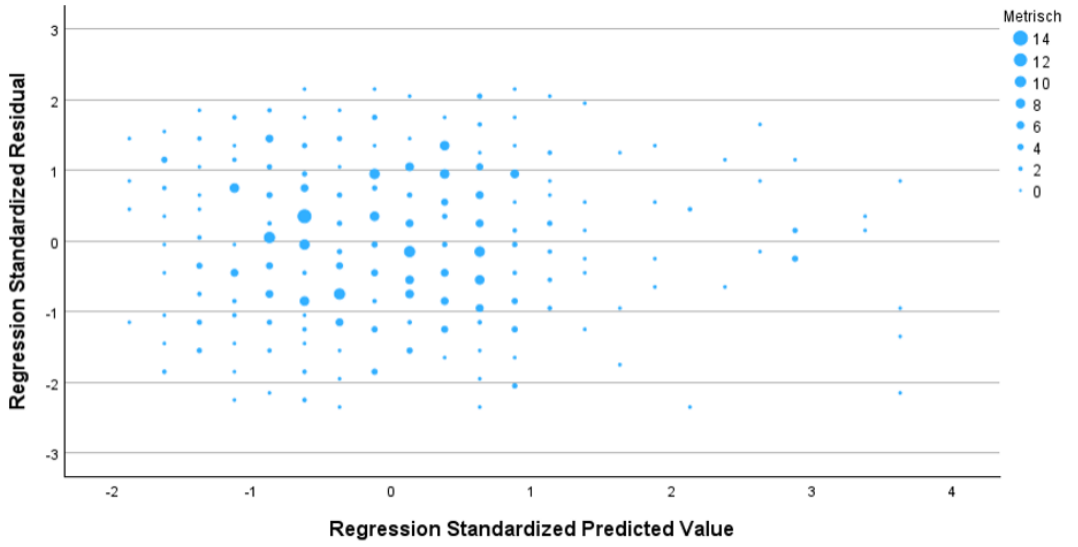
A.2.3 Homoscedasticity

Figure A.48 Standardized Residuals vs. Fitted Values, IILS-R, boys



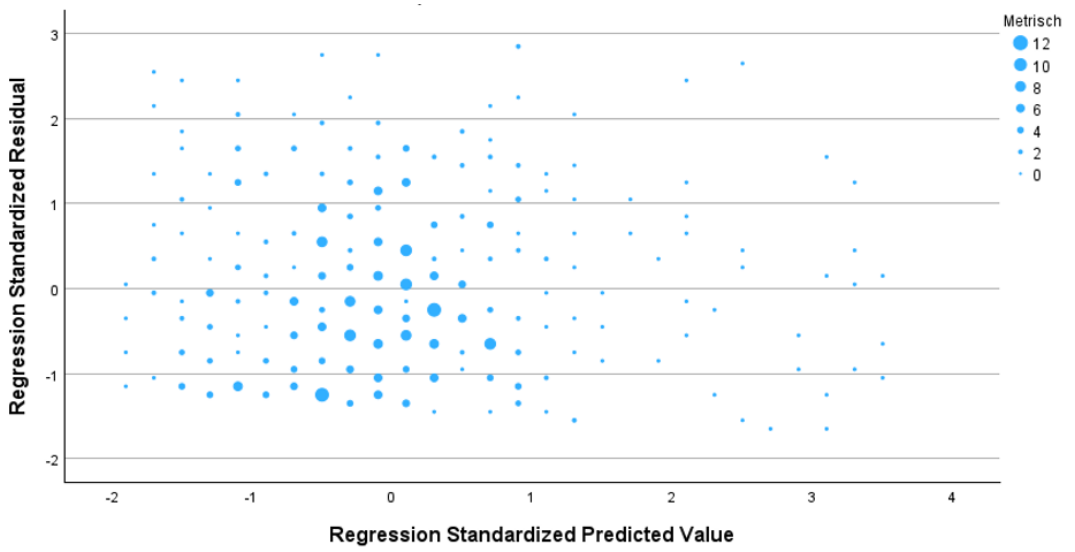
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.49 Standardized Residuals vs. Fitted Values, IILS-I, boys



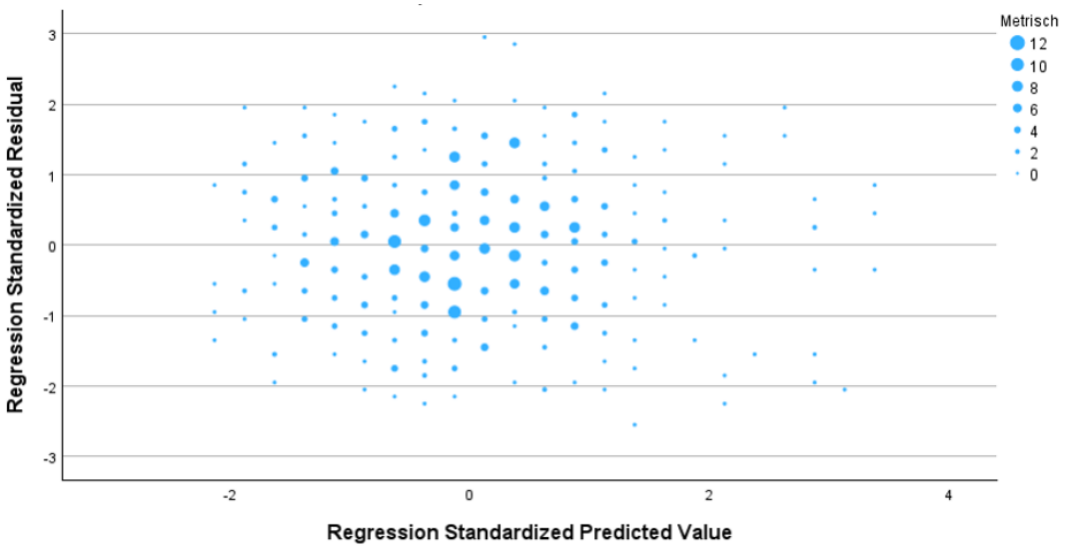
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.50 Standardized Residuals vs. Fitted Values, IILS-A, boys



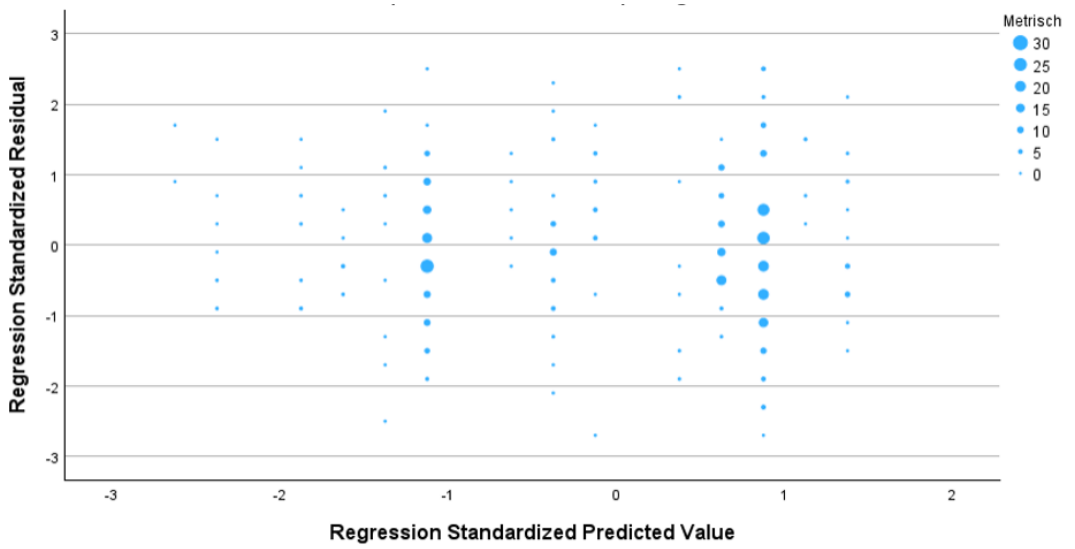
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.51 Standardized Residuals vs. Fitted Values, IILS-S, boys



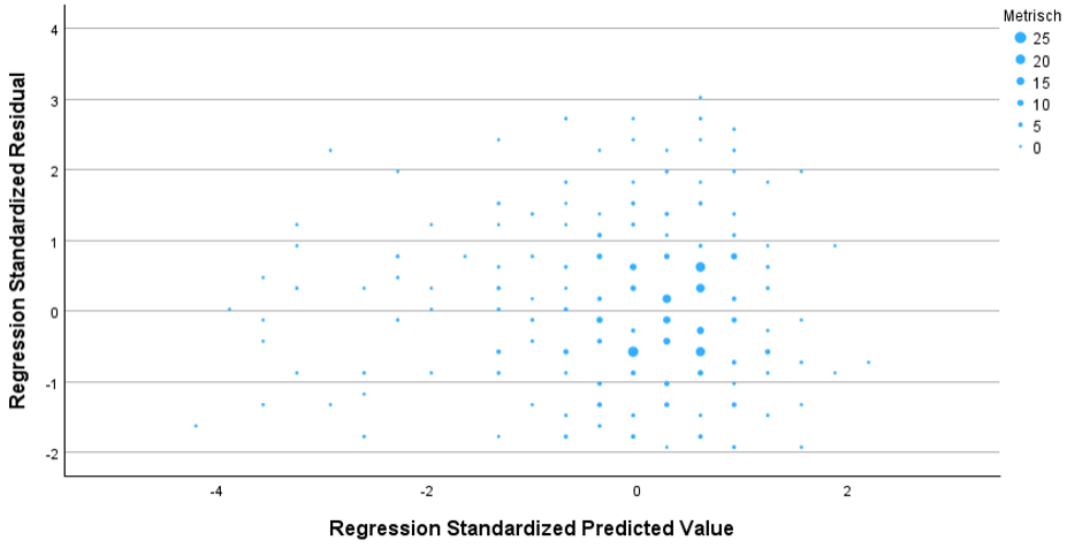
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.52 Standardized Residuals vs. Fitted Values, IILS-E, boys



