Implicit gender-science stereotypes and college-major intentions of italian adolescents

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Abstract

Gender stereotypes are often viewed as one of the root causes of the gender gap in STEM. According to Eccles' model, they would indirectly influence major choices by shaping expectations of success and values attached to the viable options. However, empirical findings on the link between implicit gender-science stereotypes and college major intentions are limited. To fill this gap, the current study examines this association in a mixed-gender sample of 302 Italian high-school students. Logistic regression analysis revealed that implicit gender stereotypes were directly associated with females' intention of majoring in STEM. Unlike previous findings, the mediation analysis could not confirm that other relevant factors, i.e., interest in the subject, performance at school, identification with the subject, and value attributed to the job's salary and social utility, moderated this association.

Keywords Gender stereotypes · STEM participation · College-major choice · STEM gender gap · Gender-science stereotypes

1 Introduction

The issue of the gender gap in STEM (Science, Technology, Engineering, and Mathematics) is notorious but still puzzling. In the last years, many studies have investigated the causes and proposed various solutions to reduce the underrepresentation of women in STEM, while the counterpart underrepresentation of men in female-dominated fields has only recently gained attention (Chaffee et al., 2020; Dunlap & Barth, 2019; Heyder et al., 2017; Kalokerinos et al., 2017).

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Various and often interrelated factors explaining this gender gap have been proposed. While early scholars argued that differences in performance, interests, and preferences were due to biological characteristics (Lueptow et al., 1995), more recent research has focused on socio-cultural factors, especially on gender stereotypes that frame societal expectations on attitudes and behaviors of both women and men (Guiso et al., 2008; Kersey et al., 2019; Reinking & Martin, 2018; Spelke, 2005; Wang & Degol, 2017).

Gender stereotypes, defined as beliefs that people have about the characteristics of males and females (Martin & Dinella, 2001), can be endorsed both at the conscious (explicit) and unconscious (implicit) level. While explicit gender stereotypes are self-reported, thus conscious, beliefs about gender differences in abilities, interests, and attitudes related to STEM, implicit gender-science stereotypes are automatic beliefs about the association between gender and STEM (Whitley & Kite, 2016). Focusing on the latter, previous studies have found an association between implicit gender-science stereotypes and females' performance in scientific tasks and attitudes toward math (Cvencek et al., 2015; Kiefer & Sekaquaptewa, 2007; Nosek & Smyth, 2011; Smeding, 2012). All these factors eventually contribute to women's progressive abandonment of the scientific field, both in educational and professional choices.

As theorized by Eccles' model of achievement-related choices (Eccles, 1983), stereotypes would indirectly influence career-related and educational choices through expectations of success and values attached to the viable options, i.e., perceived utility, interest, identification, and the cost related to the choice. While studies on implicit gender-science stereotypes have suggested an indirect association of these stereotypes with major choice (e.g., Cundiff et al., 2013), research on explicit gender-science stereotypes also indicated a direct association between stereotypes and major choice (e.g., Plante et al., 2013).

Unfortunately, the focus of academic research and policies has been on women's aspirations in the STEM sector, thus neglecting the gender gap in humanities-related sectors. Indeed, instruments measuring implicit gender-science stereotypes report the difference in the time needed to associate men with STEM and women with humanities, and the time needed to associate men with humanities and women with STEM. However, evidence of the link between (implicit) gender-science stereotypes and men's intentions of choosing an educational or professional path in humanities is almost absent (Chaffee et al., 2020; Kalokerinos et al., 2017). On the other hand, the gender gap in humanities persists and, in some domains, even to a higher extent compared to the gender gap in STEM (Bothwell et al., 2022). There is, thus, the need to understand whether, similarly to what has been found for women in STEM, men's underrepresentation in humanities is related to the endorsement of gender stereotypes.

This study aims to examine the direct and indirect association between implicit gender-science stereotypes and major choice intentions of both female and male high-school students. It contributes to the existing literature in two ways: first, it includes both male students and female-dominated majors, thus contributing to the scarce literature on the association between gender stereotypes and the gender gap in humanities. It then provides evidence of the direct association between implicit gender-science stereotypes and major intentions.

2 Theoretical background

2.1 The gender gap in STEM majors

At the end of high school, students usually face the first important choice of their life, i.e., whether they want to enroll at university or start a professional path. In both cases, their choice depends on personal characteristics, extrinsic factors, e.g., opportunities and salaries, and interpersonal relationships (Akosah-Twumasi et al., 2018). In this context, women and men differ both in their choices and in the type and the extent to which various factors are involved in the decision.

