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Exposing students to professionals working in male- and female-dominated sectors: Effects of an online experiment on Italian high-school students

Elena De Gioannis

Studies on the effect of role models have gained momentum, especially in the STEM sector. However, they have not yielded consistent results. This study contributes to this theme by testing exposure to female and male professionals' video interviews in an online experiment on 325 Italian high-school students. Participants were shown video interviews with professionals working in male-dominated (STEM) and female-dominated (humanities, psychology) sectors. They were randomly assigned to one of the following conditions: (1) only counterstereotypical exemplars (women working in STEM, men working in humanities), (2) both stereotypical and counterstereotypical exemplars (a man and a woman for each sector), or (3) (gender-neutral) transcripts of the interviews. Results were mixed and varied depending on students' gender. Female participants exposed only to counterstereotypical models were more aware of the gender gap in some, but not all, humanistic and engineering-related studies. As regards male participants, those exposed to both counterstereotypical and stereotypical role models tended to perceive a reduced gender gap in psychological studies, while those assigned only to counterstereotypical role models were more likely to perceive a greater gender gap in physics-related studies. Finally, the study did not find statistically significant effects on implicit and explicit gender stereotypes.

Keywords: STEM gender gap, role models, Social Role Theory

Introduction

Research has long emphasised the importance of role modelling and the impact that exemplars may have on people. Eventually, humans' ability to imitate and acquire information from others is 'the reason for our success': 'We are adaptive learners who, even as infants, carefully select when, what, and from whom to learn' (Henrich, 2016, p. 4). More specifically, role models exert their influence on goals and motivation by acting as behavioural models, representing viable paths and being inspirational (Morgenroth, Ryan & Peters, 2015).

Role models play a pivotal role, especially for underrepresented minorities, e.g., women in male-dominated sectors (Murrell, Crosby & Ely, 1999), who dramatically lack examples to aspire to. The Social Role Theory (Eagly & Wood, 2012) posits that the division of labour between genders determines the attribution of gender-based characteristics and roles. This attribution is internalised, eventually resulting in the endorsement of gender stereotypes, which affect choices and behaviours. The persistent gender gap in the STEM (Science, Technology, Engineering and Mathematics) sector would, thus, derive from the observation of the underrepresentation of women engaged in STEM careers. i.e., since STEM professionals are more frequently male, people associate the STEM sector with being a man.

According to this theory, the provision of examples of women employed in male-dominated sectors could change the perception that those jobs are not suitable for women, eventually resulting in a decrease in the gender gap. The study conducted by Miller, Eagly & Linn (2015) on the correlation between women's participation in STEM and gender-science stereotypes in 66 nations confirmed this relationship. Countries with higher female participation in tertiary education in science were also characterised by weaker implicit and explicit gender stereotypes of women and science.

Initiatives and projects involving female role models have gained momentum, especially in the STEM sector. However, research on the effect of role models on women in STEM did not yield consistent results (De Gioannis, Pasin & Squazzoni, 2023; Olsson & Martiny, 2018). Furthermore, to our knowledge, the perception of the representativeness of women in the STEM sector has been rarely investigated. After being exposed to role models, for 10^{th}- and 12^{th}-grade French students, Breda et al. (2020) found that the intervention increased both male and female students' awareness of the underrepresentation of women in STEM.

This study aimed to investigate whether brief exposure to female and male professionals could alter perceptions of the representation of women and men in sectors typically associated with masculinity (STEM studies) or femininity (humanistic studies). This difference is relevant given that the mechanism identified by the Social Role Theory is the rationale for the effectiveness of role models' interventions.

Unlike previous studies on role models, here the focus was not only on female exemplars and STEM disciplines but also on male role models and female-dominated studies were included. The gender gap in humanistic studies is usually neglected and, unlike that in STEM studies, not perceived as a problem. Therefore, the studies on the effect of role models and gender stereotypes on men are still few and their results are mixed. However, men working in a female-dominated sector could be affected by gender stereotypes as well, as found for instance by Sczesny, Nater & Haines (2021).

Literature review

There is a large consensus on the pivotal role played by gender stereotypes in explaining the existence and persistence of the gender gap in STEM (Nosek et al., 2009). Empirical evidence suggests that female children aged six automatically associate males with mathematics (Tomasetto, Galdi & Cadinu, 2012), albeit they are not explicitly aware of this stereotype until they reach 8 to 9 years of age (Andre et al., 1999). Starting from primary school and continuing through entry into the labour market, gender-science stereotypes shape girls' experience in STEM, ultimately contributing to their gradual disengagement from the field. A survey conducted by Microsoft on 6,000 girls (Microsoft Philantropies, 2018) revealed that the percentage of those perceiving as 'not for them' jobs requiring coding and programming increased from 31% in middle school to 40% in high school. By college, 58% of young women had excluded themselves from pursuing these jobs.