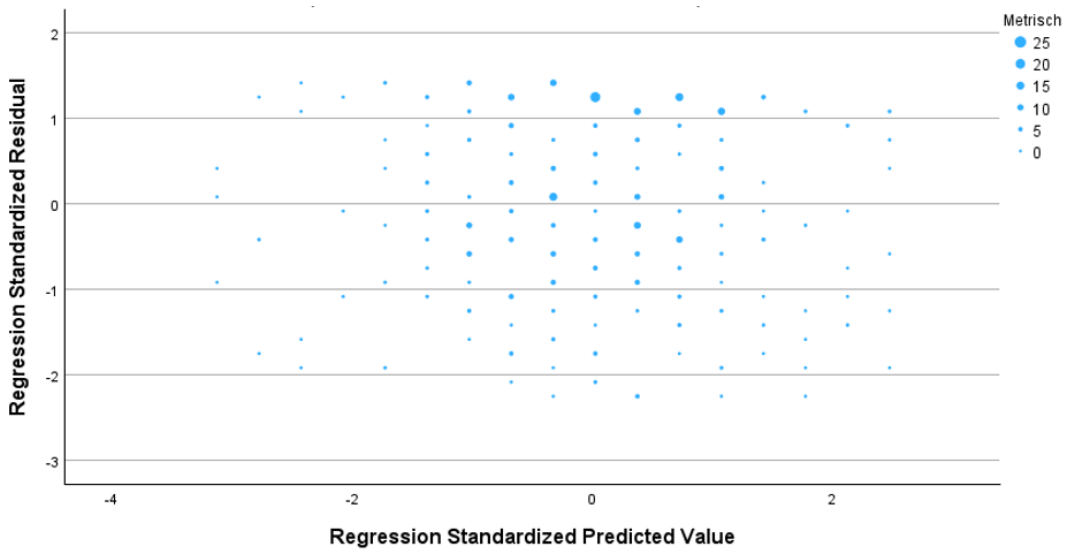
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.53 Standardized Residuals vs. Fitted Values, IILS-C, boys



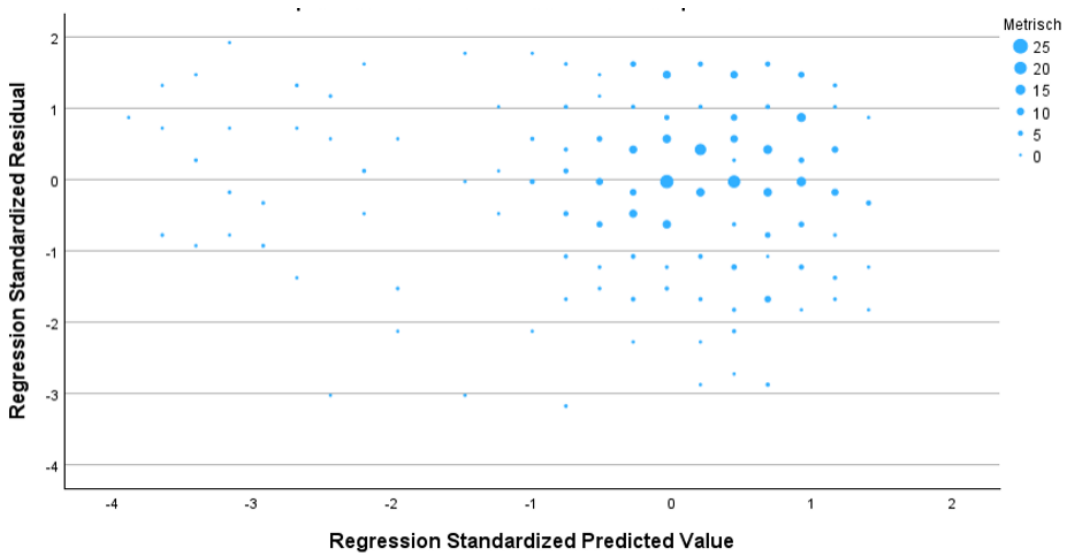
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.54 Standardized Residuals vs. Fitted Values, ASC-M, boys



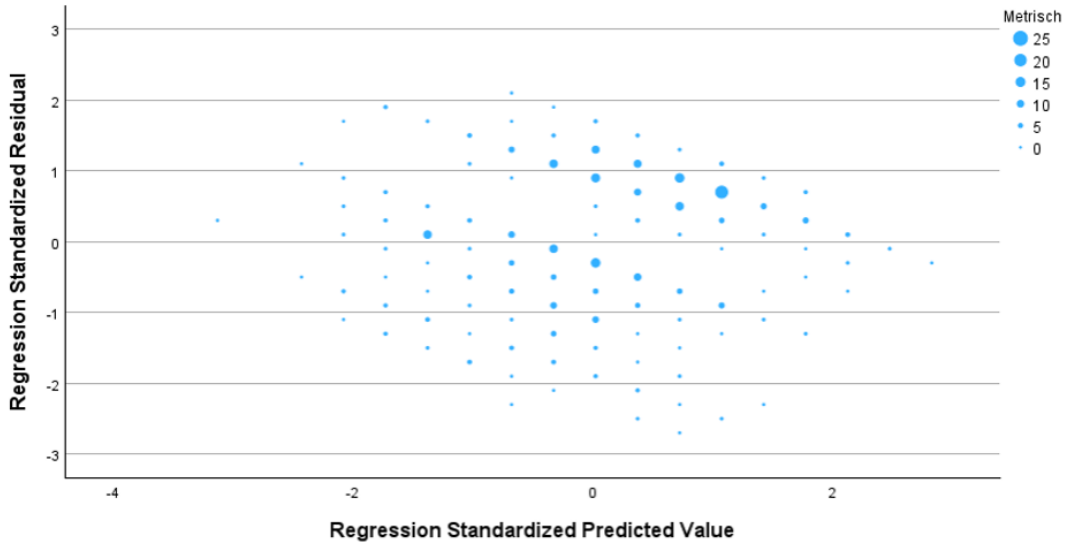
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.55 Standardized Residuals vs. Fitted Values, ASC-G, boys



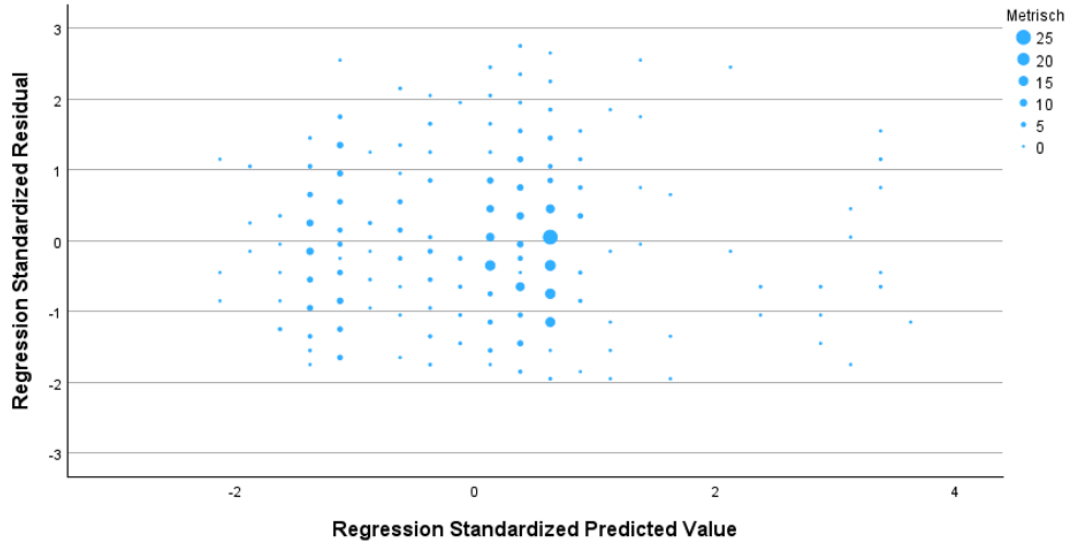
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.56 Standardized Residuals vs. Fitted Values, Gender Typicality, boys



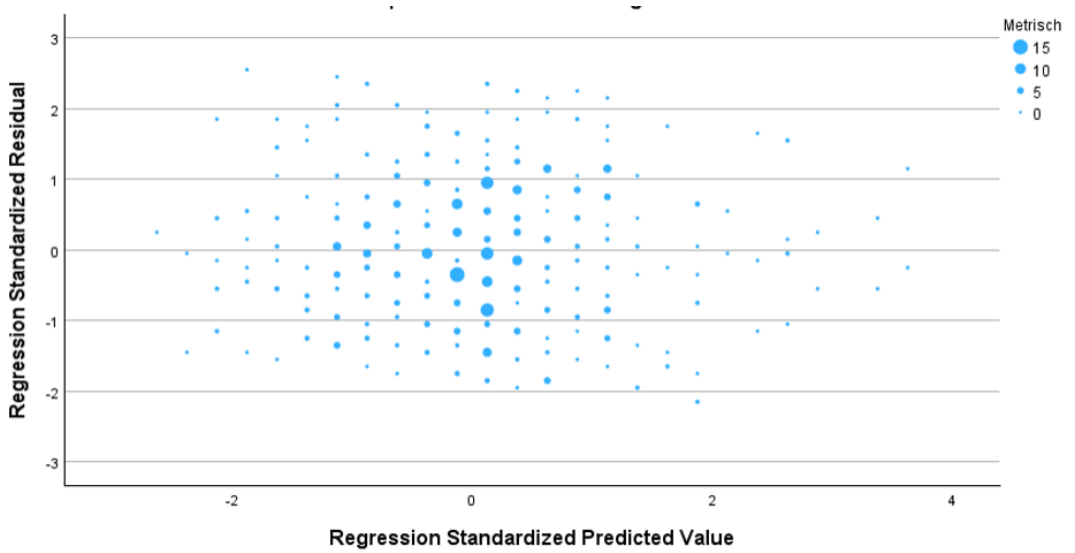
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.57 Standardized Residuals vs. Fitted Values, IILS-R, girls



