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Self-to-Prototype Similarity as a Mediator Between Gender and Students' Interest in Learning to Code

Janine Neuhaus[1] and Andreas Borowski[2]
[1]Berlin School of Economics and Law, [2]Universität Potsdam, Germany

ABSTRACT
There is scarcely any other field in which women are so underrepresented as they are in computer sciences. Socio-psychological literature suggests that students are more likely to engage in domains they perceive as fitting their identity (Kessels, Heyder, Latsch & Hannover, 2014). As the Science, Technology, Engineering, and Mathematics (STEM) prototype (e.g. a typical student interested in computer sciences) is linked with agentic-masculine traits (e.g. competitiveness) and not with communal-feminine traits (e.g. helping others), most girls regard STEM subjects as incompatible with their self-view. We investigated whether coding courses for students linked with communal goals were more attractive to girls compared to coding courses associated with agentic goals. We assumed greater self-to-prototype similarity would mediate the link between the students' gender and their interest in learning to code. Based on structural equation modeling with 459 German ninth- and tenth-grade students, our results confirm our hypothesis: girls showed greater interest in learning to code if course descriptions were focused on communal goals, while boys showed greater interest under the agentic-goal condition. As expected, self-to-prototype similarity mediated the relationship between gender and interest in the communal coding course. With regard to the agentic coding course, we found only a partial mediating effect. Our results provide recommendations for the development of STEM interventions that encourage the inclusion of female students.

KEYWORDS
Computing; coding; STEM; gender identity; self-to-prototype similarity; mediation analysis.

INTRODUCTION

The underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) careers is a well-known phenomenon in Western industrialized nations (e.g. OECD, 2016a). However, a closer look at the percentage of higher education degrees awarded to female students over the last decade reveals large differences between the STEM fields themselves (Cheryan, Ziegler, Montoya & Jiang, 2017). That is, the average percentage of female students in the life sciences (60%), physical sciences (40%), and mathematics and statistics (42%) is even higher or only slightly lower than the proportion of male students (OECD, 2014).[1] Yet, in contrast, with a share of 23% (OECD average; in Germany 11%), female students are distinctly underrepresented in the field of computing (OECD, 2014). Boys and girls between the ages of 12 to 16 already show different patterns regarding their interest in computer sciences. For instance, when ninth-graders are asked if they expect to eventually work in a scientific field, 25% of boys and 24% of girls agree. However, if asked about specific scientific fields, only 0.4% of girls see working as an Information and Communication Technology (ICT) professional as a future option, with the figure for boys higher at 4.8% (OECD, 2016a).

The unequal representation of female students in STEM fields used to be explained as a result of a lesser performance of girls and women in these subjects, although research draws a different conclusion (see also Hyde, Lindberg, Linn, Ellis & Williams, 2008; Riegle-Crumb & King, 2012; Wai, Cacchio, Putallaz & Makel, 2010). For example, results from the fifth survey of the Program for International Student Assessment (PISA)—which tested 15-year-olds focusing on science—showed a better mean performance by boys, scoring only four points higher than girls; a statistically significant, yet numerically small, difference (OECD, 2016b).[2] With regard to computer sciences, the International Computer and Information Literacy Study (ICILS; see European Commission, 2014) demonstrated low levels of Computer and Information Literacy (CIL) in all participating European countries (except the Czech Republic and Denmark), but with girls outperforming boys significantly (e.g. female–male difference in Germany: 16 score points). As CIL also depends on text-based reading (see European Commission, 2014, p. 10), gender differences in CIL are consistent with the findings of large scale assessments attesting to higher levels in reading literacy and text comprehension for girls (OECD, 2017; Stanat, Böhme, Schipolowski & Haag, 2016).

However, gender-specific differences in performance outcomes in the field of science are particularly inconsistent, as evidenced by international comparative studies. The last PISA study clearly demonstrated that gender patterns in student performances vary across nations. For example, while on average boys score significantly above girls in 24 countries (e.g. Germany), on average girls outperform boys in 22 countries (e.g. Finland; OECD, 2016b). Variations between countries regarding gender performance in science have also been found in the Trends in International Mathematics and Science Study (TIMSS). The TIMSS results show that, in 1995, boys attained higher science achievement than girls in almost all countries, whereas in 2015, boys outperformed girls in just five countries (Mullis, Martin & Loveless, 2016).