Social Role Theory and gender roles

The Social Role Theory proposed by Eagly and Wood (2012) is a cornerstone of this type of research. According to this theory, differences and similarities between men's and women's behaviour originate from the endorsement of gender stereotypes, which in turn stem from the observation of women's and men's different social roles in society. The Social Role Theory thus contrasts the hypothesis of the evolutionary approach, which attributes sex differences to reproduction and sexual selection, rather than cultural factors (Buss, 1989; Geary, 1998).

In the context of STEM, the underrepresentation of women in STEM-related jobs would favour the belief that the STEM sector is 'a male thing'. The endorsement of the belief that STEM is predominantly for males, in turn, influences women's disengagement from this sector. The traditional task specialization has produced a gendered division of labour that does not reflect modern societies anymore. However, gender role beliefs are difficult to eradicate. This is because gender roles 'seem to reflect innate attributes of the sexes' (Eagly & Wood, 2012, p. 459), thus appearing natural and inevitable. However, since gender stereotypes would derive from the observed division of labour, a change in the representation of women and men in gender-segregated occupations should also drive a change in gender stereotypes.

Empirical evidence on dynamic stereotypes seems to confirm both that stereotypes about women and men match the traits perceived as necessary for male- and female-dominated occupations (e.g., Cejka & Eagly, 1999) and that stereotypes evolve in response to a change in gender differences in occupational roles (e.g., Diekman & Eagly, 2000; Twenge, 2001). A recent meta-analysis of 16 U.S. public opinion polls conducted over 73 years (Eagly et al., 2020) found an accentuation in the stereotype of women as being more communal. This shift is attributed to an increased observation of women in roles emphasizing social skills and contribution.

While research conducted in various fields generally supports the hypothesis of the Social Role Theory, the latter has been subject to some criticisms. These include among others, the overemphasis put on the role of societal expectations and conformity, the fact that the socialization process as described by the theory lacks comprehensiveness and the fact that human agency is not sufficiently addressed (Jackson, 1998).

Role models and gender stereotypes

The hypothesis that stereotypes are not stable but would change over time depending on certain circumstances has been investigated for years. In her review of evidence on the malleability of automatic stereotypes, Blair (2002) argued that implicit stereotypes can be moderated by a wide variety of events, among which the exposure to counterstereotypical events and group members. In line with these theories, one of the most suggested and adopted strategies to increase female participation in STEM is to show girls and young women professionals or students of the same gender engaged in this sector. This is to provide a different picture of women's occupations in contemporary society or, using the words of Blair, certain positive counter-stereotypical group members.

These interventions are frequently sponsored and strongly encouraged by governments, international organisations and schools. In this line, numerous initiatives have been recently implemented, including experimental studies that tried to assess the effectiveness of this strategy on female – sometimes also male – participants. However, the type of intervention, the outcomes of interest and the instruments used to measure these effects vary considerably on a case-by-case basis (De Gioannis, Pasin & Squazzoni, 2023).

Focusing on gender stereotypes, researchers have tested whether exposure to role models could change implicit and/or explicit gender-science stereotypes. Just to mention a few examples, Stout et al. (2011) briefly exposed undergraduate women to either male or female peer experts, but the intervention had no impact on the implicit association between math and gender. On the contrary, a study conducted on French high-school students (Breda et al., 2020) found that those who met a female scientist in class were less likely to endorse explicit gender stereotypes on abilities compared to those who did not. However, the intervention had the opposite effect on explicit gender stereotypes about interest in STEM. In a study on middle-school students, Plant et al. (2009) found that boys reduced their endorsement of gender stereotypes on abilities after interacting with either a male or female agent, while girls' endorsement of gender stereotypes was not affected by the interaction with an agent. Finally, Lewis, Sekaquaptewa & Meadows (2019) found no effect of a brief video showing a mixed-gender team engaging in an engineering task on students' endorsement of gender stereotypes on abilities.