In almost all countries, men tend to choose more prestigious academic tracks, which are also those more math- and science-intensive (Buser et al., 2012). Conversely, women are more inclined to choose majors with a strong social and communal component and/or majors in which reading and language skills are required (AMACAD, 2015; Okahana & Zhou, 2017). If we look at the distribution of men and women in STEM-related majors, the underrepresentation of women is prominent. In Italy, female undergraduates are 14% in IT, 26% in engineering, and 31% in physics. The opposite pattern is observed in female-dominated fields. Male undergraduates are 7% in education, 15% in modern languages, 17% in psychology, and 39% in literary studies (AlmaLaurea, 2021).

2.2 Implicit gender-science stereotypes

One of the most relevant factors explaining the gender gap in STEM is the endorsement of gender-science stereotypes (Wang & Degol, 2017). Gender stereotypes can be defined as beliefs that people have about the characteristics of males and females (Martin & Dinella, 2001). In the context of STEM, gender stereotypes are beliefs that associate the STEM domain with men (Nosek et al., 2009). They can be endorsed both at the explicit and the implicit level. In the first case, the endorsement is conscious while in the second case it is unconscious and automatic (Whitley & Kite, 2016). Furthermore, explicit gender-science stereotypes usually assess beliefs about the different abilities of women and men, the former being naturally talented for reading or language-related tasks, the latter being naturally talented for math-related tasks (Schmader et al., 2004). Conversely, implicit gender-science stereotypes are measured as the automatic association of men with the STEM domain, and women with the humanities domain (Nosek et al., 2009). In this context, a stronger endorsement of implicit gender stereotypes means that it is easier for the individual to automatically associate men with STEM and women with humanities, than the opposite – men with humanities and women with STEM (Greenwald et al., 2003).

This study focuses on implicit gender-science stereotypes. Previous studies tested the association of these stereotypes with several factors. Nosek and Smyth (2011) found that women's endorsement of stronger implicit math=male stereotypes was associated with greater negativity toward math, weaker self-ascribed ability, and worse performance in math, as measured by the standardized exams assessing readiness for college, SAT, and ACT. Ramsey and Sekaquaptewa (2011) measured college students' endorsement of the automatic association of male/female with math/

humanities, both before students' first midterm exam and their final exam. They found that students' endorsement of implicit gender stereotypes was stronger at the end of the year. Furthermore, in the case of female students, the change in implicit stereotypes was negatively associated with performance in a calculus course. Steffens et al. (2010) measured the association of domain (math vs. language) with gender (male vs. female) endorsed by German students enrolled in the 4th, 7th, and 9th grades. They found that stronger implicit math-gender stereotypes predicted girls' higher school grades in German compared to math, enrollment preferences toward advanced courses in German rather than math, and math self-concepts, i.e., the automatic association of the concepts "I" vs. "other" with math/German domains. Finally, Cvencek et al. (2015) measured the endorsement of implicit math-gender stereotypes (math=boys) of Singaporean elementary-school children (Grades 1-5). They found that stronger implicit gender stereotypes were significantly correlated with stronger math self-concepts for male students and weaker math self-concepts for female students. Furthermore, in the case of girls, they found a negative association between implicit stereotypes and math performance in school.

2.3 Implicit gender stereotypes and educational choices

Empirical evidence has confirmed the existence of an association between (implicit) gender-science stereotypes and educational choices in STEM. Two studies (Dunlap & Barth, 2019; Smeding, 2012) found that female students majoring in STEM held weaker implicit gender-science stereotypes than women majoring in more feminine fields. Smyth et al. (2009) found that female college students with stronger implicit gender-science stereotypes were less likely to major in science, whereas the opposite occurred for male students, who were more likely to major in that sector. Interestingly, implicit gender stereotypes were a stronger correlate of science major than was math SAT.

More specifically, the intrinsic or interest value is defined as the enjoyment deriving from engaging in an activity (Eccles, 1983), while the attainment value is defined as "the value an activity has in manifesting one's social or personal identities and core values" (Eccles, 2011, p. 197). The utility value is described as the importance of the task for future goals (Eccles, 1983). In the context of STEM and humanities-related fields, a long-standing debate exists on the "communal goal incongruity", i.e., the idea that STEM-related careers do not offer the opportunity to fulfill communal, other-oriented goals, whereas they are instrumental for other goals, e.g., higher social status and salary (Diekman et al., 2017). Many studies found that women tend to value more communal goals when choosing educational and career paths (Diekman