Finally, gender-specific outcomes for girls and boys in science (like academic achievement, motivation, or educational degrees) vary between countries and over time (e.g. Ceci, Ginther, Kahn & Williams, 2014). This observation leads to the conclusion that gender differences in scientific achievement do not themselves explain the reduced participation of girls, but are more likely the result of gender socialization and associated stereotypes in changing societies. Accordingly, on the basis of data from more than half a million citizens from 34 countries, Nosek et al. (2009) proved the presence of implicit stereotypes associating science more with males than with females, as well as the predictive value of stereotypes regarding differences in eighth-grade science and mathematics achievement on the national level.[3] These results mean that in countries where science is strongly associated with "being male," females perform poorly. Likewise, studies focusing on individual-level characteristics underline a significant connection between masculine attributes and students' interest in mathematics and physics (e.g. Forgasz, Leder & Tan, 2014; Kessels, 2005; Kessels, Heyder, Latsch & Hannover, 2014), thus confirming the masculine stereotype of STEM.

In this research, we took up the idea of changing the STEM stereotype by making it "less masculine" and "more feminine" in order to encourage girls to engage in extracurricular STEM-related activities. We shed light on the underlying psychological mechanism of identity regulation that explains the educational preferences of boys and girls. In a departure from most existing studies dealing with motivational and gender-related aspects in physics (e.g. Kessels, 2005; Kessels & Hannover, 2008; Marchand & Taasoobshirazi, 2013) and mathematics (e.g. Bench, Lench, Liew, Miner & Flores, 2015; Elis, Fosdick & Rasmussen, 2016; Shapiro & Williams, 2012), our study foregrounds coding (as a component of computing) as the focus of attention. The development of abilities and skills in computing is considered to be one of the key challenges to learning and schooling in the twenty-first-century digital age (Voogt, Erstad, Dede & Mishra, 2013). Furthermore, computing is assumed to contribute to educational equality due to its motivating effects on students and the opportunities it offers for fostering individualization (Heemskerk, Volman, Admiraal & ten Dam, 2012). Thus, computing has the potential—possibly more so than other STEM fields—to close the gender gap in the technical world.

GENDER ROLES AND STEM STEREOTYPES

The influence of stereotypes on career choices in STEM fields has been proven by numerous scientific studies (for overviews, see Kessels, 2015; Yazilitas, Svensson, de Vries & Saharso, 2013). In general, stereotypes are defined as overgeneralizations of the characteristics and abilities of an entire group, and assumptions about how members typically behave (Eagly, Wood & Diekman, 2000; Ruble, Cohen & Ruble, 1984). Stereotypes reflect not only descriptions of men's and women's actual behavior, but are also an expression of what kind of behavior is expected from members belonging to specific gender groups (Eagly & Sczesny, 2009; Heilman, Wallen, Fuchs & Tamkins, 2004). Thus, stereotypes include descriptive ("what is") and prescriptive norms ("what ought to be") in our society (Cialdini, Reno & Kallgren, 1990).

STEM stereotypes refer to aspects associated with STEM-related fields, including beliefs "about the people who excel, work in, or like these domains" (Kessels, 2015, p. 281). By contrast, gender role stereotypes reflect shared beliefs and perceptions about the appearance, behavior, and other characteristics of women and men. According to social role theory, gender role stereotypes have their roots in traditional behavioral patterns: while women were typically engaged primarily with caring for children, requiring traits associated with "warmth," "friendliness," and the "willingness to help others" (so-called feminine attributes), men were always seen as protectors and providers, demonstrating "independence," "competitiveness," and "dominance" (so-called masculine attributes; Eagly & Karau, 2002). The above-cited feminine and masculine attributes have been validated by several gender role self-concept scales in past decades (e.g. Bem, 1974; Spence & Helmreich, 1978; Spence, Helmreich & Holahan, 1979), as well as in most recent publications (e.g. García-Cuetoa et al., 2015; Kachel, Steffens & Niedlich, 2016; Krahé, Berger & Möller, 2007).

Closely associated with the gender role self-concept is the agency-communion approach, with agency referring to self-assertion, instrumentality and a sense of separateness as typical traits for men, and communion to relatedness and a desire for union with others as typical traits for women (Bakan, 1966). Sout, Grunberg and Ito (2016) examined the relationship between students' stereotypes about science professions and course completion in science fields. Their results provided evidence that STEM careers were more closely associated with agency-related traits (like self-direction and self-promotion) than with communion-related traits (like working with—and for—the betterment of others). In line with these results, Yang and Barth (2015) found that "people" jobs (working with and for the well-being of others) were perceived as more likely to achieve communal goals than "thing" jobs (working with and for the functionality of machines). Additionally, "thing" jobs were also perceived as more likely to achieve agentic goals than "people" jobs. From these results, Yang and Barth concluded that the different perceptions of "people" versus "thing" jobs—linked with communal versus agentic goal orientations—demonstrate the observed gender-specific career choices, even within different STEM domains. Thus, they conclude, women are more likely to prefer communally-oriented "people" jobs (e.g. biology, or life sciences), while men will prefer agentic-oriented "thing" jobs (e.g. computing, or engineering).