Interventions involving role models are numerous and quite heterogeneous not only regarding the outcome of interest and the findings, but also regarding the type of role models, and the type and duration of exposure. As summarised by De Gioannis, Pasin & Squazzoni (2023), in most studies participants are exposed to STEM role models by reading an essay or a biography about them, while less frequently they watch a video or meet and interact with the role models in person. Therefore, the duration of exposure varies depending on the type of exposure: it lasts a few minutes in the case of reading an essay (e.g., Stout et al., 2011), around ten minutes in the case of a video (e.g., Wyss, Heulskamp & Siebert, 2012) and around one hour when role models meet the participants in person (e.g., Wei, Strage & Rheee, 2018). In almost all studies participants are asked to complete the post-treatment questionnaire right after the exposure, while studies that tested also a medium- or long-term effect of exposure are quite a few (e.g., Van Camp, Gilbert & O'Brien, 2019).

Coming back to the mechanism hypothesised by the Social Role Theory, for a role model intervention to be effective, role models should be perceived as a representative sample of social roles in contemporary societies. In other words, any intervention would be condemned to failure if role models are classified as the 'exception that proves the rule'. This mechanism, referred to as subtyping (Kunda & Oleson, 1995), might hinder the change of stereotypes. Dasgupta and Greenwald (2001, p. 808) suggested that the absence of an effect of role models on explicit stereotypes could be related to subtyping and correction, which is more evident when 'perceivers have the cognitive resources to reflect on and re-categorize counterstereotypical exemplars'. This would also explain why they found an effect on implicit stereotypes, which are usually measured through time-constrained psychological tests.

To our knowledge, one study explicitly tested the effect of role models on the perceived distribution of women and men in STEM-related careers. After an intervention held in class for Grade 10 and Grade 12 French students, Breda et al. (2020) asked participants to what extent they agreed with the statement 'There are more men than women in science-related jobs'. Results showed that the intervention increased both male and female students' awareness of the underrepresentation of women in STEM.

Male role models and the humanistic sector

Compared to other studies, here also male role models and humanistic studies were included. This perspective has been essentially neglected in previous research. There are studies including both female and male role models (e.g., Cheryan et al., 2011; Wei, Strage & Rhee, 2018) and a few even include male role models only (Pietri et al., 2021), but they focus only on the STEM sector and on whether both the female and male exemplars are beneficial for young women (and men) as regards STEM-related outcomes. However, these two associations, linking men with STEM and women with humanities, should be considered together as they represent complementary stereotypes (Jost & Kay, 2005). One attributes strength to males (and a perceived weakness to females) in math/science, while the other attributes strength to females (and a perceived weakness to males) in reading/verbal tasks. While research has already pointed out the existence of gender differences in facing non-traditional careers and educational paths (e.g., Croft et al., 2015; Simpson, 2005), this issue has still not gained sufficient attention and empirical evidence is too scarce to provide a clear picture in the context of role models' interventions. For instance, Kurtz-Costes et al. (2014) found that 6th and 8th graders endorse the belief favouring girls in verbal domains but not traditional math and science stereotypes.

This is relevant as breaking the association between women and humanities could also serve the scope of increasing female participation in the STEM sector. An intriguing insight from a longitudinal study conducted by Wang, Eccles & Kenny (2013) on 12th-grade students, who were later interviewed at age 33, revealed that individuals highly proficient in both math and verbal tests during school were less inclined to pursue STEM careers compared to those with high math skills but moderate verbal skills. The authors suggest that this trend could stem from individuals choosing careers where they feel more likely to succeed, indicating that abilities alone may not persuade girls to veer away from paths perceived as safer.

Aim and hypotheses

This study aimed to test the effects on high-school students of a brief video showing interviews with both male and female professionals working in the STEM or humanities-related sectors. The experiment proposed two types of exposure. The first video exclusively presented counterstereotypical examples ('counterstereotypical' treatment), featuring female professionals in STEM studies and male professionals in humanistic studies. The second video ('equality' treatment) showcased both stereotypical and counterstereotypical examples, including male and female professionals for both STEM and humanistic sectors. Lastly, a control group viewed transcriptions of the interviews, unaware of the interviewees' genders. Those assigned to this group did not know whether the interviewee was a man or a woman.