The mechanism through which gender stereotypes would affect educational (and career-related) choices is described in the model of achievement-related choices proposed by Eccles (1987; 1994). According to this model, educational and vocational choices are determined by both expectation of success in the task and what Eccles called subjective task values (STV), i.e., "the value individuals attach to various achievement-related options they believe are available to them (Eccles et al., 1999, p. 163). STV are further dived into four components: (1) utility value, (2) intrinsic value, (3) attainment value and (4) the cost deriving from engaging in the task.

et al., 2011), whereas men usually value a higher salary (Briel et al., 2022). Being the STEM area characterized by above-average salaries (U.S. Bureau of Labor Statistics, 2021) and the humanities area traditionally considered a social-oriented area (Nussbaum, 2012), we could expect that job's salary and social utility would be among the main goals that STEM and humanities, respectively, can help perspective students to fulfill.

Both expectations of success and STV are the outcome of personal experiences and perceptions which are, in turn, determined by stereotypes and other relevant people's beliefs and behaviors, e.g., parents, teachers, role models, and peers (Eccles, 1987). Therefore, according to this model, gender stereotypes would indirectly influence educational choices by influencing expectation of success, perceived utility of the course, interest in the subject, identification with the course's field, and the cost of choosing one course rather than another.

Previous studies found evidence for the application of Eccles' model in the context of the STEM gender gap. In a study on college students, Lane et al. (2012) found that the gender gap in students' intentions of pursuing science was completely accounted for by implicit gender stereotypes. However, for women, this association was mediated by implicit identification with science. Similarly, Young et al. (2013) found an indirect and negative association between implicit science stereotypes and women's career aspirations. The association was mediated by both implicit and explicit attitudes toward and identification with science, the former referring to positive or negative feelings towards the scientific field (e.g., "I very much like doing science'") and the latter to the association between the self and the scientific field (e.g., "'In general, being a science student is an important part of my current self-image"). Cundiff et al. (2013) found that among women enrolled in an introductory science course, stronger implicit gender-science stereotypes were associated with weaker science identification and, in turn, weaker science career aspirations.

Despite the assumptions of Eccles' model, in some studies both direct and indirect paths between gender-science stereotypes and career intentions were found (e.g., Plante et al., 2013). However, stereotype endorsement in those studies was measured using self-reported rather than implicit instruments. It is thus unclear whether implicit gender stereotypes are also directly associated with college-major choices. Unlike previous studies on the theme, this study tests both the direct and indirect association between implicit gender-science stereotypes and educational choices.

Furthermore, in all studies testing the association between implicit gender-science stereotypes and major choices the sample consisted of undergraduate or graduate students, in some cases already majoring in STEM. It would be interesting to test whether the association also holds for younger students who are required to choose what they want to major in. In this context, Eccles' model would help predict students' final choices. This is why the sample in this study included high school, rather than college, students.

2.4 Men's gender stereotypes and educational choices

As mentioned before, implicit gender-science stereotypes are usually derived from the comparison of the time needed to automatically associate men with STEM and

women with humanities and that needed to associate men with humanities and women with STEM (Greenwald et al., 1998). What is measured is then the relative strengths of pairs of associations rather than the absolute strength of a single association (Greenwald & Farnham, 2000). In this case, we consider "complementary stereotypes" (Jost & Kay, 2005), one attributing a strength to males (and a weakness to females), i.e., having a feel for math/science, the other attributing a strength to females (and a weakness to males), i.e., having a feel for reading/verbal tasks.

Plante et al., (2009) found that when asked about the maleness and femaleness of math and language domains, elementary and high school Canadian students did not believe that mathematics was a male domain, while they clearly viewed language as a female domain. Conversely, in a study testing implicit gender stereotypes separately for math domain and language domain on a sample of adolescents and college students, Steffens and Jelenec (2011) found that males endorsed implicit math-male stereotypes. On the contrary, females revealed a strong language-female implicit association, whereas males showed language-male counterstereotypes, i.e., a strong association between men and language.

The relevance of gender-science stereotypes for men has been rarely of interest. Studies on the STEM domain with a mixed-gender sample reported also results on male participants. For instance, a study conducted by Cundiff et al. (2013), mentioned before, reported an opposite result for men compared to women. Stronger implicit gender-science stereotypes were associated with higher science identification and, in turn, with stronger science career aspirations. However, the gender gap in humanities, favoring women, has only recently gained attention, with only a few studies testing whether gender stereotypes are keeping men away from female-dominated majors and careers (Chaffee et al., 2020; Chaffee, Lou, Noels, et al., 2020).