Accordingly, Diekman, Brown, Johnston and Clark (2010) showed that STEM careers—relative to other careers—are perceived to impede communal goals and that a communal-goal orientation negatively impacts STEM careers, even when taking into account past experiences and self-efficacy in science and mathematics. Prior research, indicating women's preference for careers affiliated with communion and men's preference for careers affiliated with agency, underpins these findings (Lippa, 1998; Morgan, Isaac & Sansone, 2001). Interestingly, Yang and Barth (2015) demonstrated in the research mentioned above that female undergraduate students completed a lower proportion of STEM courses than their male fellows did, but this gender disparity disappeared when they perceived greater opportunities for communion. Similarly, Weisgram and Bigler (2006) confirmed that girls who perceive science to be consistent with altruism—and thus linked with communal goals—tend to show increased interest in scientific careers. This means that connecting STEM with communal goals demonstrably helps to increase girls' engagement.

GENDER SELF-CONCEPT AND STEM STEREOTYPES: "FITTING IN" AS IDENTITY REGULATION

Complying with the prevailing STEM stereotype—once linked with masculine traits (e.g. Nosek et al., 2009; Forgasz et al., 2014)—means for most girls going against their gender role identity (e.g. Kessels, 2005, 2015; Kessels et al., 2014). Although expectations of adherence to traditional gender roles has generally been on the decline (Swim, Mallett, Russo-Devosa & Stangor, 2005), violations of gender role norms—such as men acting shyly or displaying insecurity in social situations (Moss-Racusin, Phelan & Rudman, 2010), or women working in non-traditional occupations (Becker, 2010)—still lead to social sanctions and rejection (Parks-Stamm, Heilman & Hearns, 2008; Parrott & Gallagher, 2008; Parrott, Peterson, Vincent & Bakeman, 2008).

In this research, we use the Interests as Identity Regulation Model (IIRM; Kessels & Hannover, 2004; Kessels et al., 2014) as a framework with which to explain girls' disengagement from STEM as the result of a perceived mismatch between their gender self-concept (or identity) and the masculine stereotyping of STEM fields, such as computing. The IIRM states that students seek to construct and extend their self-concept with social content that is compatible with their view of who they are (actual self), or who they would like to be (desired self). Preferring certain school subjects—and disliking others—helps students to develop and demonstrate their identity, not only as an individual, but also as a member of the social group to which they belong (Kessels et al., 2014).

Gender is one of the most powerful social categories impacting human behavior and cognition (Fiske, 1998). As students constantly receive feedback about their behavior from their social environment, from an early age, they build up self-knowledge about what kind of behavior is appropriate for their gender. The IIRM suggests two main factors that influence students' academic interests: the students' perceived image of the subject field, and socially shared attitudes towards the characteristics of a typical student who likes specific school subjects—the so-called prototype (Kessels & Hannover, 2004; see also Kessels et al., 2014). Several studies have shown strong correlations emphasizing the masculine image of STEM subjects such as mathematics and physics. For example, when students are asked whether they perceive mathematics as more appropriate for girls or for boys, most students opt for boys (e.g. Martinot, Bagès & Désert, 2012). Studies using implicit measurements have justified this strong association between masculinity and mathematics (e.g. Ambady, Shih, Kim & Pittinsky, 2001; Cvencek, Meltzoff & Greenwald, 2011).

Unlike stereotypes, which focus on the characteristics of an entire group, a prototype describes just one person who is considered particularly representative of the group in question (Cantor & Mischel, 1979). As Hannover and Kessels (2004) have shown, students have in mind particular prototypes with regard to the sciences, and these prototypes influence their perception of school subjects. For instance, students describe prototypical students disliking mathematics, physics and chemistry more positively than students liking these subjects, whereas the opposite is true for the fields of German and English. Moreover, when students evaluate prototypical male and female peers who like physics, they attribute more masculine than feminine traits to them; they display the opposite pattern when asked to rate prototypical male and female peers who favor music (Kessels, 2005).

A central assumption of the IIRM is that students are more likely to engage in domains they perceive as fitting their (actual or desired) self-concepts (Kessels et al., 2014). This "underlying fit" mechanism is described in the self-to-prototype matching paradigm (Niedenthal, Cantor & Kihlstrom, 1985) that students conduct when making educational choices (see also Kessels, 2005; Kessels et al., 2014). In order to choose between several options—e.g. in the case of a free choice of school courses—students imagine the subject field's prototype and compare it with their own self-view. As a result of this comparison, students choose the option that indicates the highest similarity between the prototype and their self-concept. Kessels's (2005) research found that students preferred physics (as well as music) to the extent that they described themselves as similar to the corresponding prototype. Accordingly, a number of studies have shown that the perceived fit between students' self-concept and a subject field's prototype is a significant predictor of educational decisions, such as the choice of specific subjects as a major field of study (e.g. Hannover & Kessels, 2004; Kessels & Taconis, 2012).