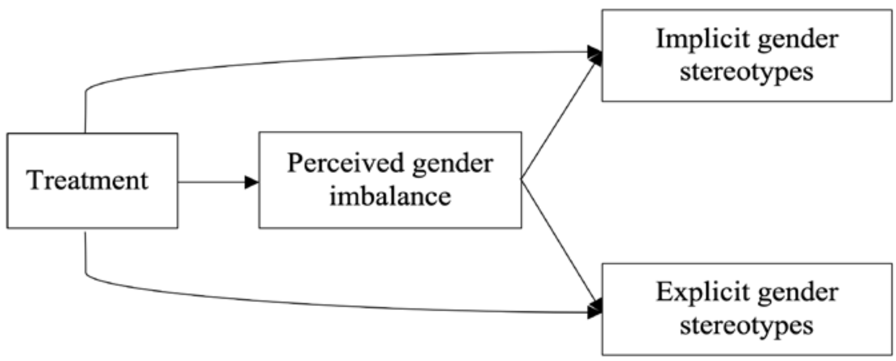
Specifically, the experiment tested the effect on four factors.

1. The perceived gender imbalance in STEM and humanistic studies.
2. Implicit gender-science stereotypes on the association between STEM/humanities studies and gender.
3. Explicit gender stereotypes on abilities in STEM and humanities.
4. Attribution of explicit gender-science stereotypes' attribution, i.e., causes attributed to gender differences in STEM and humanistic studies.

Since most studies in this field highlight that the impact of exposure to role models strongly depends on participants' gender, this study tested these effects by distinguishing between male and female students.

Following the assumption of the Social Role Theory, the study also investigated whether the effect of the treatments on gender stereotypes was mediated by the perceived gender imbalance, as depicted in Figure 1.

Figure 1. Indirect effects' model



Based on the Social Role Theory, it was hypothesised a positive effect of both treatments on the four factors, higher for the 'counterstereotypical' treatment compared to the 'equality' treatment, because of the presence of both stereotypical and counterstereotypical role models in the latter case. However, it was hypothesised a similar, positive, effect of both treatments on the perceived gender imbalance. As found in previous studies on the effect of role models, a small effect size was expected.

As regards the mediating role of the perceived gender imbalance on gender stereotypes, it was hypothesised that the perception of gender imbalance was associated with both implicit and explicit gender stereotypes, i.e., the higher the perceived unbalance, the stronger the endorsement of gender stereotypes is, with, consequently, a mediating role of perceived gender imbalance in the effect of treatments on the two outcomes.

Methodology

Trial design

This was a single-blind randomised control trial (RCT) with a parallel-group design comparing the effects of a brief intervention exposing high school students to role models working in either a male- or female-dominated sector. Participants were told they would have taken part in a research project aimed at studying the relevance of role models for major choice. They were informed that, as part of the project, they would have seen a video collecting interviews with professionals coming from several fields and that the researchers were interested in their opinions on the benefits of hearing about role models' experiences. They were, thus, blind to the experimental nature of the study, the true aim of the study and the existence of multiple interventions and they were randomly assigned only to one of them. The study was approved by the Ethics committee of the University of Milan. Note that both the exposure to the treatments and the use of deception could pose some ethical concerns. However, it was avoided to expose students to situations that could have detrimental rather than positive consequences, e.g., exposure to stereotypical-only exemplars.

Interventions and randomization

Young professionals who got a degree in either a male-dominated sector, i.e., engineering, IT and physics, or a female-dominated sector, i.e., literature, modern languages and psychology, were contacted. Professionals were selected to be at an early stage of their career, to favour participants' perception of role models' similarity (Asgari et al., 2012). Those who agreed were video interviewed and asked to briefly answer a few questions about their job and their experience in their field (more details in the Appendix). To avoid heterogeneity among the professionals, both men and women were asked to wear sober clothes during the video interview, e.g., a sweater or a shirt, and were all filmed half-length in front of a white, empty wall.

A total number of 18 professionals were interviewed, three for each sector. These eighteen videos were then edited together to be included in the final video, in the following way. The final video consisted of a presentation of six degree programs, i.e., engineering, IT, physics, literature, modern languages and psychology. For each degree program, the video first showed a slide summarizing the typical career opportunities of that degree program and then a double interview of two professionals working in that sector. This was repeated for each six programs. In the double interview, two professionals were shown side by side on the screen. An off-screen voice asked the questions and the interviewees, alternately, briefly answered them.

Three different videos were created to reflect the two treatments and the control condition, lasting around ten minutes.

- 'Counterstereotypical' treatment: the video showed only counterstereotypical exemplars, i.e., two female professionals when the sector was male-dominated and two male professionals when it was female-dominated.
- 'Equality' treatment: the video showed both a male and a female professional for each six sectors.
- Control: the video showed the transcription of the interviews as an online chat between the interviewees and the interviewer. Participants did not have any clue about professionals' gender, as this could not be inferred by the answers of the interviewees (i.e., the words used were gender-neutral).