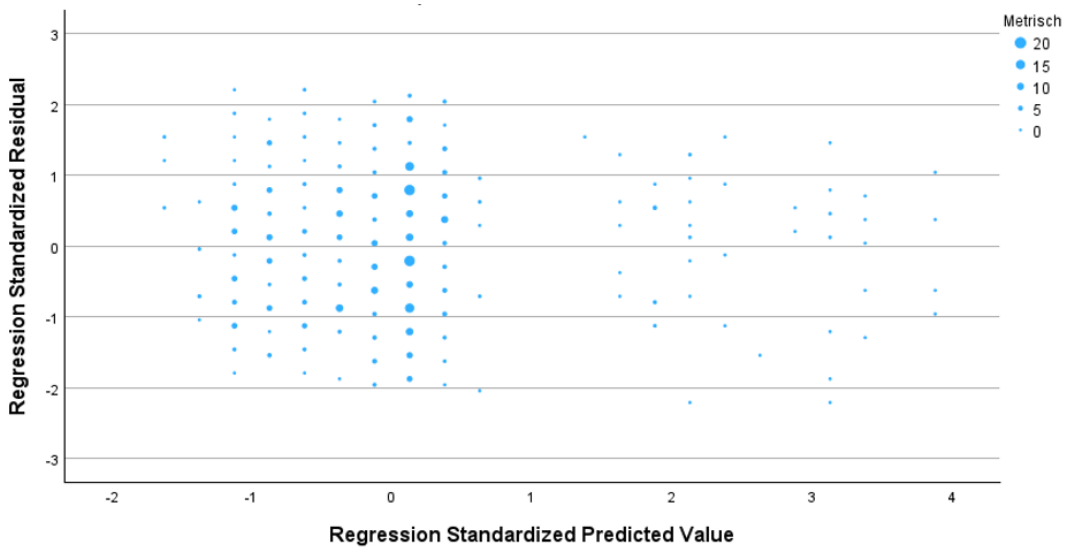
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.58 Standardized Residuals vs. Fitted Values, IILS-I, girls



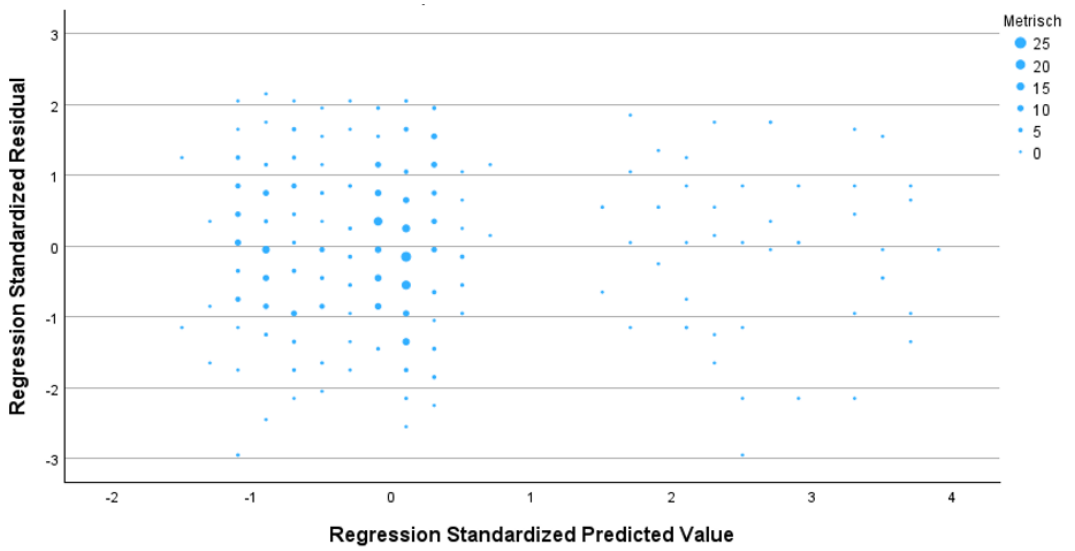
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.59 Standardized Residuals vs. Fitted Values, IILS-A, girls



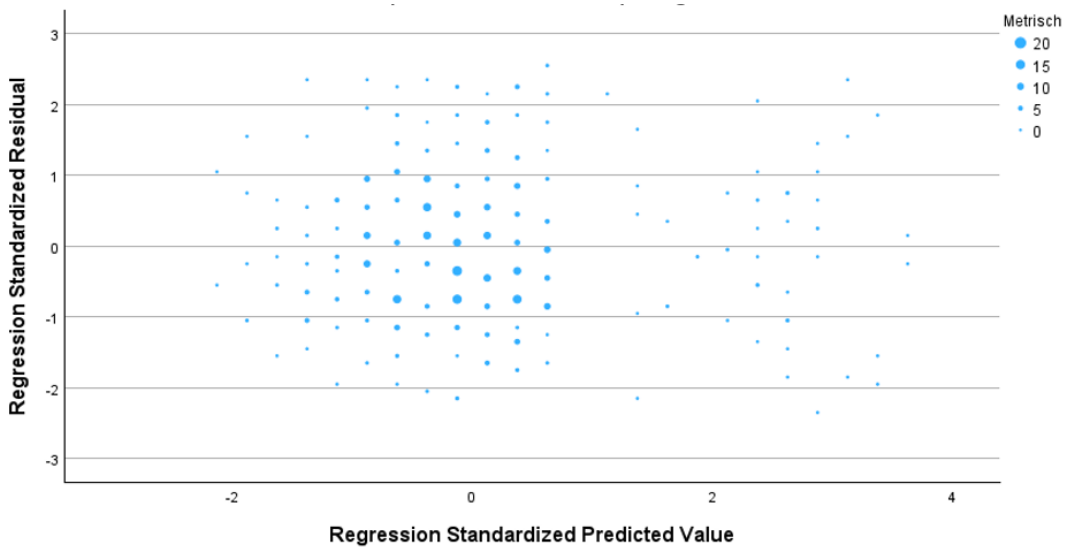
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.60 Standardized Residuals vs. Fitted Values, IILS-S, girls



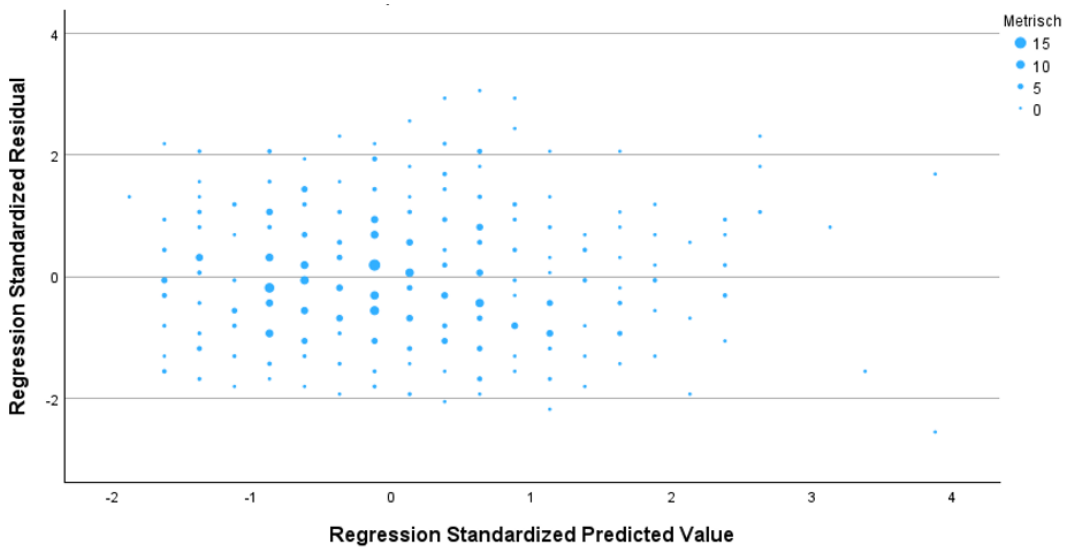
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.61 Standardized Residuals vs. Fitted Values, IILS-E, girls



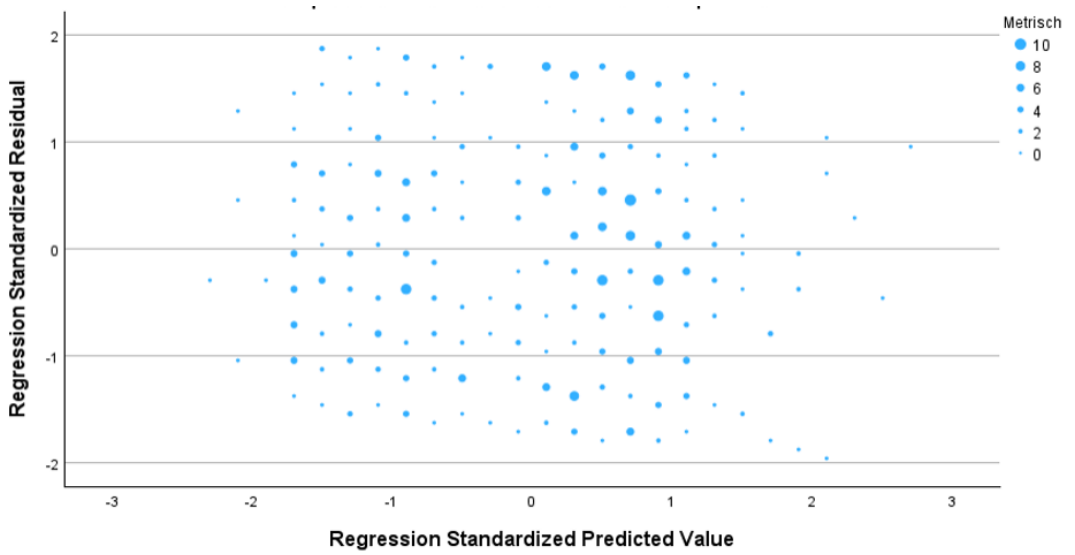
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.62 Standardized Residuals vs. Fitted Values, IILS-C, girls