Consequently, when it comes to free choice, the effects of gender stereotypes are particularly evident. Abbiss (2009) showed that more choice in the ICT curriculum in secondary school leads to less ICT-participation by girls. Conversely, research suggests that when students are required to take science-related A-level subjects, the proportion of female students entering science courses at university increases (van de Werfhorst, Sullivan & Cheung, 2003; for an overview, see Yazilitas et al., 2013). In Europe, computing is part of the school curriculum in only 12 out of 20 countries (Balanskat & Engelhardt, 2014). In German schools, computing is an optional subject and many courses are part of extracurricular activities. Thus, gendered patterns in computing in Germany should also be considered a result of free choice.

THE PRESENT RESEARCH

This study aims to explain gendered patterns in educational choices with a focus on coding by combining the agency-communion approach (Bakan, 1966) with the self-to-prototype matching paradigm (Niedenthal et al., 1985). To this end, we developed two coding course descriptions with the same objective (learning how to code), but in two different contexts: one course description focused on a communal goal ("helping old people"), while the other was linked with an agentic goal ("participating in a competition"). We expected that girls would show greater interest in the communal goal-focused coding course than in the agentic goal-focused coding course, while the converse should be true for boys.

In order to understand the psychological mechanism causing this gendered pattern of educational choice, we investigated whether the goal (i.e. agentic versus communal) affects the self-to-prototype similarity. Our assumption was that girls would feel a greater affinity with the communal coding prototype, whereas boys would feel a greater affinity with the agentic coding prototype. Thus, we tested the hypothesis that self-to-prototype similarity works as a mediator between the genders, and interest in learning how to code (communion-focused versus agency-focused prototype respectively).

METHOD

Participants

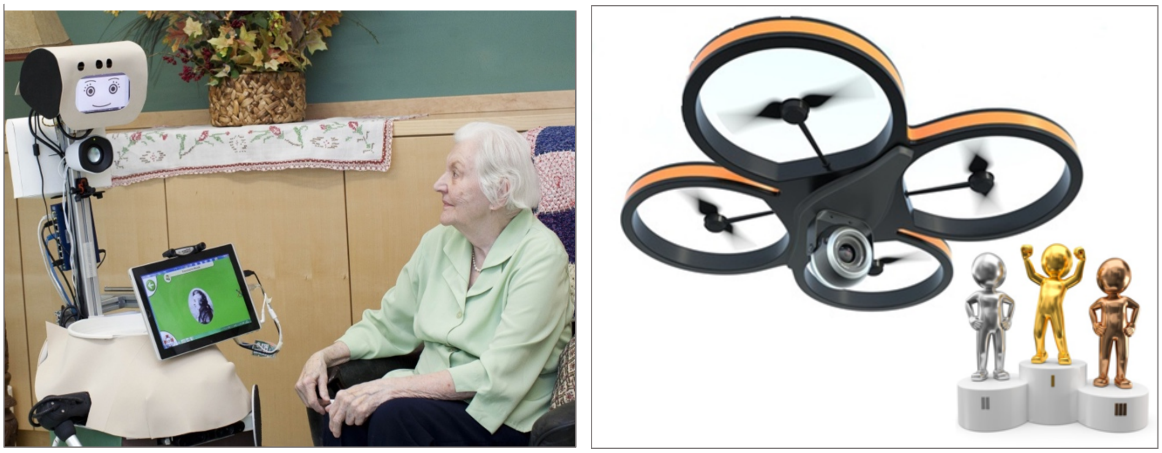
A total of 459 students from 27 classrooms in ten secondary schools in the German federal state of Brandenburg participated in our study (54% boys; 46% girls). The mean age of the students was M = 15.2 years (SD = 0.8). With 62%, the majority of students attended the upper school track (*Gymnasium*), while 38% came from a lower school track (*Oberschule*). For recruitment, we contacted all 200 upper and lower school tracks in Brandenburg and asked for support (5% response rate). The survey was approved by the German state authority responsible for school surveys—the Ministry of Education, Youth and Sports.

Questionnaire Measures

Students completed our questionnaire during a regular consecutive classroom lesson. First, they were asked to describe themselves by rating masculine (e.g. "risk-seeking") and feminine trait adjectives (e.g. "fond of children"), the two subscales measuring the gender role self-concept (Kessels, 2005) on a 7-point scale from 1 (not typical at all) to 7 (very typical). The internal consistency of both subscales was good ("feminine" scale with 15 items, α = .81; "masculine" scale with 15 items, α = .85).