Furthermore, existing studies were more interested in traditional gender ideologies, linked with gender stereotypes on occupational choice, rather than specifically on gender-science stereotypes. These gender ideologies refer to the traditional attribution of agentic qualities to men and communal qualities to women, the former referring to a goal-achievement and self-orientation, the latter referring to caregiving and others-orientation (Abele & Wojciszke, 2019; Sczesny et al., 2018). This dichotomy would explain women's overrepresentation in occupations requiring social skills, e.g., humanities-related, and men's overrepresentation in things-oriented occupations, e.g., STEM-related.

Therefore, this study aims to contribute to the growing literature on gender stereotypes and men's choices by giving information on the link between implicit gender-science stereotypes and the major intentions of men in the humanities field.

3 Research questions and related hypotheses

This study aims to investigate the association between implicit gender-science stereotypes and major choice intentions of a sample of Italian high-school students. In particular, the three following research questions are considered:
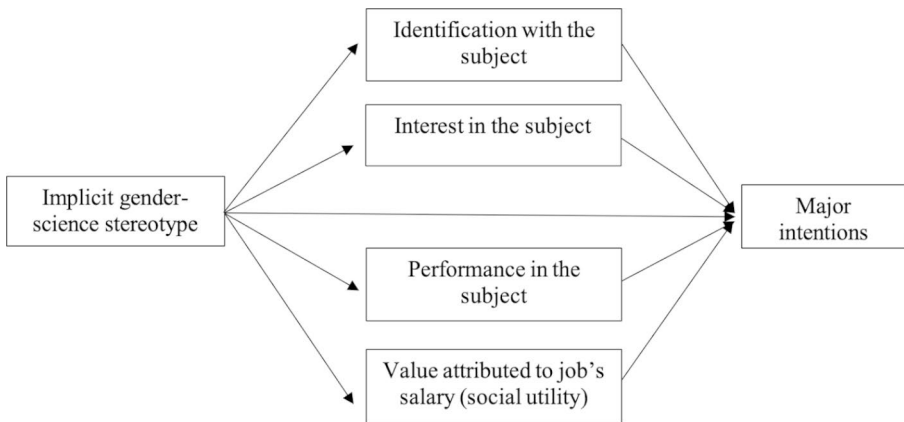
Fig. 1 *Estimated model with direct and indirect links*

1. Are implicit gender-science stereotypes associated with students' intentions of majoring in STEM and humanities?
2. Are there gender differences in the way and the extent to which implicit gender-science stereotypes are associated with major intentions?
3. Is the association mediated by identification with the field (STEM/humanities), interest in the field, performance in the related school subject, and value attributed to job salary or its social utility?

Figure 1 shows the estimated model, with hypothesized direct and indirect links.

As regards questions 1 and 2, it was expected that implicit gender-science stereotypes were associated with major intentions in both male- and female-dominated fields, with different, opposite results for men and women. In particular, it was hypothesized a positive association in humanities for female students, negative for male students, and the opposite association in STEM.

As regards question 3, based on Eccles' model (1987; 1994), it was expected that the association between gender stereotypes and career choice was mediated by other factors. Here the mediating role of three of the factors mentioned in the Eccles' model is tested, i.e., (1) identification with the field – attainment value, (2) interest in the related school subjects – intrinsic value, and (3) value attributed to job salary, or social utility in the case of humanities – utility value. Finally, a fourth variable – performance – was included among the mediating variables, given that most studies on implicit gender stereotypes, as summarized in the previous section, highlighted a relevant association between the endorsement of gender stereotypes and academic performance in STEM-related courses.

4 Methodology

4.1 Participants

The sample consisted of 302 Italian students (61% females), aged 18 years old, attending the last year of high school (Level 3, ISCEED 2011) and coming from five schools located in Milan and the surrounding area.

In Italy, there are three types of high school that differ in their academic or vocational scope. All secondary schools have a common set of core subjects and complete the program of study focusing on a specific field, e.g., humanities in *liceo classico*, science in *liceo scientifico*, foreign languages in *liceo linguistico*. Students in the sample came from these types of high schools. The belonging school type does not preclude college-major choice, but it is likely to reflect students' inclinations and interests. Consequently, most students in humanities-oriented schools are females (83%), while the opposite occurs in science-oriented schools (32%). Furthermore, students tend to choose a college major coherent with what they studied in high school. This implies that controlling for the type of school is required when analyzing the association between gender and major intentions.