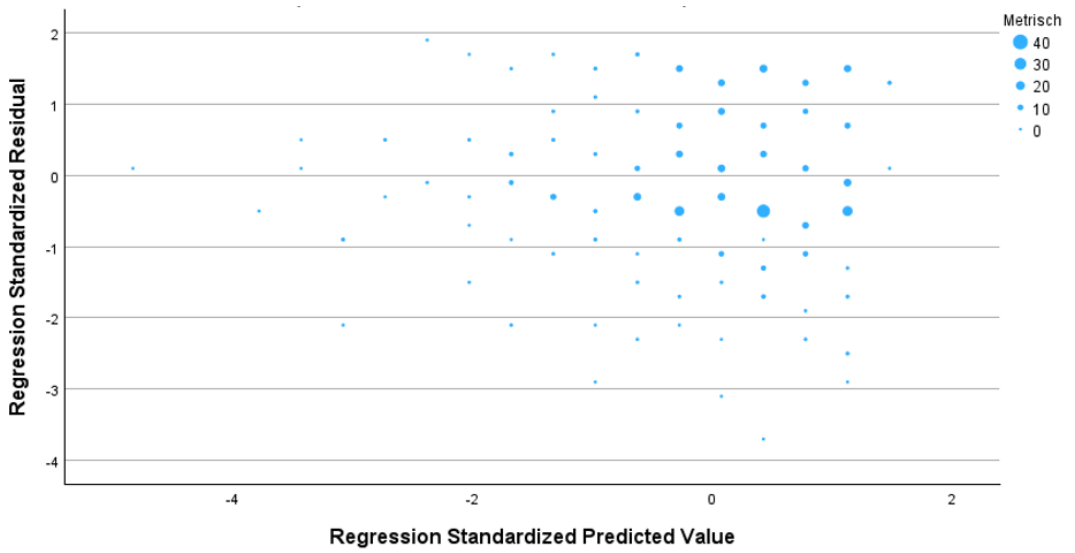
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.63 Standardized Residuals vs. Fitted Values, ASC-M, girls



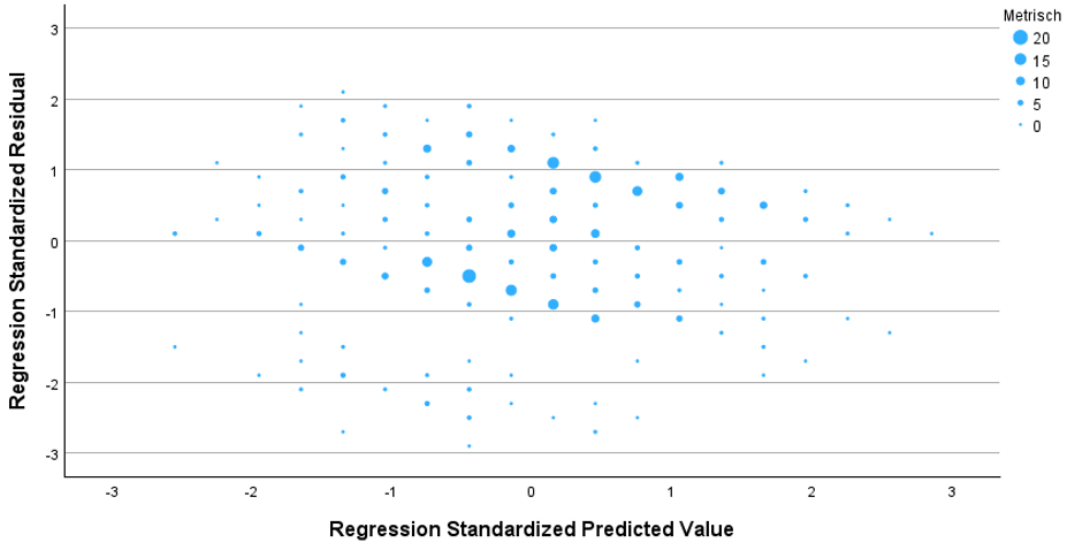
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.64 Standardized Residuals vs. Fitted Values, ASC-G, girls



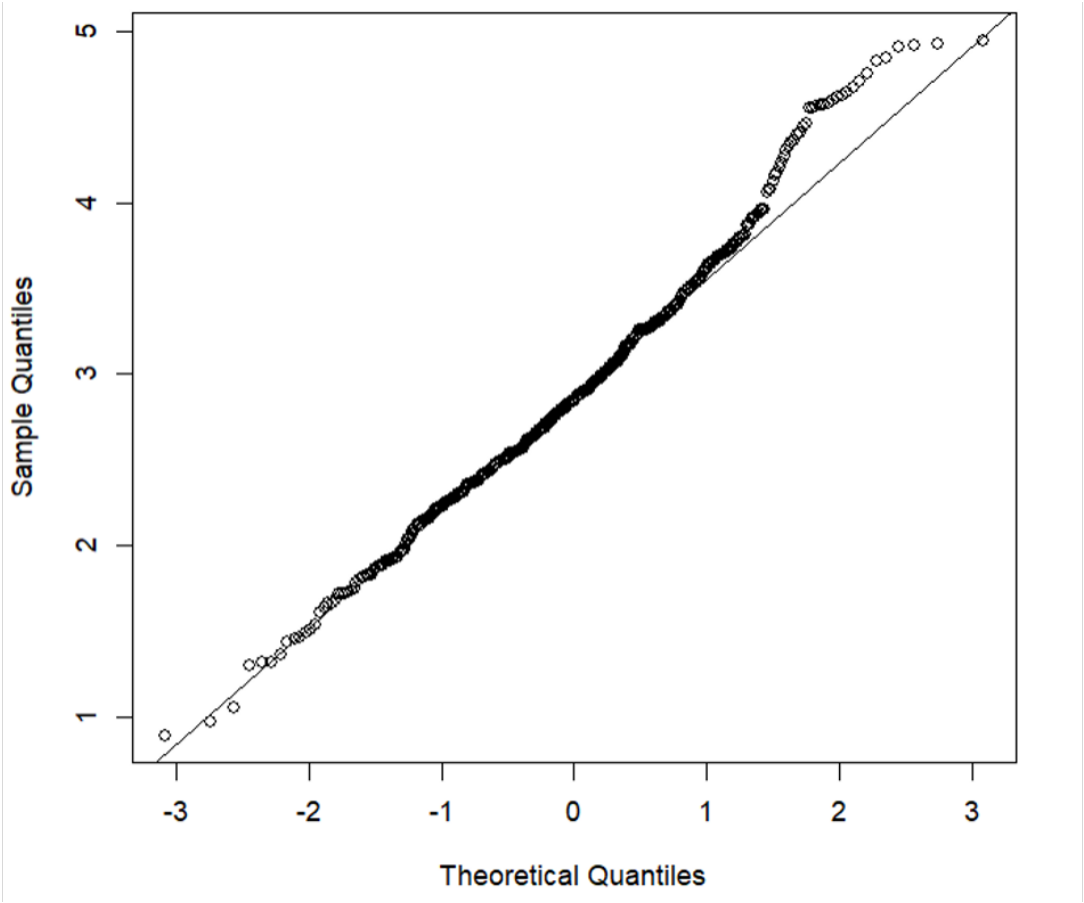
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.65 Standardized Residuals vs. Fitted Values, Gender Typicality, girls



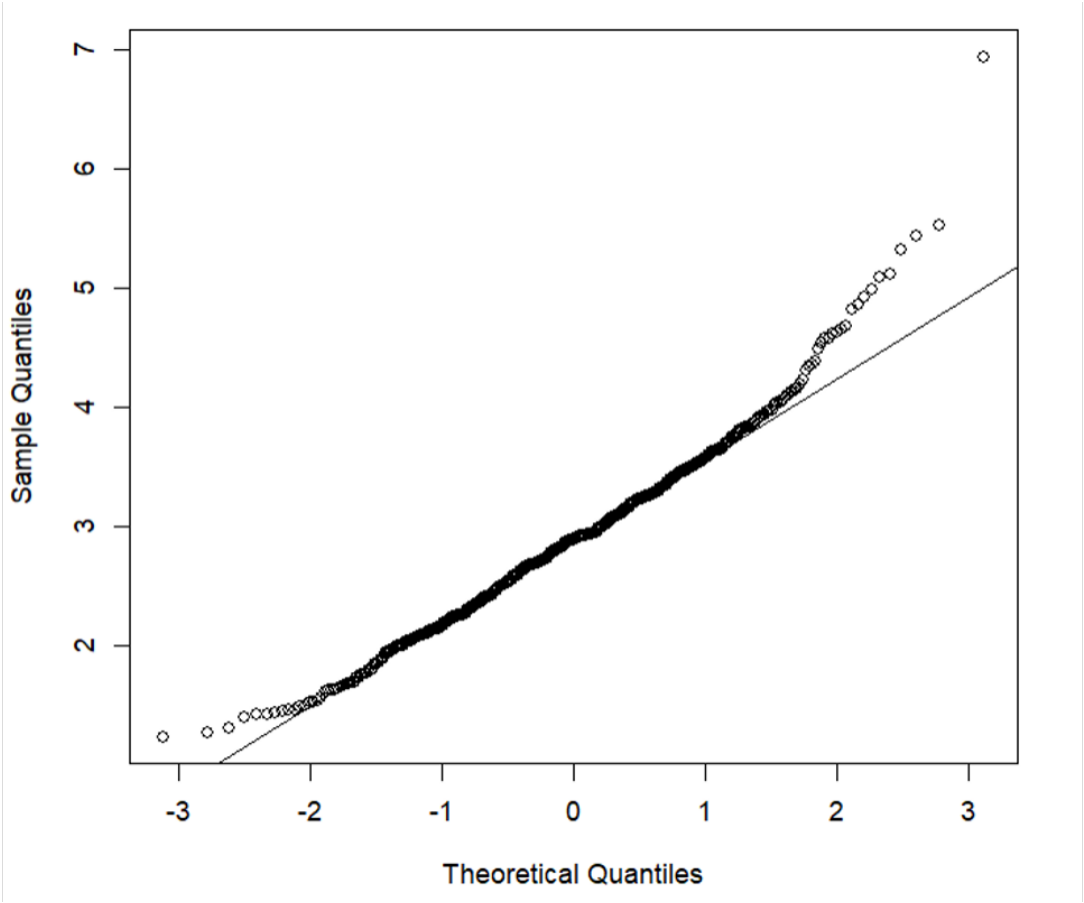
Note: No systematic pattern or funnel shape is observable, indicating homoscedasticity. Output from R 4.2.2.