Following the self-descriptions, each student was confronted with two coding course descriptions that varied contextually. In the communion-focus setting, students read the description of the coding course "Roberta, the robot," which contained the following text: "Roberta is a remote-controlled robot, helping old people to cope better with their daily lives. Roberta brings food and beverages or can clean the rooms. You just have to do the coding for it!" In the agency-focus setting, students read the description of the "Drone XF10f": "Drone XF10f is a remote-controlled flying object, allowing you to demonstrate your skills in the Olympiad for Informatics. With Drone XF10f, you can fly tight curves and fast aerial maneuvers. You just have to do the coding for it!" Both descriptions ended with the same basic information about the course and its target group: "The two-hour course addresses students who would like to get a first taste of the world of coding or who already have some experience." Each coding course description was accompanied by a matching picture (see Figure 1). In the Roberta setting, we used a picture accentuating the common-benefit significance of coding (working for the betterment of people). In contrast, in the drone setting we stressed the competitive and object-oriented character of the coding course. The two coding course descriptions were presented in random order to prevent sequence effects.

Figure 1: Pictures presented in the coding-course descriptions



(a) Roberta, communion-focus setting (source: APA-Fotoservice/Pauty)

(b) Drone, agency-focus setting (source: lucadp – Fotolia / fotomek – Fotolia)

After each course presentation, students were asked about their interest in participating in the course ("How interested are you in participating in the coding course?"), which was answered on a 7-point scale from 1 (absolutely not interested) to 7 (very interested). Then, the students were asked to rate what they thought a typical (same-gender) student participating in the respective course would be like ("What would a typical student be like who participates in the Roberta course presented here?"; "What would a typical student be like who participates in the drone course presented here?"). To do this, the students used the same 30-trait adjective list per prototype (typical student "Roberta" versus typical student "drone") as the gender role self-concept and gave their ratings again on a 7-point scale from 1 (not typical at all) to 7 (very typical). The internal consistencies of the Roberta-prototype subscales ("Roberta feminine": α = .87; "Roberta masculine": α = .88) and the drone-prototype subscales ("drone feminine": α = .84; "drone masculine": α = .89) were excellent. Finally, students were asked about their sociodemographics.

To check whether the communion-focused Roberta course was perceived as "less masculine"—as intended—we asked the students to rate on a 7-point scale how typical the course was for each gender, with 1 representing the attribute "absolutely typical for boys" and 7 the attribute "absolutely typical for girls." The students evaluated the drone course in the same way.

The Self-to-Prototype Matching Paradigm

The aim of our study was to investigate whether the similarity between the students' self-views and the respective prototype (Roberta versus drone) explains the relationship between gender and interest in the two coding course types. To this end, we calculated the self-to-prototype similarity scores separately for the two prototypes, using Kessels's procedure (for details, see Kessels, 2005, p. 7). Therefore, we computed for each of the 30-trait adjectives the absolute difference between the individual's self-description and the description of the respective prototype, added it up, and divided it by 30. The resulting score indicates the similarity between self-view and prototype with a range between 0 (self- and prototype description are completely alike) and 6 (maximal deviance between self and prototype). In effect, this means that the lower the self-to-prototype score, the higher the similarity between self and prototype.

Statistical Analyses

To test our hypothesis, we used a Structural Equation Model (SEM) with gender as the independent variable (dummy-coded, with male = 0 and female = 1); interest in the Roberta course and interest in the drone course as the two (correlated) dependent variables; and the two self-to-prototype similarity scores (related to Roberta and the drone, respectively) as mediators. Due to our clustered data, with individual students nested within classrooms, we used adjusted standard errors to preclude error rate inflation by using the type-is-complex procedure in Mplus (Muthén & Muthén, 1998–2015). We also controlled for the potential impact of school type. Regression analyses and the SEM were conducted by means of robust maximum likelihood estimation (MLR in Mplus, see Muthén & Muthén, 1998–2015, p. 608). To deal with missing values (less than 3%), we used full information maximum likelihoods for model estimation (Collins, Schafer & Kam, 2001).

RESULTS

Firstly, we evaluated the gender-typicality of the two courses to investigate whether the students surveyed perceived the Roberta course as less masculine than the drone course. Indeed, results demonstrated that the Roberta course (M = 3.4, SD = 1.2) was evaluated as less typical for boys—and thus less masculine—than was the case for the drone course (M = 1.8, SD = 1.4), $F_{(1,455)} = 316.34$, $p < .001$. Secondly, we analyzed the gender-specific interest in participating in the two coding courses and the dependent self-to-prototype ratings. As expected, girls showed a higher interest in the communion-focused Roberta course than in the agency-focused drone course, while boys were more interested in the drone course than in the Roberta course (see Table 1). Accordingly, girls felt a greater affinity with the Roberta prototype (compared to boys), while boys felt more similar to the drone prototype (compared to girls). Boys and girls did not differ significantly in their ratings.