Figure 2. Illustrative frames of the videos used in the experiment

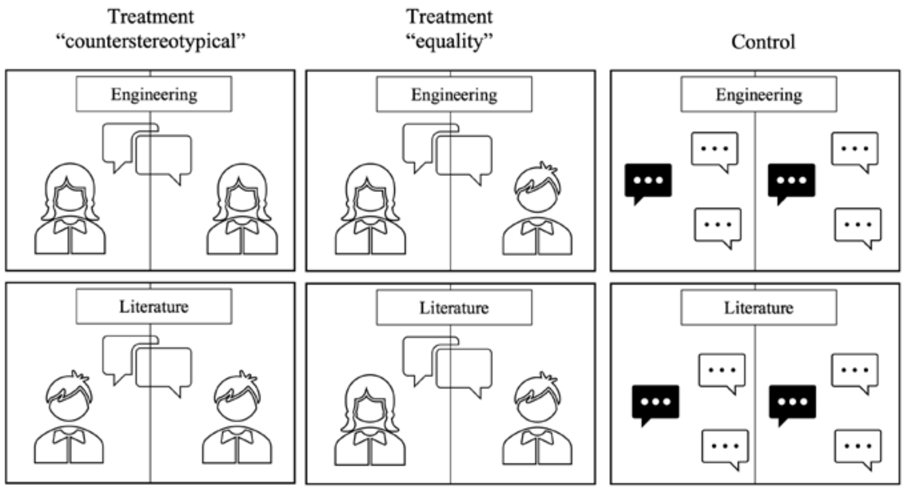


Figure 2 shows two illustrative frames of the video presented. In the control group, white boxes represent the interviewer's questions and black boxes the interviewees' answers. The two, questions and answers, appeared on the screen sequentially, mimicking a normal conversation on a chat platform.

Participants were randomly assigned to one of the three interventions, with a normal equally distributed type of draw, which ensures that every intervention is drawn equally often.

Participants

Given the aim of the project and how it was presented to schools, the ideal participants were students not yet enrolled in university but interested in enrolling. In Italy, most degree programs require an admission test, which can take place during the summer before the start of the academic year or even earlier, when prospective students are still in the fifth or even the fourth year of high school. Eligible participants were thus students attending at least the fourth year of high school in either a *liceo* or a technical school. In Italy, there are three types of high schools: *liceo*, technical school and vocational school. While university entrance is allowed from all types of high schools, most students in vocational schools decide to enter the job market rather than university after the end of high school. This is why they were not eligible to take part in the experiment.

It was not set a fixed sample size before the data collection as students' participation was voluntary. The final sample consisted of 325 participants, of which 108 were assigned to the 'counterstereotypical' treatment, 98 to 'equality' treatment and 119 to the control group (more details in the Appendix). A sensitivity power analysis conducted using G*Power (Faul et al., 2007) revealed that for the female sample (N = 236, α =.05, power =.8, predictors = 2) the minimum detectable effect is f^2 =.04, while for the male sample (N = 89, α =.05, power =.8, predictors = 2) the minimum detectable effect size is f^2 =.11, assuming a continuous dependent variable.

Most of the participants were female (73%) and Italian (95%). 62% of them were attending the last year of high school at the time of the project, while 38% of them were attending the penultimate year. Almost all came from a *liceo*, while a minority from a technical school. Almost all participants lived in the North-West area (98%) – more specifically in Lombardy, while the remaining lived in either the Southern part of Italy or in the North-East area.

Procedure

All Italian high schools were contacted and asked to advertise the project among their students, by circulating a leaflet with a brief description of the project and a link to the experiment's platform. Participation was voluntary. Those interested in participating were invited to click on the link provided in the leaflet and follow the instructions. The study was conducted online using the SoSci Survey platform (Leiner, 2019).

The website of the experiment was organised in sequential pages, guiding the participant through the phases of the experiment, i.e., (1) informed consent, (2) pre-treatment questionnaire, (3) intervention (exposure to the video), (4) attention test, (5) post-treatment questionnaire. The post-treatment questionnaire was thus answered right after participants saw the video. Students could abandon the project at any moment. Those who did not accept the informed consent were not allowed to proceed. The experiment took place between March and May 2021.

Outcomes

Perceived gender gap in STEM and humanities: Students were asked to indicate the representativeness of women and men in both four STEM (physics, engineering, maths, IT) and four female-dominated (literature, modern languages, education and psychology) majors. They could choose among five options, i.e., 'Almost all men', 'More men than women', 'Equal number of women and men', 'More women than men', 'Almost all women' (Barth et al., 2018). The Cronbach alpha was too low to construct a single instrument (a_{STEM} =.57; a_{Hum} =.49), thus results are presented separately for each major.