Figure A.66 Q-Q Plot of Mahalanobis Distances, boys



Note: No systematic deviation from the diagonal is observable, with only minor curvature in the upper tail, indicating approximate multivariate normality. Output from R 4.2.2.

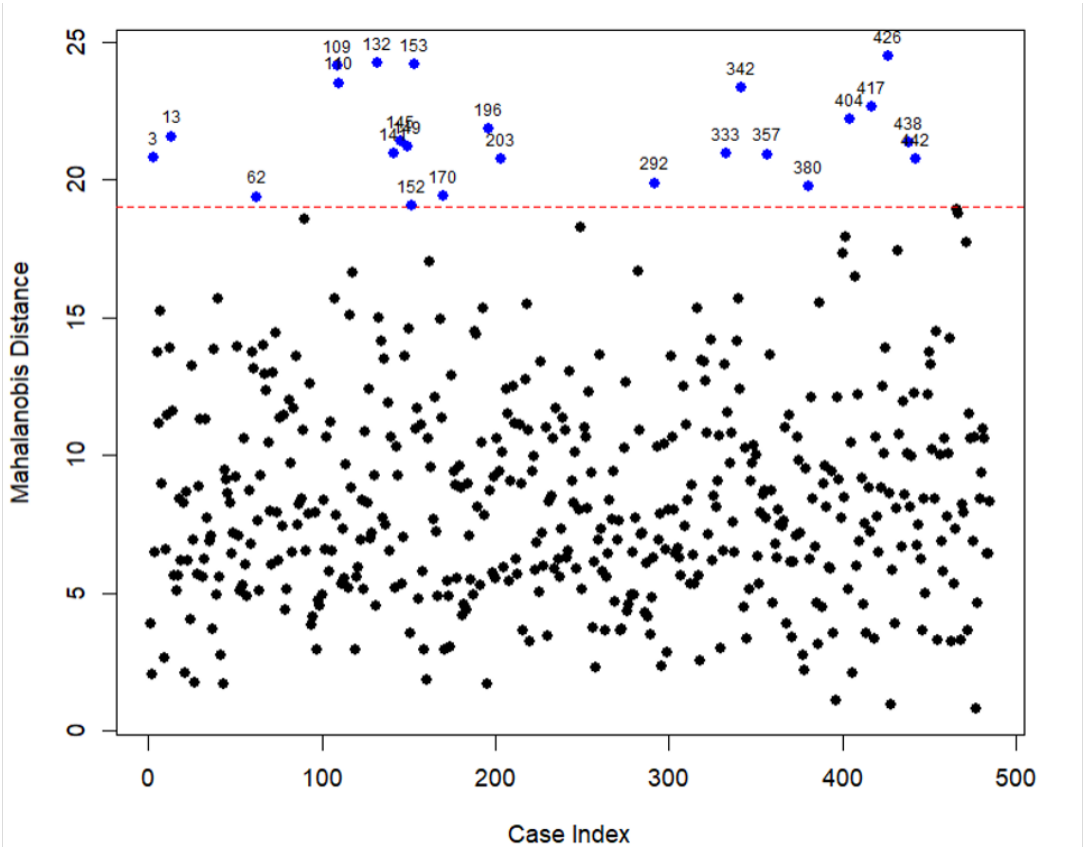
Figure A.67 Q-Q Plot of Mahalanobis Distances, girls



Note: No systematic deviation from the diagonal is observable, with only minor curvature in the upper tail, indicating approximate multivariate normality. Output from R 4.2.2.

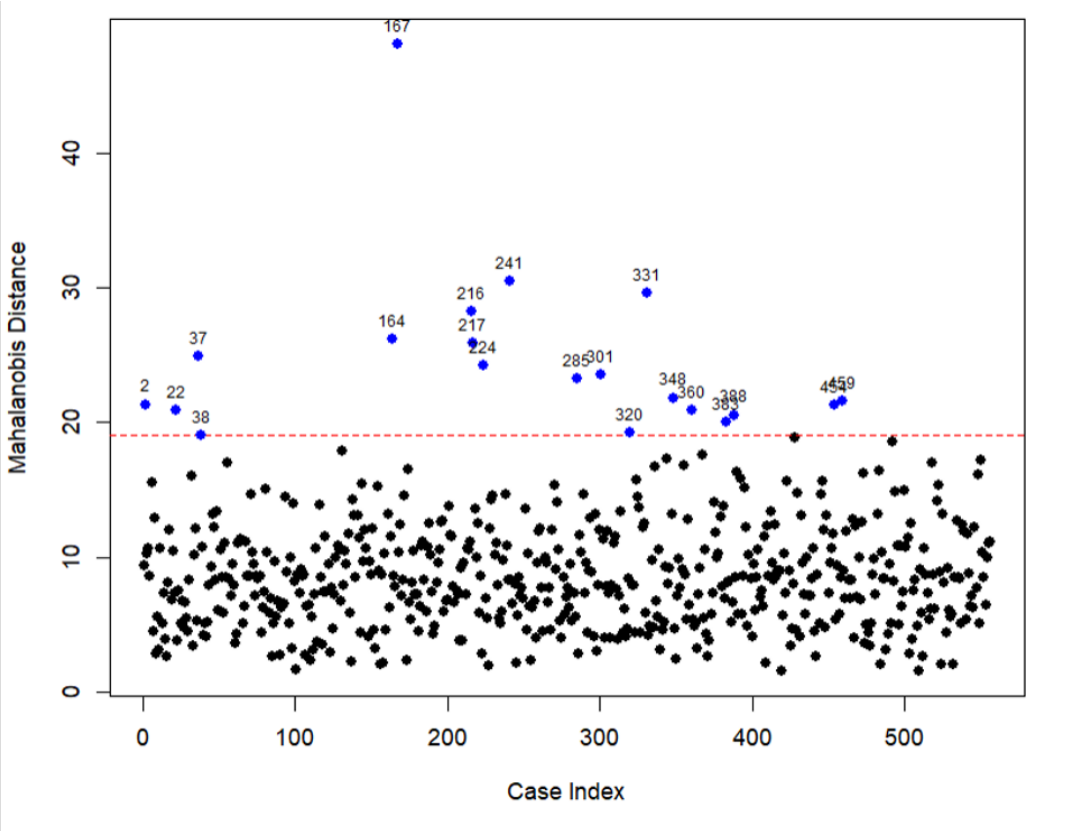
A.2.5 Multivariate Outliers

Figure A.68 Mahalanobis Distances for Endogenous Variables, boys



Note: Most observations fall below the χ^2 cutoff line (red), while 24 cases (3.7%) exceed the threshold and are identified as potential multivariate outliers (blue points). Output from R 4.2.2.

Figure A.69 Mahalanobis Distances for Endogenous Variables, girls



Note: Most observations fall below the χ² cutoff line (red), while 20 cases (2.9%) exceed the threshold and are identified as potential multivariate outliers (blue points). Output from R 4.2.2.

A.2.6 Internal Consistency

Table A.2 Internal consistency of the observed variables

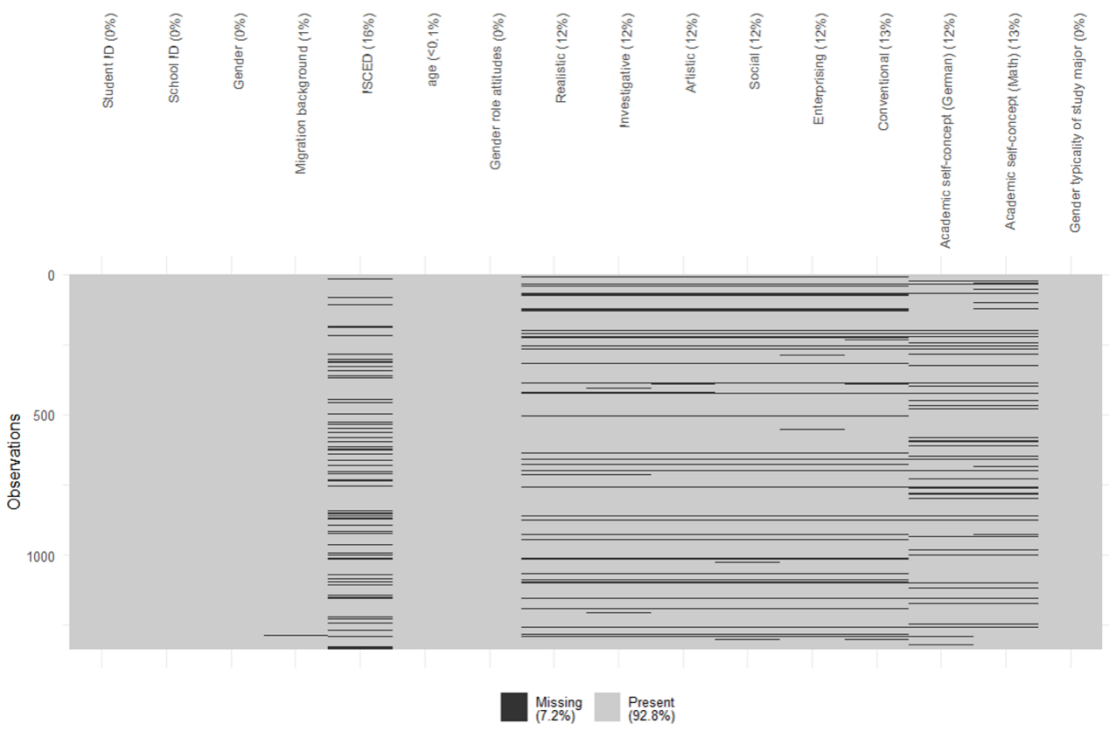
Measure	Cronbach's !
Gender Role Attitudes	0.748
Vocational Interests	
Realistic	0.712
Investigative	0.682
Artistic	0.685
Social	0.769
Enterprising	0.480
Conventional	0.564
Academic Self-concept	
Math	0.893
German	0.828

Note: Results from SPSS 31.0.0.0.