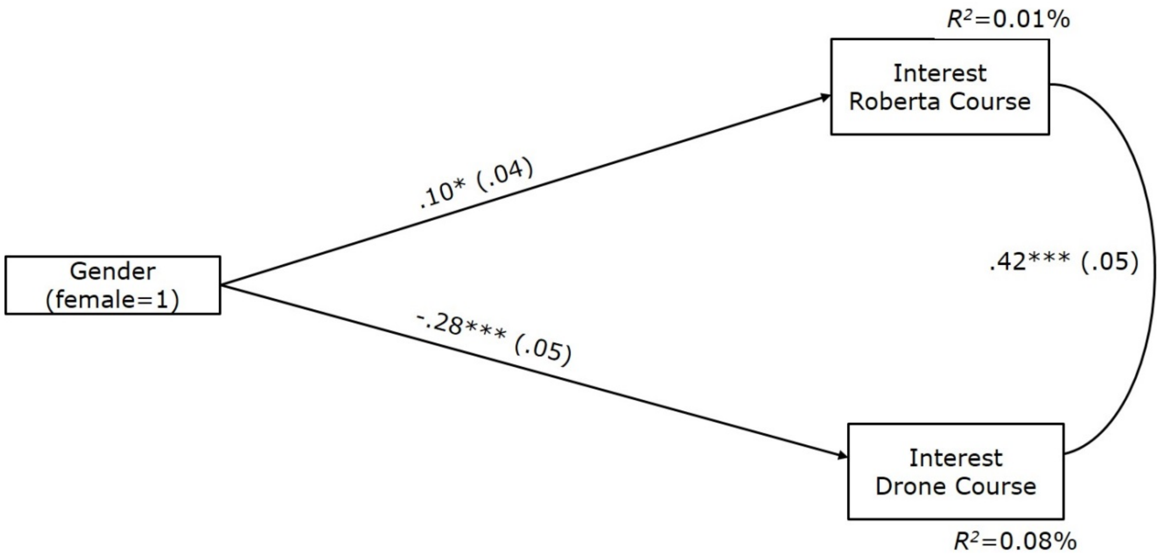
Table 1: Descriptive statistics

	Girls		Boys	
Dependent variables	*M*	*SD*	*M*	*SD*
Interest Roberta course	4.0	1.4	3.5	1.8
Interest drone course	3.7	1.7	4.4	1.5
Self-to-prototype Roberta	2.5	1.3	3.5	1.5
Self-to-prototype drone	3.5	1.5	3.0	1.4

Note: n = 459. A high interest score indicates high interest. A high self-to-prototype score indicates a high deviance between self and prototype.

Finally, we tested the mediation hypothesis by conducting a SEM analysis. The results confirmed the gendered patterns described above. In order to test the mediational effect of the self-to-prototype similarity, we specified two regression models. Firstly, we analyzed the effect of gender on the interest in the two coding courses (see Figure 2). The results of this simple model indicated the expected gender effect on interest in the Roberta course (significance level of 0.05) and the drone course (significance level of 0.001).

Figure 2: Structural Equation Model, results of Simple Regression Analysis

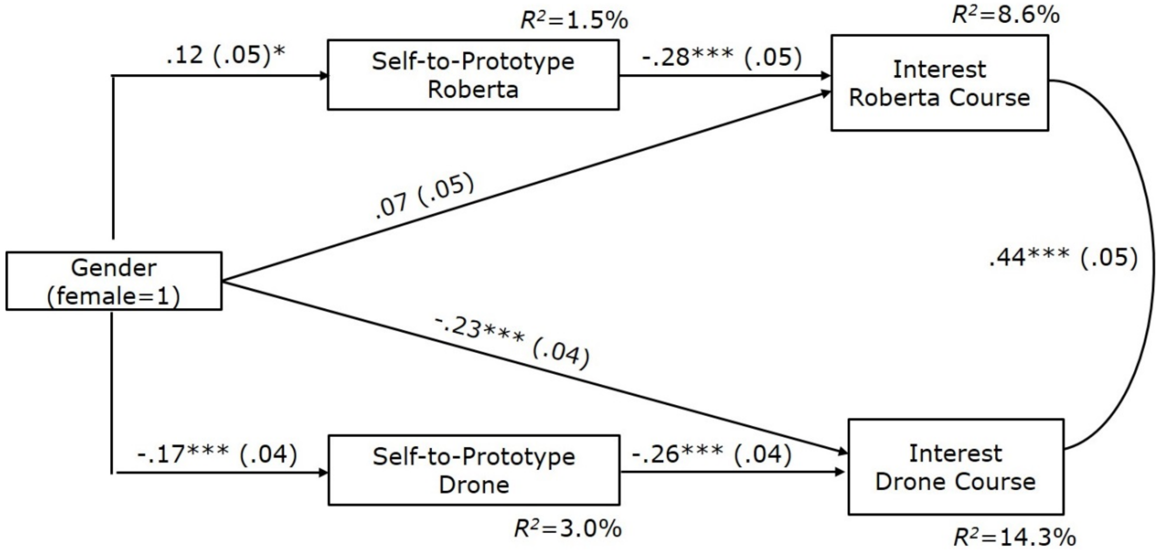


*Note: *p < .05, **p < .01, ***p < .001. N = 459. Values represent standardized regression coefficients (standard errors in parentheses).*