4.2 Procedure

Data were collected for a larger study on the effect of role models on gender stereotypes. Participants were asked to complete two questionnaires, one before and the other after the exposure to role models. Data in this study came from the pre-treatment data collection. Schools were contacted via mail and with those who accepted to participate two meetings for each class were organized. The data collection lasted about one month, from the end of January 2020 to the end of February 2020, and was conducted on the SoSci Survey platform (Leiner, 2019), which includes a module for performing the implicit association test.

4.3 Instruments

Data were collected through a computer-assisted questionnaire administered in the participants' schools during regular school time. Students were asked to sign an informed consent before answering the questionnaire.

Major intentions. Students were asked whether they intended to enroll in university after high school and, if so, to indicate, among a list of all possible majors, those they were considering. The list included 51 majors taken from the Italian official national list which were then classified into 7 macro-areas, i.e., health, vet or agrarian, STEM, law, economic/statistic, sociopolitical, arts, and humanities. These macro-areas reflect the Italian disciplinary groups in which degree programs are organized at the national level. Those related to STEM and humanities were further grouped to be coherent with the international definition of these domains. The two groups of STEM and humanities were used, separately, as dependent variables, with a value equal to 1 if the student was interested in at least one of the majors in that field, and 0 otherwise.

Independent variable. The main variable of interest was the implicit association between gender and majors. Students were asked to perform the Implicit Association Test, IAT (Greenwald et al., 1998), which is commonly used to assess automatic gender stereotypes (Greenwald et al., 2009). The version of the IAT adopted here is that used in the Project Implicit website for gender-science stereotypes (Nosek et al., 2009), where the target – gender – is represented by male and female names, while the attribute – majors – by STEM-related and humanities-related majors (see the Appendix for the list of stimuli). The variable used in the analysis was the test score, i.e., the so-called IAT D measure (Greenwald et al., 2003), ranging from -2 to 2. More specifically, a negative value in the scale means that the student associated math with females and/or humanities with males more easily (counterstereotypical association), while a positive value means that the student associated math with males and/or humanities with females more easily (stereotypical association). Finally, values around zero indicate that the student did not show any associations between gender and majors. The test consists of 7 blocks, of which only the fourth and the seventh are used to compute the final score, while the others allow the participant to become familiar with the required task. In each block, participants are asked to associate the word appearing in the middle of the screen – stimuli – with the belonging category, either to the left or to the right side of the screen, by clicking the corresponding letter on the keyboard, "E" in the first case and "I" in the second case. In the fourth block, stimuli are both names and majors, and the categories are grouped such that both male names and STEM majors are on the left side of the screen, while female names and humanities majors are on the right side of the screen (compatible association). In the seventh block, one of the categories is switched, i.e., female names and STEM majors are on the left side of the screen, while male names and humanities majors are on the right side of the screen (incompatible situation). Here we followed the suggestion of Greenwald et al. (2003) and increased the number of trials performed in the seventh block from 20 to 40.

Mediators. Four mediating variables were included to test the indirect association of implicit gender stereotypes and major intentions, i.e., identification with the subject, interest in the subject, performance, and value attributed to job salary or social utility.

Identification with STEM/humanities was measured using a battery of items suggested by Brown and Josephs (1999). This included: relevance of the subject, relevance attributed to others' opinion about personal ability in the subject, reaction to a failure in a school test in the subject, the relevance of the ability in the subject for future career and success in college (see the Appendix for the full list of items). All five questions were asked for Italian, math, and science subjects, separately, on a 5-point Likert scale (Cronbach alpha 0.9 in Italian, 0.8 in math, 0.9 in science). Due to multicollinearity issues, math and science were combined to create a unique variable of identification with STEM (Cronbach alpha 0.9).

Interest in the subject was assessed by asking students to indicate, among a list of all possible school subjects, their favorite ones. Two binary variables were then created grouping subjects in the STEM and humanities areas, with a value equal to 1 if the student indicated at least one belonging to that area as a favorite subject, and 0 otherwise.

Performance was derived from the final grade obtained in the previous academic year in Italian, math, and science, as reported by students in the questionnaire. The variable on performance was continuous and ranged from 6 to 10, as students with a final grade below 6 cannot pass to the next year.

Finally, in order to obtain an indicator of the value attributed to a job's salary and social utility, students were asked to indicate the factors that played a relevant role in their decision process for major choice among a list of potential. The list included factors on a future professional path (i.e., variety of career opportunities, job' social utility, salary, prestige), personal characteristics (i.e., interest in the subject, realize a dream, performance in the subject, relevant others' expectations and suggestions), and factors pertaining the program of study (i.e., challenging courses, number of years for graduating, course competitiveness, entry test). Two binary variables were created for salary and social utility, with 1 if the student selected that factor, and 0 otherwise.