Implicit gender-science stereotypes: The automatic association of gender with STEM and humanistic majors was tested using the Implicit Association Test (Greenwald, McGhee & Schwartz, 1998). The IAT measures the difference in the time needed to do an association between compatible constructs (e.g., women and humanistic majors, men and STEM majors) and the time needed to do an association with incompatible constructs (e.g., women and STEM majors, men and humanistic majors), where compatibility reflects stereotypical beliefs. The version of the IAT used here required participants to associate male and female names with STEM and humanistic majors (more details are reported in the Appendix). Results report the D score, as suggested by Greenwald, Nosek & Banaji (2003). This indicator ranges from -2 to +2, where negative values mean that it is easier for the participant to associate incompatible rather than compatible constructs, a value around 0 indicates that the participant is indifferent between compatible and incompatible constructs, while a positive value means that it is easier for him/her to associate compatible rather than incompatible constructs. Thus, the higher the value of the D score, the stronger automatic stereotypical beliefs are.

Explicit gender stereotypes on abilities: Students were asked to rate on a 5-point Likert scale the extent to which they agreed with statements on gendered abilities in STEM and humanistic studies, i.e., 'Men are generally more inclined to scientific studies', 'Women are generally more inclined to humanistic studies' (Galdi, Mirisola & Tomasetto, 2017).

Causes attributed to the gender gap: Students were asked to rate on a 5-point Likert scale their agreement on statements regarding the reason for the observed gender gap, in both the STEM and humanities areas. Items were adapted from Nosek, Banaji & Greenwald (1998). Almost half of these items suggested a cause ascribable to individual aptitude and biological characteristics, e.g., 'Women are usually better than men in humanistic studies because they are by nature more sensitive'; 'If there are more men than women in STEM studies is because men are more interested in this field'. The remaining statements suggested a cause ascribable to social pressure, e.g., 'Men are encouraged more than women to choose STEM-related majors'; 'If there are more women than men in humanistic studies is because men are hampered and discriminated in this field' (see the Appendix for the complete list of items).

Two indicators were created for each field of study (STEM and humanities), one called 'Attribution to biological characteristics' (Cronbach alpha 0.67 for STEM, 0.68 for humanities) and the other called 'Attribution to social pressure' (Cronbach alpha 0.81 for STEM, 0.64 for humanities). The variable used in the analysis is the difference in the propensity to attribute the gender gap to biological rather than social causes by measuring for both sectors the difference between the two scales. The indicator was zero when there was no difference in the attribution of gender differences to any of the two explanations. A positive value indicated that biological characteristics counted more than social pressure, while a negative value indicated that social pressure counted more than biological characteristics in explaining the gender gap.

Statistical methods

The analysed sample consisted of students who completed both the pre-treatment and the post-treatment questionnaire and who passed the attention test. The latter consisted of a set of questions asked right after the video, asking participants about the jobs of the professionals interviewed in the video. Those who answered at least half of the questions correctly passed the test. A second criterion based on the time spent on the page of the video was also applied. Those who spent less than 8 minutes (the length of the video) and more than one hour were dropped from the final sample.

The effect on the outcomes was tested using ordered logistic regression models, except for the implicit gender-science stereotype, which was tested using a linear regression model. Differences among the three groups were verified using a post-estimation Chi-square test, with Holm's correction for multiple comparisons (Holm, 1979). In the case of statistically significant results, marginal effects were computed to assess the entity and direction of the difference between groups. Given that previous research mostly highlighted that the response differed depending on the participant's gender

(Cheryan, Meltzoff & Kim, 2011; Marx & Roman, 2002), the analysis was conducted separately for male and female participants.

Mediation analysis for implicit and explicit stereotypical beliefs tested the mediating role of the perceived gender imbalance on the treatment's effect. The indirect effects' significance was determined using percentile bootstrap 95% confidence intervals (Bollen & Stine, 1990), while the direct association between perceived gender imbalance and the outcomes of interest was estimated using an ordinal regression model in the case of explicit gender stereotypes and a linear regression model in case of implicit gender stereotypes.