Secondly, we included the two self-to-prototype scores in the model in order to check their ability to mediate the effect of gender on the interest in the two coding courses (see Figure 3). In line with the descriptive results, this full regression model proved that girls felt more similar to the Roberta prototype than to the drone prototype, while boys felt a greater affinity with the drone prototype than with the Roberta prototype.

By entering the self-to-prototype scores into the model, the direct effects of gender on the interest in the two coding courses lost statistical significance: In the case of the Roberta course, results indicate a full mediation—i.e. the related self-to-prototype score reduced the significant relationship between gender and interest in the Roberta course. In contrast, the results regarding the interest in the drone course showed a decreased effect, indicating only a partial mediation, as the relationship between gender and interest in the drone coding course remained significant. Overall, the final regression model (Figure 3) explains a 27.4% variation and shows a good model fit (χ^2 = 6.2, df = 2, p = .05, RMSEA = 0.07, CFI = 0.99, SRMR = 0.03).

Figure 3: Structural Equation Model, results of Full Regression Analysis



Note: *p < .05, **p < .01, ***p < .001. N = 459. Values represent standardized regression coefficients (standard errors in parentheses).

DISCUSSION

In this paper, we examined whether coding courses linked with communal goals were assessed more positively by female students than coding courses associated with agentic goals. We assumed that an association with communal goals would help girls perceive coding (as a specific field of computing) as fitting better with their (feminine) identity and, consequently, show greater interest in learning to code. We deduced this assumption by referring to the agency-communion approach (Bakan, 1966) and the IIRM (Kessels & Hannover, 2004; Kessels et al., 2014). To determine the degree of fit, we used the self-to-prototype matching paradigm (Niedenthal et al., 1985)—a procedure that has already been used successfully to explain girls' dislike of school subjects such as physics (e.g. Kessels, 2005).

Our study extends previous research in several respects. Firstly, to our knowledge there does not exist any empirical research combining the agency-communion approach with assumptions that stem from the IIRM. Secondly, in analyzing students' interest in learning how to code, we focused on a subject that has been only briefly studied in the past, and not from a specific psychological perspective. Finally, unlike most other studies using identity processes as an explanation for girls' disengagement with STEM, we tested a mediational model. That is to say, we analyzed whether self-to-prototype similarity could explain gender-specific evaluations, depending on the contextual setting.

In line with our assumption, girls showed a greater interest in the communion-related Roberta course, while boys felt more attracted to the agency-related drone course. However, with a beta weight size of .10 (simple model) and about 9% explained variance, the effect of gender on the interest in the Roberta course was clearly weaker than the effect of gender on the interest in the drone course. To interpret this finding accurately, it is important to take the evaluation of the two courses into account. So, although the Roberta course was rated as being less typical for a boy than the drone course, it was still rated as more typical for a boy than for a girl.

Consequently, the significant but weak effect of gender on interest in the Roberta course indicates that the course was perceived as less masculine, but still more masculine than feminine. This finding shows that even the feminine label created by naming the communion-related course "Roberta"—familiar as a female name—was not sufficient to influence its evaluation as actually more typical for a girl than for a boy. The shared perception of coding courses as masculine, independent of their contextual embedding, is also illustrated by the significant correlation between the two course ratings. Thus, our results regarding the masculine connotation of coding is in line with findings focusing on other STEM domains, such as physics (Kessels, 2005) and mathematics (e.g. Ambady et al., 2001; Cvencek et al., 2011; Martinot et al., 2012).

A similar pattern also appears in relation to the mediational model including the two self-to-prototype scores. Here again, we found a slightly weaker gender effect on the communal, Roberta-associated self-to-prototype rating than on the agentic, drone-related self-to-prototype score. However, in both cases the self-to-prototype similarity scores accurately predicted the interest in the two coding courses. This result underlines the validity of the IIRM (Hannover & Kessels, 2004; Kessels & Hannover, 2004, Kessels et al., 2014), which states that students are more likely to engage in subjects they perceive as fitting their self-image. Moreover, our results are consistent with findings focusing on other STEM domains. For example, Kessels (2005) found a strong correlation between self-to-prototype similarity and the extent to which students preferred physics. Furthermore, Kessels and Taconis (2012) supplied empirical evidence for the perceived similarity between a typical science teacher and students' self-concept, and its influence on the choice of a mathematics or physics major.