Control variables. It was controlled for the type of high school and the mother's level of education. School type was a binary variable taking value equal to 1 for humanities-oriented (female-dominated) schools and 2 for STEM-oriented (male-dominated) schools. The mother's level of education was classified as below high school (value 1), completed high school or equivalent vocational school (value 2), degree and post-degree (value 3).

4.4 Statistical analysis

The association between gender stereotypes and major intentions was tested using two logistic regression analyses, i.e., one on STEM majors and the other on humanities majors. Since students in the sample were nested in school classes, clustered standard errors were used, computed using the cluster bootstrap technique, suggested in the case of few clusters (Cameron et al., 2008; Cameron & Miller, 2015; MacKinnon, 2019).

The analysis was performed in three steps separately for both dependent variables. First, to detect gender differences, a regression model including control and mediating variables was performed and each variable interacted with gender. Subsequently, a model including the implicit stereotype score and its interaction with gender was performed. Finally, a mediation analysis was used to compute the direct and indirect association (MacKinnon, 2012) of implicit gender stereotypes via the four mediating variables. Percentile bootstrap 95% confidence intervals were used for significance testing (Preacher & Hayes, 2008).

Missing data were between 4% (IAT D score) and 10% (identification with the subject) of the total and were estimated using multiple imputation by chained equations (Azur et al., 2011). The number of imputations was set to 20 and the variables included in the imputation model were those included in the regression model. Data analysis was performed using Stata (StataCorp, 2021).

Table 1 Correlations for study variables

	1	2	3	4	5
STEM					
1. Major intentions	–				
2. Performance	.18**	–			
3. Interest	.49***	.14*	–		
4. Identification	.45***	.29***	.51***	–	
5. Job salary	.23***	.10	.18**	.15*	–
6. IAT D score	-.11	.11*	-.14*	-.03	.03
Humanities					
1. Major intentions	–				
2. Performance	.04	–			
3. Interest	.10	.21***	–		
4. Identification	.19***	0.21***	.19**	–	
5. Job social utility	.13*	.01	.13*	.16**	–
6. IAT D score	.09	.07	.03	.06	.11

Note: Pearson correlation in case of a continuous variable, point biserial correlation in case of a binary variable.

5 Results

5.1 Descriptive statistics

Table 1 shows the study variables' pairwise correlations. Implicit gender-science stereotypes were significantly and positively correlated with performance in science at school and negatively with interest in science-related subjects at school. As regards intentions of majoring in STEM, this variable was positively correlated with all the variables included in the model, and the correlations were statistically significant. Conversely, intentions of majoring in STEM were slightly correlated with the variables included in the model, and correlations were statistically significant only in the case of identification with Italian and relevance of jobs' social utility.

5.2 Logistic regression analysis

Regression analysis including an interaction term of gender with all the variables in the model indicated no statistically significant gender differences in the association between the dependent variables and these factors. Therefore, only the interaction of gender with implicit stereotypes was included in the final model. Table 2 shows the results from the analysis of STEM majors' intentions.

Results suggest that identification with STEM, interest in STEM subjects at school, and school grade in science were positively associated with the intention to major in STEM. However, only the first two were statistically significant. The association between major intentions and the relevance of the job's salary on the choice was positive and statistically significant. Not surprisingly, students attending a STEM-oriented high school were more likely to express the intention of majoring in STEM compared to those attending a humanities-oriented high school. The association was statistically significant.

Results on humanities paint a different picture (see Table 3). Among the included factors, only identification with the field and the type of school were statistically significant, while for the other factors we cannot reject the null hypothesis of no

Table 2 Results from logistic regression analysis on STEM majors' intentions

Logistic regression	Estimate	SE	Percentile bootstrap 95% CI		p-value
			LB	UB	
STEM					
Gender [Female]	0.24	0.49	−0.47	1.15	.625
IAT D score	0.35	0.49	−0.74	1.58	.472
Gender*IAT D	-1.44	0.65	-3.39	−0.22	.026
School grade in science	0.29	0.13	−0.07	0.74	.025
Identification with STEM	0.91	0.35	0.39	1.78	.010
Interest in STEM subjects	1.06	0.42	0.24	1.86	.011
Relevance of job's salary	0.73	0.36	−0.14	1.56	.042
Mother's education [a] [below high school]	−0.01	0.52	-1.31	1.05	.981
Mother's education [a] [high school]	−0.52	0.41	-1.33	0.28	.207
Type of school [b] [STEM-oriented]	1.04	0.36	0.24	2.06	.004

Note: Total $N=302$; Estimate reports the log odds.