Results

Perceived gender imbalance

Results on the effect of treatments on participants' perceived gender imbalance were mixed. As regards humanistic studies, contrary to the initial hypothesis, compared to the control group, young women in the 'counterstereotypical' treatment were more likely to believe that in psychology there are almost all women (CME =.12, z = 2.17, p-value =.030) and less likely to believe that there is an equal number of women and men (CME = -.09, z = -2.20, p-value =.028). Similarly, compared to those assigned to the 'equality' treatment, those in the 'counterstereotypical' treatment were more likely to believe that in psychology there are almost all women (CME =.12, z = 2.18, p-value =.030) and less likely to believe that there is an equal number of women and men (CME = -.09, z = -2.11, p-value =.035). There was also a statistically significant difference in the perception of educational studies, i.e., female participants assigned to the 'counterstereotypical' treatment were more likely to believe there are almost all women in educational studies (CME =.16, z = 2.30, p-value =.021) and less likely to believe that there are more women than men (CME = -.10, z = -2.17, p-value =.030) or an equal number of women and men (CME = -.06, z = -2.06, p-value =.039). In the case of male students, there was a statistically significant difference in the perceived gender imbalance in psychological studies. In this case, the difference is coherent with the hypotheses, i.e., those assigned to the 'equality' treatment were more likely to believe there is an equal number of men and women (CME =.29, z = 2.99, p-value =.003) and less likely to believe that there are almost all women (CME = -.21, z = -2.74, p-value =.006) compared to those in the control group.

As regards STEM-related studies, results showed a statistically significant difference among young women for studies in engineering, and among young men for studies in physics. In both cases, the difference disconfirms the hypotheses. Female participants assigned to the 'counterstereotypical' treatment were less likely to believe there is an equal number of men and women in engineering (CME = -.11, z = -2.28, p-value =.022) and more likely to believe that there are almost all men (CME =.12, z = 2.24, p-value =.025) compared to those in the control group. A similar difference is observed comparing the 'counterstereotypical' treatment group and the 'equality' treatment group, i.e., the former were less likely to believe there is an equal number of men and women in engineering (CME = -.08, z = -2.08, p-value =.038). Finally, male participants assigned to the 'counterstereotypical' treatment were more likely to believe there are almost all men in physics-related studies (CME =.13, z = 2.14, p-value =.033) and less likely to believe there is an equal number of men and women (CME = -.23, z = -2.01, p-value =.044) compared to those in the control group.

Gender-science stereotypes

As regards both implicit and explicit gender stereotypes, results showed no statistically significant differences between those assigned to treatments and those assigned to the control group.

Causes attributed to the gender gap

As regards female participants, there was a statistically significant difference between those assigned to the 'equality' treatment and those in the control group. Young women in the former group were more likely to believe social pressure counts more in explaining gender differences in STEM studies (CME =.15, z = 2.05, p-value =.041), while they were less likely to believe biological characteristics count more (CME = -.07, z = -2.03, p-value =.042). As regards male participants, there was a statistically significant difference between those assigned to the 'equality' treatment and those assigned to the 'counterstereotypical' treatment. Young men in the former group were more likely to consider biological characteristics more important in explaining gender differences in STEM studies (CME =.25, z = 2.39, p-value =.017), while they were less likely to consider social pressure as more relevant (CME = -.25, z = -2.43, p-value =.015).

Mediation analysis

Results from the mediation analysis confirmed the hypothesis that perceiving the sector as more unequal is associated with stronger gender stereotypes for female students in the case of humanities studies (see Table 1). Compared to those who believe that there is an equal number of women and men in the humanities sector, young women who believe there are almost all women exhibited stronger implicit and explicit stereotypes.

As regards male participants, results were not statistically significant, with one exception. Contrary to expectations, male participants who believe that in the STEM sector, there are almost all men exhibited weaker implicit gender stereotypes compared to those who believe there is an equal number of women and men.

Table 1. Direct effect of perceived gender imbalance on implicit and explicit gender stereotypes (female participants)

Predictor	Estimate	*SE*	*t*	*p-value*	95% CI	
					LB	UB
Implicit gender stereotypes						
Perceived gender imbalance[1] (hum)						
More women than men	.17	.11	1.58	.117	-.04	.38
Almost all women	.32	.12	2.69	.008	.09	.56
Perceived gender imbalance[1] (STEM)						
Almost all men	.16	.09	1.90	.059	-.01	.33
More men than women	-.02	.06	-.32	.751	-.15	.11
Explicit gender stereotypes (humanities)						
Perceived gender imbalance[1] (hum)						
More women than men	.72	.54	1.34	.180	-.33	1.78
Almost all women	1.17	.64	1.82	.069	-.09	2.43
Explicit gender stereotypes (STEM)						
Perceived gender imbalance[1] (STEM)						
Almost all men	1.54	.70	2.19	.028	.16	2.92
More men than women	.94	.39	2.43	.015	.18	1.70

Note. SE = Robust standard errors; CI = Confidence interval; LB = Lower bound; UB = Upper bound; [1] Reference category: 'Equal number of women and men'

However, indirect effects were almost equal to zero and, based on percentile bootstrap 95% confidence intervals, only the indirect effect of the 'counterstereotypical' treatment on implicit gender stereotypes through the perceived gender imbalance in humanities was statistically significant.