A.3 Missing Data Analysis

Only students with valid data for gender role attitudes and gender typicality of study choice were included in the sample (see **4.3**), hence, the two variables had no missing data. Overall, 7.2% of the data were missing across the analytical sample, showing a *general pattern* of missingness (Enders and Little, 2022) (see **Figure A.70**).

Figure A.70 Location of missing data across all variables



Note: The figure indicates no clustering of missing values suggesting that missingness in one variable is largely unrelated to missingness in other variables. Output from R 4.2.2.

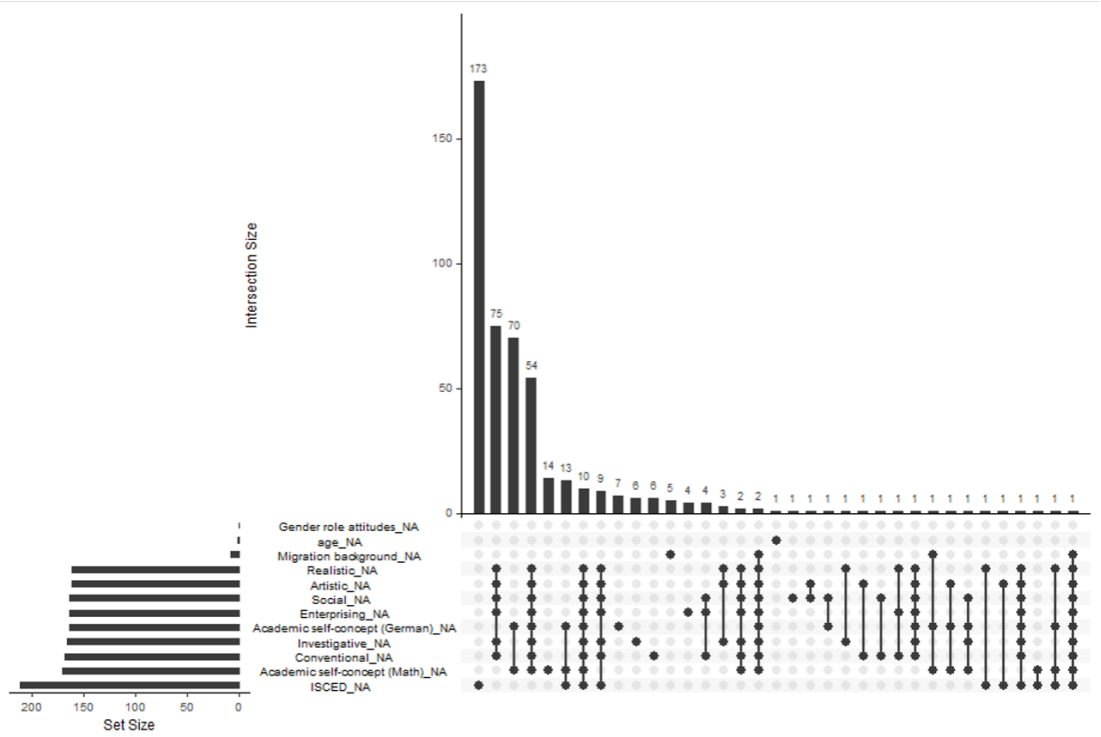
On the variable level, the proportion of missing responses ranged up to 15.8% (see **Table A.3**). The highest proportion of missing data was observed for the control variable measuring parents' highest educational level (ISCED, *n*= 173). As this variables was included solely as a control, it was retained in the model.

Table A.3 Missing data per variable

	N	%
Gender	0	0
Migration Background	9	0.673
Parents's ISCED	211	15.8
Gender Role Attitudes	0	0
Realistic	162	12.1
Investigative	166	12.4
Artistic	162	12.1
Social	164	12.3
Enterprising	164	12.3
Conventional	168	12.6
ASC Math	171	12.8
ASC German	164	12.3
Study Choice	0	0

In the vocational interest variables and academic self-concept, missingness ranged between 12.1 and 12.8% and resulted from wave nonresponse and item nonresponse. Most of the missing data in these variables were missing due to wave nonresponse, primarily because students were absent in the respective measurement waves (e.g., due to illness or other situational factors). Of the 1,337 students in the sample, n=75 were absent in t_3, when vocational interests were assessed, and n=70 were absent in t_2, when academic self-concepts were measured. A total of n=54 were absent in both assessment waves and therefore had missing data on both vocational interests and academic self-concept (see **Figure A.71**).

Figure A.71 Relationship between missing data across the predictor variables



Note: Missing-data patterns are primarily driven by wave nonresponse in vocational interests and academic self-concept, with ISCED missing largely independently and remaining patterns representing only a small number of cases. Output from R 4.2.2.

The rest of missing data the interest and self-concept variables were missing due to item nonresponse, with students participating in a given wave but not answering all items. No systematic patterns were identifiable for item-level missingness. following no identifiable patterns. However, both wave nonresponse and item nonresponse are unlikely to satisfy the assumption of missing completely at random (MCAR) (Enders and Little, 2022; Graham, 2009). Applying Little's MCAR test ($\chi(436)=615.00$, $p < .001$) further supported that data were not missing completely at random (Little, 1988). Overall, the observed missing-data patterns and the results of Little's MCAR test support the treatment of missing data as missing at random, as described in the main text.

A.4 Data Preparation

A.4.1 Data Sets and Merging

The analytic dataset was constructed from multiple NEPS data files, namely CohortProfile, pTarget, pParent and spVocTrain. Variables for gender, gender role attitudes, vocational interests and academic self-concept were included in pTarget, age and school ID in the CohortProfile, parent's ISCED and migration background in pParent and information on the first study major in spVocTrain.

CohortProfile, pTarget, pParent were originally recorded in long format, with one row per student per wave. To facilitate the calculation of composite scores and merging of datasets, these data were reshaped to wide format, creating separate columns for each item at each wave. This ensured that each student was represented by a single row containing all relevant item responses.

```
ptar_wide <- ptar_var %>%
  pivot_wider(
    names_from = wave,
    values_from = c(t436370, t436300, t436360, t436150),
    names_glue = "{.value}_wave{wave}"
  )
```

The spVocTrain dataset was recorded in spell format. To prepare it for merging, only fully harmonized episodes were retained.

```
voc <- subset(voc, voc$subspell == 0)
```

After separately preparing the files, they were merged using the unique person identifier(`ID_t`).

```
neps_sc3 <- neps_sc3 %>%
      left_join(school_ID, by = "ID_t")
```

A.4.2 Sample Selection

Only students with valid data on gender role attitudes and study majors were included. Students missing these variables were excluded.

```
neps_sc3 <- neps_sc3 %>%
  filter(!is.na(gra))
```

A.4.3 Gender Role Attitudes Index

To compute the gender role attitudes index, I reverse coded items 1, 3, and 4 so that higher values reflected more traditional attitudes and calculated the gender role attitude index for all students that had valid data in at least three of the four items.

```
ptar_var <- ptar_var %>%
  mutate(
    t436300 = case_when(
      t436300 == 1 ~ 4,
      t436300 == 2 ~ 3,
      t436300 == 3 ~ 2,
      t436300 == 4 ~ 1,
      TRUE ~ t436300
    ),
    t436360 = case_when(
      t436360 == 1 ~ 4,
      t436360 == 2 ~ 3,
      t436360 == 3 ~ 2,
      t436360 == 4 ~ 1,
      TRUE ~ t436360
    ), t436150 = case_when(
      t436150 == 1 ~ 4,
      t436150 == 2 ~ 3,
      t436150 == 3 ~ 2,
      t436150 == 4 ~ 1,
      TRUE ~ t436150
    )
```

```
  )

gra6 <- c("t436370", "t436300", "t436360", "t436150")
ptar_wide <- ptar_wide %>%
  rowwise() %>%
  mutate(
    n_nonmiss = sum(!is.na(c_across(all_of(gra6)))),
    gra = if (n_nonmiss >= 3)
      mean(c_across(all_of(gra6)), na.rm = TRUE)
    else NA_real_
  ) %>%
  ungroup()
```

A.4.4 Outcome Variable – Gender Typicality of Study Choice

To generate the outcome variable, I prepared and imported a separate csv file with the population statistics on the average sex ratio for each study area (see **Table A.4**) into the R environment and merged the file to the data set using the study area of the students. To compute the outcome variable correctly based on the students' gender, I subtracted the average female share from 1 for boys (t700031 == 1).

```
ptar_merged <- ptar_merged %>%
  left_join(femaleshare_destatis, by = "ts15404_g1R")

 ptar_merged <- ptar_merged %>%
  mutate(gender_typicality = case_when(
    t700031 == 1 ~ 1 – female_share,
    t700031 == 2 ~ female_share,
    TRUE ~ NA_real_
  )
  )
```

Table A.4 Average Female share within each Study Area (Destatis 2010/11)

NEPS Code	Study Area	Average 2010-2025
51	Veterinary medicine	84.7%
17	Special Education	82.8%
60	Nutritional and domestic sciences	82.5%
11	Romance studies	78.6%
16	Educational sciences	78.4%
9	German Studies (German, Germanic Languages excl. Anglistics)	77.7%
27	Social services	77.0%
74	Arts, art science in general	76.0%
15	Psychology	75.3%
6	Library science, documentation	74.6%
7	General and comparative literature and linguistics	74.5%
48	Health sciences general	74.1%
14	Cultural studies (in narrow sense)	73.3%
12	Slavic, Baltic, Finno-Ugrian studies	72.9%
1	Linguistic and cultural studies in general	72.3%
10	English and American studies	71.2%
41	Pharmacy	69.7%
24	Area studies	67.2%
50	Dentistry	64.6%
23	Law, economics and social science in general	63.2%
42	Biology	63.1%
76	Design	63.1%
13	Non-European linguistics and cultural studies	62.7%
77	Performing Arts, motion pictures and television, dramatics	62.6%
49	Human medicine (without dentistry)	62.2%
26	Social sciences	60.1%
2	Protestant theology/religious education	59.5%
66	Architecture, interior design	58.8%
75	Fine arts	58.2%
57	Landscape conversation, environmental design	57.9%
8	Classical philology, Modern Greek	57.2%
83	Outside the study area structure	56.2%
28	Law	56.1%
36	Mathematics, sciences in general	55.2%
3	Catholic theology/religious education	54.7%
78	Music, musicology	53.0%
29	Administration sciences	51.5%
67	Spatial planning	50.9%
44	Geography	49.6%

30	Economics	48.3%
58	Agricultural sciences, food and beverage technology	47.9%
37	Mathematics	46.7%
4	Philosophy	46.4%
5	History	45.7%
40	Chemistry	45.0%
25	Political sciences	44.3%
43	Earth sciences (without Geography)	42.7%
22	Sport, Sport science	38.7%
59	Forestry, wood industry	34.6%
69	Surveying	30.3%
68	Civil engineering	28.9%
39	Physics, astronomy	27.1%
31	Industrial engineering and management with focus on economics	26.6%
70	Industrial engineering and management with focus on engineering	21.9%
61	Engineering in general	21.5%
63	Mechanical engineering, process engineering	20.7%
38	Computer science	20.4%
62	Mining, metallurgy	18.7%
64	Electrical engineering	13.0%
65	Traffic engineering, nautics	12.4%

Source: Federal Statistical Office of Germany (Destatis) (2025c) author's calculations.