SE=Bootstrap standard errors; CI=Confidence interval; LB=Lower bound; UB=Upper bound.

[a] Reference category "Above high school".

[b] Reference category "Humanities-oriented"

association. As expected, a higher identification with the humanistic field is associated with a higher probability of expressing the intention of majoring in humanities. Furthermore, students attending a humanities-oriented high school were more likely to be interested in majoring in humanities compared to those attending a STEM-oriented high school.

As regards gender and implicit gender stereotypes, both were not statistically significant in either model, while the interaction term was statistically significant in both models. The absence of a statistically significant result for the main effects suggests that implicit stereotypical beliefs have the opposite association for the two genders. Marginal effects were computed to understand how males and females differ and whether the association was statistically significant. Table 4 shows the average marginal effect (AME) of implicit gender stereotypes on major choice intentions for male and female students separately. Confidence intervals (CI) can be used to determine the significance of the marginal effect, i.e., when the CI did not include zero, the marginal effect was statistically significant.

As expected, implicit gender stereotypes were negatively associated with female students' STEM major intentions, while confidence intervals suggest that the association between implicit gender stereotypes and major choice intentions in the case of male students and humanities was not statistically significant.

5.3 Mediation analysis

Finally, a mediation analysis was performed to check whether the association between implicit gender stereotypes and major choice intentions was mediated by other fac-

Table 3 Results from logistic regression analysis on humanities majors' intentions	Logistic regression	Estimate	SE	Percentile bootstrap 95% CI		p-value
				LB	UB	
	Humanities					
	Gender [Female]	0.45	0.34	−0.43	1.15	.192
	IAT D score	−0.89	0.53	-2.02	0.32	.087
	Gender*IAT D	1.30	0.49	−0.02	2.95	.007
	School grade in Italian	−0.16	0.10	−0.54	0.12	.111
	Identification with humanities	0.53	0.22	0.14	0.98	.017
	Interest in humanities-related subjects	0.37	0.31	−0.26	1.15	.240
Note: Total N=302; Estimate reports the log odds.	Relevance of job's utility	0.35	0.27	−0.21	0.99	.198
SE=Bootstrap standard errors; CI=Confidence interval; LB=Lower bound; UB=Upper bound	Mother's education [a] [below high school]	−0.05	0.46	-1.22	1.36	.919
[a] Reference category "Above high school"	Mother's education [a] [high school]	−0.60	0.27	-1.32	0.13	.025
[b] Reference category "Humanities-oriented"	Type of school [b] [STEM-oriented]	−0.78	0.33	-1.56	−0.19	.017

Table 4 Average marginal effect of implicit stereotypes on major intentions by gender		AME	SE	Percentile bootstrap 95% CI	
				LB	UB
	STEM				
	Male	0.052	0.073	−0.127	0.233
Note: AME=Average marginal effect; SE=Bootstrap standard error; CI=Confidence interval; LB=Lower bound; UB=Upper bound.	Female	**−0.151**	0.047	−0.346	−0.056
	Humanities				
	Male	−0.107	0.067	−0.260	0.032
	Female	0.106	0.074	−0.096	0.312

tors. Bootstrap 95% confidence intervals suggest that the data could not reject the null hypothesis of no indirect association.

6 Discussion

The gender gap in STEM has progressively gained so much attention to stimulate several initiatives aimed to reduce the underrepresentation of women in this field (UNESCO, 2017). Gender stereotypes are usually considered one of the root causes of this gender gap, thus motivating various initiatives aiming to change gender stereotypes on gendered abilities in math and science. However, empirical findings on the association between implicit gender stereotypes and majoring choices and intentions are scant, with mixed results, and restricted to the case of women and STEM,

neglecting the importance of stereotypes of men in female-dominated fields. This limits our understanding of whether and how gender stereotypes influence women and men's professional paths.

The aim of the study was threefold: verifying the association between implicit gender-science stereotypes and major choice intentions, detecting possible gender differences in this association and understanding whether the association was direct, indirect, or both direct and indirect. The analysis was conducted on a sample of Italian high-school students using logistic regression models and mediation analysis.

Results revealed a statistically significant association of implicit gender stereotypes with major choice intentions only in the STEM field for female students. This is coherent with previous studies on implicit gender stereotypes. For instance, Smyth et al. (2009) found that female college students with stronger implicit gender-science stereotypes were less likely to major in science.