However, our mediational model revealed results that are not completely in line with our assumptions. While we found a full mediation effect with regard to the prediction of interest in the Roberta course (keeping in mind the overall smaller effect of the link between gender and interest in the course), only a partial mediation effect was found for the prediction of interest in the drone course. Considering that the full mediational model explained about 27%, it becomes apparent that alternative variables unaccounted for might have played a role in predicting the students' interest in the two courses. For example, the students might be influenced in their choice by their perceived likelihood of succeeding in learning to code, or by their expectation of experiencing negative treatment from peers who do not favor coding. Both aspects refer to the expectancy-value model (Eccles, 1987), which, in addition to self-similarity, is known to be powerful in predicting educational choices.

A large number of studies place the "leaky pipe" at the starting point, which refers to the loss of women from STEM at various stages from childhood through mid-career (e.g. Berryman, 1983; Blickenstaff, 2005). With this research, we focused on an early life stage—a focus that helped us to understand the selection of science-related courses and majors. It was our intention to investigate psychological mechanisms that are able to explain gender differences in the choice of extracurricular activities in STEM, such as coding, which is optional in German schools. In so doing, we focused on one possible entrance to the STEM pipeline. Thus, our results do not provide information about what happens to girls once they have entered it. For example, our findings show that linking a coding-course description with communal goals leads to greater interest among girls. This effect could be an important door opener, but it is necessary to keep in mind that communion-linked course descriptions might set the wrong expectations. For example, girls may recognize that coding is mainly a "thing" activity and that working for the betterment of people—an important value particularly for women (e.g. Sout et al., 2016; Yang & Barth, 2015)—does not necessarily mean working with people.

As our study features a cross-sectional design, showing results from a given sample group at a specific point in time, our results do not give insights into developmental processes and the effects of intervention over time. Moreover, as we decided to contrast the two conditions in the course descriptions (communal versus agentic focus), we missed the chance to determine the baseline—that is to say, the overall gender effect, independent of the goal. By doing so, we are not able to compare the students' gender-specific interest in the two goals to their interest in coding courses in general.

We consider the participation in coding courses at school to be a potential first step toward entering the so-called STEM pipeline. Furthermore, science competitions such as the German *Jugend forscht* ("Youth Research," see http://www.jugend-forscht.de/information-in-english.html) are seen as popular instruments designed to foster student engagement in STEM. In contrast, our findings clearly indicate that science competitions are particularly appealing to boys, appealing to traits such as "competiveness" and "dominance" that are considered typical for the male gender role (e.g. Bem, 1974; Eagly & Karau, 2002; Krahé et al., 2007). Conversely, our findings suggest that linking course descriptions with communal goals in line with feminine gender role attributes has a motivating effect on girls. While our study focused on the choice of an extracurricular coding course and the underlying processes of identification influencing entrance to the STEM pipeline, further research should address the development of identification with the related STEM domain during and at the end of measurements. So, as identification is a relevant predictor for entrance into the STEM pipeline, it can be presumed that leaving the pipeline likewise stands for a dis-identification with STEM. Thus, better knowledge about the effects of STEM programs on the engagement of girls in consideration of moderators and mediators (such as identity regulation processes) over time is still needed (see also Williams, 2014).

CONCLUSION

Our findings underscore the way STEM courses are contextually embedded. An agentic context highlighting masculine traits (such as competiveness) addresses boys in particular, while a communal framing linked with feminine traits (such as helping others) leads to increased interest among girls. This gender-specific outcome is—at least partly—caused by the sense of affinity students perceive when they think about a typical student who participates in the (agency- or communion-) related course. Thus, our study provides recommendations for the arrangement of student course descriptions that might represent an important first step into the STEM pipeline at middle-school age.

ENDNOTES

[1] It should be noted that the situation differs markedly between countries. In Germany, for example, the proportion of female students in the physical sciences is still 27% lower than the OECD average (Statistisches Bundesamt, Destatis, 2015/2016).

[2] PISA 2015 defines science as "the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" (OECD, 2016b, p. 50). Science performance refers to "competencies to explain phenomena scientifically, to evaluate and design scientific enquiry, and to interpret data and evidence scientifically" (OECD, 2016b, p. 50).

[3] Nosek et al. (2009) used the Implicit Association Test (IAT) for their study, which was designed by Greenwald, McGhee and Schwartz (1998) to detect the strength of a person's ability to make automatic associations between mental representations of objects (concepts) in memory. The IAT is mainly used to avoid biased results caused by socially desirable responses, for example in studies examining prejudices.

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