A.4.5 Parents' Highest educational level

The variable for parents' highest educational level was computed as the maximum of the available ISCED values for each parent.

```
isced <- isced %>%
  mutate(
    isced = pmax(p731802_g1, p731802_g1, na.rm = TRUE)
  )
```

A.5 Data Use Agreement

Please send the filled and signed document to the Research Data Center (FDZ-LIfBi)

by E-Mail: fdz@lifbi.de

by Post: Leibniz-Institut für Bildungsverläufe, FDZ, Wilhelmsplatz 3, 96047 Bamberg, Germany

Only employees of scientific institutions with at least a university degree are eligible to apply. University students are allowed to be included in the NEPS Data Use Agreement as additionally involved persons in the research project (see Art 2 no. 4).

NEPS Data Use Agreement

with case number: ☐☐☐☐☐

(filled out by FDZ-LIfBi)

Between the

Leibniz Institute for Educational Trajectories (LIfBi)

Wilhelmsplatz 3, 96047 Bamberg, Germany

represented by the LIfBi Directorate,

this represented by the Research Data Center,

- hereinafter called LIfBi -

and

Name First name Titel / Function E-mail	[redacted]
Telephone (optional)	
Institution	University of Oxford
Address of institution	University of Oxford 15 Norham Gardens Oxford, OX2 6PY
Proof that the institution is a research facility[1]	
Research facility is located in a EU member state	☐ Yes ☑ No

- hereinafter referred to as the data recipient -

together referred to as the parties in the following,

the following agreement is concluded on the granting of rights to use data of the National Educational Panel Study (NEPS):

[1] The proof is not required for universities and recognized research institutes.

Article 1: Object of Agreement

LIfBi grants the data recipient the simple and temporary right of use of factually de-personalized NEPS microdata.

Article 2: Scope and Content of Right of Use

1. The scope and content of the right of use are determined by this agreement and, additionally, by the relevant legal requirements (European General Data Protection Regulation (GDPR), Federal Data Privacy Act (BDSG), etc.).

2. The data may be exclusively used for in-house scientific research of the data recipient in the research project described below.

Title of the research project ® English (obligatory)	Occupational sex segregation: The role of gender stereotypes for study choice
Title of the research project ® German (optional)	
Project duration	Start: 01 / 07 / 2025 (Day / Month / Year) End: 30 / 11 / 2025 (Day / Month / Year)
Project with another NEPS agreement at a different institution[2]	☑ No ☐ Yes ® please indicate the co-operation partner (name, institute):
Renewal of a previous NEPS project[3]	☑ No ☐ Yes ® please indicate the contract number or project title:
Short description of the project (Please outline the main research questions or the scientific objective of the project in a few sentences)	Although women have made substantial progress in higher education attainment and labour market participation, occupational sex segregation remains a persistent challenge. Given the low occupational mobility in Germany, initial university major choice has long-term implications for individual career trajectories. Since majors remain highly segregated by sex, this project examines the role of gender stereotypes for the choice of university majors.
Project for academic qualification	☐ No ☑ Yes ® please indicate the type of academic qualification: ☑ Bachelor/Master/Diploma ☐ PhD/Doctorate ☐ Habilitation

[2] In addition to the data recipient mentioned in this agreement, there is at least one further data recipient at a different research institution involved in this project with a separate NEPS Data Use Agreement.

[3] The project is a continuation of a previous NEPS project due to a change of affiliation of the data recipient or a resumption of a previous NEPS project after temporary cessation.

3. Any use for commercial or other economic purposes is not permitted.

4. The data recipient commits himself not to disclose, neither in modified form, the data to third parties, or grant access to them. Third parties are persons other than the ones listed below who are additionally involved in the research project. Additionally involved persons may be university students or interns/trainees who are not yet in possession of a university degree and/or who are not contractually affiliated to a research institution. All persons involved must belong to the same institution as the data recipient.[4]

Note: The data recipient does not have to be specified again at this point.		
1	Name: First name: E-mail: Institution: Title / Function:	Gaede Milena milena.gaede@stx.ox.ac.uk University of Oxford Student
2	Name: First name: E-mail: Institution: Title / Function:	
3	Name: First name: E-mail: Institution: Title / Function:	
4	Name: First name: E-mail: Institution: Title / Function:	
5	Name: First name: E-mail: Institution: Title / Function:	

[4] For joint research projects between two or more research institutions, each institution is required to conclude a separate NEPS Data Use Agreement with own data recipient (see footnote 3).

5. When using data collected in connection with schools or higher education institutions, it is not allowed to use Federal-State-related information directly or indirectly contained in the data for analyses aiming at a direct Federal State comparison, direct conclusions to be drawn about a Federal State, or a reconstruction of the concrete Federal State affiliation of persons, households, and institutions. In fact, using the Federal State label in conjunction with NEPS data collected in connection with schools or higher education institutions is only permitted in the following cases:

   a) if, in the context of exploring scientific research questions, it is exclusively used for control purposes in order to incorporate it as a covariate in the planned analysis; the identification of individual Federal States in the displayed results is impermissible

   b) if, in the context of exploring scientific research questions, it is exclusively used for incorporating contextual characteristics or other third-party variables; the identification of individual Federal States in the displayed results is impermissible

   c) if, in the context of exploring scientific research questions, it is exclusively used for comparing aggregated groups of Federal States where at least two states are combined to form a single meaningful group with regard to substantive issues; the identification of individual Federal States in the displayed results is impermissible

   d) if, in the context of exploring scientific research questions, it is exclusively used for sample descriptions (e.g., the distribution of participants by state and by different types of schools within states)

   The Federal State label in the starting cohorts of schools and higher education institutions can only be accessed via remote access (RemoteNEPS) and by logging in as a guest in Bamberg (On-site). Individual analysis results are reviewed by LIfBi to ensure that this agreement has been observed before being passed on electronically to the data user in a password-protected environment. The abovementioned restrictions do not apply to data collected in a nonschool context and/or in Federal-State-specific educational reform studies.

Article 3: Term of Agreement

1. The agreement starts on the day of signature by both parties and ends upon completion of the research project listed in Art. 2 without requiring notice of termination.

2. The data recipient may terminate the agreement any time without stating any reasons. Extraordinary termination of the agreement by LIfBi is possible under the conditions set out in Art. 8 of this agreement. Notice of termination must be in writing.

3. The rights of use of the data recipient and of the persons involved in the research project end automatically, without notice of termination, upon their retirement from the research project and/or from the contractual institution, and in the case of the persons involved in the research projects, also upon the data recipient's retirement from research project and/or from the contractual institution. The same applies if the institution is wound up, reestablished or taken over.

4. LIfBi shall be informed unrequested and immediately of any change in the aforementioned sense.

Article 4: Persons Involved in the Research Project

The persons involved in the research project are equally bound by the provisions of this agreement as the data recipient.

Article 5: Data Privacy

The data recipient and the persons involved in the research project commit themselves, in particular, to

1. observe the provisions of the European GDPR and the German BDSG,
2. keep secret the NEPS data provided,
3. keep secret transmitted access codes (individual identification and password),
4. refrain from any action aimed at and suitable for re-identifying persons, households or institutions (e.g., education or support facilities),
5. immediately inform LIfBi of any accidental re-identification and keep secret individual data gained therefrom,
6. refrain from combining the data, and neither partially, with other data permitting the re-identification of persons, and,
7. make LIfBi aware of any security leaks regarding data protection and data security, or any data quality deficiencies.

Article 6: Processing of Personal Data of the Data Recipient and the Persons Involved in the Project

1. LIfBi processes the personal data of the data recipient and the persons involved in the research project as follows:
   a) for the execution of this contract and on the basis of scientific probity, the information provided within the scope of this contract, including personal data, is stored and processed by LIfBi (Art. 6 para. 1 sentence 1 lit. a) and f) GDPR),
   b) to publish information on the research project (title, duration and short description of the project) and the persons involved (name, title, research institution) on the NEPS website (Art. 6 para. 1 sentence 1 lit. f) GDPR).

   The personal data will be deleted 10 years after termination of the contractual relationship with LIfBi at the end of the calendar year.

Article 7: Liability

1. LIfBi commits itself to carry out the data preparation, de-personalization and provision of the NEPS data with common and adequate care, without assuming any guarantee for the faultless condition of the data sets.

2. The data recipient discharges LIfBi from all liability for reasons of data privacy violation. Accordingly, the same applies to the liability of the persons involved in the research project mentioned in Art. 2 no. 4 of this agreement towards LIfBi.

Article 8: Extraordinary Termination and Consequences Resulting from Breach of Agreement

1. LIfBi may terminate the agreement for a substantial reason and without meeting a deadline. A substantial reason would particularly be a violation of

   a) the prohibition of data dissemination,

   b) the requirement to keep the NEPS data secret (see Art. 5 no. 2),

   c) the prohibition of re-identification (see Art. 5 no. 4),

   d) the terms regarding the use of the Federal State label (see Art. 2 no. 5), or

   e) other essential duties under this agreement.