As regards gender differences, results suggest that the association between implicit gender stereotypes and major choice intentions is positive for male students in the STEM field and female students in the humanities field. It is negative for female students in STEM and male students in humanities. However, the association was statistically significant only for female students in STEM. Therefore, the study's results could not confirm the existence of an association between gender stereotypes and educational choices also for men, as found in previous studies. Among others, in the above-mentioned study conducted by Smyth et al. (2009), male college students with stronger implicit gender-science stereotypes were more likely to major in science, compared to those endorsing weaker stereotypes. Similarly, Cundiff et al. (2013) found that stronger implicit gender-science stereotypes were associated with higher science identification and, in turn, with stronger science career aspirations for men included in their sample.

Finally, unlike previous studies (Dunlap & Barth, 2019; Plante et al., 2013) and Eccles' model (1987; 1994) assumptions, in this study, results from the mediation analysis could not reject the hypothesis of no indirect association for any of the included mediating variables. While this could be due to the limitations of the sample – discussed below, the absence of a mediating role for these factors could have relevant implications for initiatives and policies aimed at reducing the gender gap in STEM. If the association of stereotypes with academic-related choices is not mediated by other factors, reducing the stereotypical association of STEM with men should in theory be effective in changing women's participation in STEM courses and careers. On the contrary, in the case of an indirect association mediated, for instance, by identification with the domain, changing the representation of women and men in STEM would not be sufficient to have an impact on women's choices. In this case, interventions should reinforce the individual relationship of women with STEM, whereas showing how other women are successfully involved in STEM activities could be ineffective (Olsson & Martiny, 2018).

The study has contributed to the scarce literature on the link between men's endorsement of gender stereotypes and female-dominated fields. In particular, results suggest that men endorsing strong implicit gender stereotypes are more likely to choose a STEM major and less likely to choose a major related to humanities. However, data could not confirm whether this difference was significantly different from

zero. Future research should examine the mechanism through which stereotypes may be associated with men's choices and whether exposure to role models could be effective in changing these choices.

7 Limitations

Having said this, this study also has limitations. First, the small size of the sample and the cross-sectional nature of data, in particular, limit any generalization. The small sample implies low statistical power, biased effects size estimation, and low reproducibility (Button et al., 2013; Colquhoun, 2014).

Furthermore, the cross-sectional nature of data hampers the possibility to make any inference on causal relationships. As noted by Smyth et al. (2009), longitudinal data has advantages when – as here – the purpose is to understand how stereotypical beliefs evolve and therefore when and how they can be reduced and eventually eliminated. While female students in this sample were more stereotyped than their male peers, these differences disappear when we consider students in STEM-oriented high schools. With a cross-sectional dataset, it is impossible to determine whether female students in humanities-oriented schools were already more stereotyped or strengthened their stereotypical beliefs whenever attending a female-dominated school. Since most studies on stereotypes rely on this type of data, future research should focus on longitudinal data to shed light on the causal inference in the identified paths.

Moreover, when interested in assessing the differences between interest in majoring in STEM and interest in majoring in humanities, the Implicit Association Test is limited, as it does not allow us to disentangle the strength in the association between gender and the two fields of STEM and humanities. In this context, other psychological tests permitting this distinction, e.g., the Go/No go Association Test (Nosek & Banaji, 2001), would have been a better choice. As found by Gilbert et al. (2015), the association between the sense of fit in math and English and the four components of gender-science stereotypes – men-STEM, men-humanities, women-STEM, women-humanities associations – is heterogeneous.

Finally, other factors may mediate the association between gender stereotypes and major intentions, such as those mentioned in the Eccles' model that, however, were not included in this study, i.e., the expectation of success and the cost of choosing one path instead of another.

8 Conclusions

The study confirmed the association between implicit gender-science stereotypes and intentions of majoring in STEM found in previous studies for female students (Jugovic, 2017; Smyth et al., 2009). However, unlike other studies (Dunlap & Barth, 2019; Plante et al., 2013; Schuster & Martiny, 2017; Vleuten et al., 2016), only the direct path between the two was statistically significant.

While the data allowed to confirm the association of gender-science stereotypes with major intentions only for female students, further research is necessary to verify

whether gender stereotypes are also associated with men's attitudes toward female-dominated sectors.

Statements and Declarations

Conflicts of interest/Competing interests The author declares that there is no conflict of interest.

Ethics approval All procedures involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The protocol and the informed consent were reviewed and approved by the Ethics committee of the University of Milan (number 49/19). All participants signed an informed consent before taking part in the study.

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