2. In case of an intentional or grossly negligent violation of the contractual duties, the data recipient and the persons involved in the research projects are obliged to pay a contractual penalty of up to 100,000 Euro. The amount of the contractual penalty is determined by the LIfBi directorate, with the enforcement of further claims remaining unaffected.

3. If the data recipient and/or one of the persons involved in the research project violates the contractual duties, she and/or he will be excluded from the use of NEPS data for a period of up to 2 years. In case of serious violations, she and/or he will be permanently excluded from using NEPS data, which again is for the LIfBi directorate to decide.

4. If a violation occurs, the name of the person involved will be published and a notification sent to the research data centers organized in the Standing Committee Research Data Infrastructure (FDI) and to the German Data Forum (RatSWD).

Article 9: Publications

1. In case of publications or other studies (e.g., master theses, working papers, etc.) into which the NEPS data are integrated, the data recipient and the persons involved in the research project commit themselves to refer to NEPS as a reference source. The data recipient is furthermore committed to refer to the version of the data used in all such papers. Instructions on the citation of the data and data documentation can be found on the NEPS website and in the relevant data manuals.

2. Publications and the use of NEPS data must comply with the provisions of the European GDPR, the German BDSG, and the national provisions on data privacy; in particular, publications must not permit any conclusions on the persons, households or institutions interviewed within the context of NEPS.

3. LIfBi has to be notified of any kind of publication resulting from the use of NEPS data immediately after publication. Together with the notification LIfBi is to be provided with a copy of the publication as print or electronic version.

4. In case NEPS micro data are to be made available within the framework of extended, electronic publications (so-called "enhanced publications"), written approval by the LIfBi directorate will be required.

Article 10: Data Deletion

The data recipient and the persons involved in the research project will ensure that the data, including those in modified form, possible backup copies, excerpt and/or auxiliary files, will be deleted on all data carriers where they are stored when the agreement expires and/or terminates.

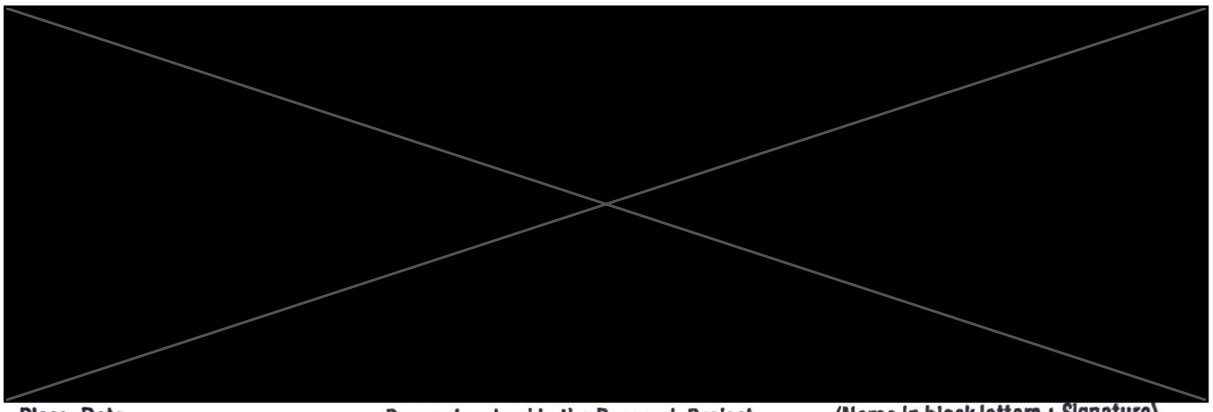
Article 11: Costs

The use of NEPS data is basically free of charge. Costs incurred by LIfBi due to special requirements of the data recipient such as use of own software or addition of external data, may be charged separately.

Article 12: Other Provisions

1. Any disputes about the scope and content of the rights of use granted by this agreement will be decided upon by the LIfBi directorate.

2. Any changes or supplements to this agreement must be made in writing to be effective (see also form Supplement/Change to the data use agreement). If a provision of this agreement is invalid, this will not affect the agreement as a whole. In such a case, the agreement shall be interpreted according to the meaning and purpose of the agreement by taking into account what the parties would have intended if they had been aware of the invalidity of the respective provision.



Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	LIfBI Representative	(Name in block letters + Signature)

Please send the filled and signed document to the Research Data Center (FDZ-LIfBi)

by E-Mail: fdz@lifbi.de

by Post: Leibniz-Institut für Bildungsverläufe, FDZ, Wilhelmsplatz 3, 96047 Bamberg, Germany

The data recipient is the person who has signed the corresponding NEPS Data Use Agreement as the data recipient. The supplement request must be signed by the data recipient and those persons involved in the project who intend to use the RemoteNEPS data access.

Supplement to the NEPS Data Use Agreement

with case number: ☐☐☐☐☐

On the Use of Data of the National Educational Panel Study (NEPS) Through

RemoteNEPS

The Leibniz Institute for Educational Trajectories (LIfBi)
Wilhelmsplatz 3, 96047 Bamberg, Germany
represented by the LIfBi Directorate,
this represented by the Research Data Center,
- hereinafter called LIfBi -
and

Name	[redacted]
First name	
E-mail	
Telephone (optional)	
Institution	University of Oxford

- hereinafter referred to as the data recipient -

as well as the persons involved in the research project agree that the existing NEPS Data Use Agreement and/or the change to this NEPS Data Use Agreement shall be supplemented as follows:

Article 1: Supplementary Data Privacy Provisions

1. The data recipient and the persons involved in the research project are aware that
   a) biometric authentication is a prerequisite for access to the data-processing systems of LIfBI,
   b) biometric data are personal data that are processed by LIfBI on the basis of Art. 6 para. 1 sentence 1 lit. b) GDPR,
   c) by signing the contract they confirm that they have provided an information sheet on keystroke biometrics and taken note of it.

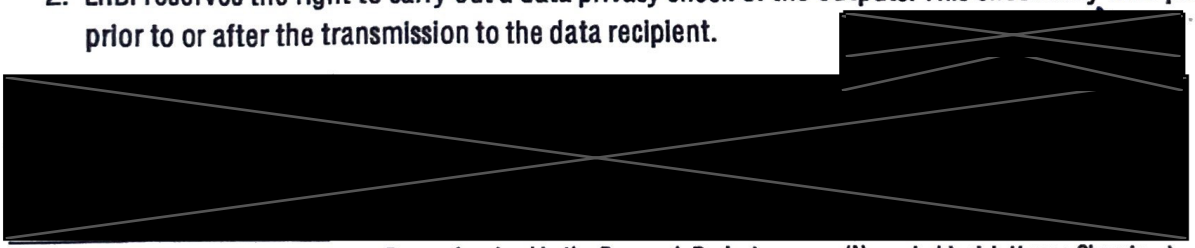
   The keystroke biometrics will be deleted 10 years after termination of the contractual relationship with LIfBI at the end of the calendar year.

2. The data recipient and the persons involved in the research project commit themselves to
   a) participate in a NEPS data user training. In exceptional cases, the obligation to participate in a training may be canceled by the LIfBI directorate.
   b) utilize the access possibility provided by the data use agreement exclusively for own purposes, in a closed environment and particularly not in public.
   c) refrain from using equipment for image recording (cameras, camera cellphones) and producing screenshots when working with the NEPS data.

Article 2: Analyses and Outputs

1. LIfBI has the right to store all analyses results and files (outputs) requested for extraction from the RemoteNEPS environment for an unlimited period of time and on its own discretion. LIfBI is not obliged to store the analyses results, outputs or other project data and files beyond the ending date of the agreement.

2. LIfBI reserves the right to carry out a data privacy check of the outputs. This check may take place prior to or after the transmission to the data recipient.



Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	Person involved in the Research Project	(Name in block letters + Signature)
Place, Date	LIfBI Representative	(Name in block letters + Signature)

LIfBi
LEIBNIZ INSTITUTE FOR EDUCATIONAL TRAJECTORIES

Biometric authentication of Data Users by – Keystroke Biometrics – to ensure the security of access to data-processing systems of the Leibniz Institute for Educational Trajectories (LIfBi)

Information for the Data User

The Leibniz Institute for Educational Trajectories (LIfBi), represented by the Directorate, as responsible institution for the National Educational Panel Study (NEPS) is required, according to Art. 32 GDPR, to implement the necessary organizational and technical measures to ensure data security and data integrity requirements. In addition to a separate obligation of each data user to maintain data confidentiality, only authorized data users are permitted to use NEPS data in order to ensure data security. Access to these data from outside the LIfBi data security area requires an unambiguous, biometric authentication of the data user.

For this purpose, LIfBi uses a biometric authentication system, so-called keystroke biometrics. It recognizes the data user exclusively by his individual keystroke behavior. For authentication the data user enters his user name and a sample sentence. This is checked against the stored user profile by a software using complex mathematical algorithms to compare specific features of typing habits with the stored user profile, which has been calculated from the last ten successful logins. If the current typing sample matches the stored data user profile, the keystroke biometric service will grant access to the systems where the data can then be retrieved. With each successful login process, the software will continuously learn and adapt the keystroke data so that security will be further enhanced. The process of keystroke biometrics is based on the finding that typing behavior is as unique as a personal handwriting.

Biometric data are personal data. Their processing is necessary for the implementation of the RemoteNEPS Supplementary Agreement, cf. Art. 6 para 1 sentence 1 lit b) GDPR. The keystroke biometrics will be deleted 10 years after termination of the contractual relationship with LIfBi at the end of the calendar year.

We would like to draw your attention to the right to information, correction, deletion and restriction of processing of personal data. The same applies to the right of objection and the right of appeal to a data protection supervisory authority.

Contact to the Research Data Center:

LIfBi – Leibniz Institute for Educational Trajectories
Research Data Center
Wilhelmsplatz 3
96047 Bamberg
Germany

Phone: +49 (0) 951 863 3511
E-mail: fdz@lifbi.de

Contact to the Internal Data Protection Officer:

LIfBi – Leibniz Institute for Educational Trajectories
Brigitte Bogensperger
Wilhelmsplatz 3
96047 Bamberg
Germany

Phone: +49 (0) 951 863 3418
E-mail: betrieblicher-datenschutz@lifbi.de