Discussion

This study aimed to test the effect of a role models' intervention on female and male high school students. In particular, it verified whether being exposed only to counterstereotypical examples – women working in male-dominated sectors, men working in female-dominated sectors – or to both stereotypical and counterstereotypical models could affect the perception of the representativeness of women and men in these sectors. It also explored the influence of these interventions on both implicit and explicit gender stereotypes.

Results from the experiment are mixed and differ depending on the student's gender. Compared to those assigned to either stereotypical and counterstereotypical role models or the control group, female participants exposed only to counterstereotypical examples were less likely to believe that there is an equal number of women and men in psychological and education-related studies. They were also more likely to believe that there are almost all men in engineering studies, thus disconfirming the initial hypothesis. As regards male participants, those assigned to both types of role models were more likely than those in the control group to believe that there is an equal number of women and men in psychological studies, as initially hypothesised. Conversely, those assigned to counterstereotypical role models were more likely to believe that there are almost all men in physics-related studies compared to those assigned to both types of role models.

As regards implicit and explicit gender stereotypes, results showed no statistically significant difference between the two treatment groups and the control group. Finally, as regards stereotypes' attribution, female participants assigned to both types of role models considered social pressure as more relevant in explaining the gender gap in STEM than biological characteristics, compared to those assigned to the control group. The opposite effect was found between male participants assigned to both types of role models and those assigned to counterstereotypical models. The former group was more likely to believe social pressure counts less in explaining the gender gap in STEM.

Results from the mediation analysis suggest that, for female participants, implicit gender stereotypes were associated with the perception of the gender gap in humanities, while explicit gender stereotypes in STEM were associated with the perception of the gender gap in STEM. The association confirms the initial hypotheses, i.e., a more equal perception of the sector is associated with weaker gender stereotypes.

The mixed nature of the study's results prevents us from either confirming or disconfirming the mechanism hypothesised by the Social Role Theory, i.e., that exposure to counterstereotypical examples would induce a more equal perception of the male- and female-dominated sectors that, in turn, would favour the decrease in the endorsement of gender stereotypes. Nevertheless, the experiment provides some interesting information. First of all, the negative effect of exposure to counterstereotypical role models on young women's perception of the gender gap could be explained by the mechanism known as subtyping, mentioned in the introduction. Role models may be seen as an exception rather than representative of workers in those sectors. This finding is coherent with Breda et al. (2020)'s outcomes. In their study, students attending Grade 10 and Grade 12 met female researchers or professionals employed in the STEM sector, who explicitly talked about the underrepresentation of women in this area. After the exposure, students were more aware of the gender gap in the STEM sector. While in this case, the gender gap issue was not explicitly mentioned in the interviews, still, the exposure seems to have partially strengthened the idea of a wide difference in the representation of women and men in the two sectors. Interestingly, a difference was found between female students assigned to both counter-stereotypical and stereotypical role models and those in the control group.

Furthermore, the difference was confirmed only for some of the majors included. While this could be related to the sample size and to the role models, it also suggests that we should not treat majors as equivalent, even when related to the same, broad domain. The gender gap is not homogenous among scientific domains (Cheryan et al., 2017). Further research would be needed on the heterogeneity of women's and men's representation in these sectors and on whether gender stereotypes differently affect attitudes toward these sectors.

It is interesting to note that the perceived representativeness of women and men in humanities was associated with the endorsement of implicit gender stereotypes of female participants, while the perceived representativeness in STEM was associated with females' endorsement of explicit gender stereotypes. In particular, as predicted by the Social Role Theory, those who believe that sectors were more gender-balanced endorsed a weaker explicit and implicit association between gender and the two sectors. Unfortunately, the fact that the implicit association test did not allow us to disentangle the weight of the men/STEM vs. women/humanities associations prevents us from understanding the different contributions of the awareness of the gender gap on the automatic association of gender and STEM/humanities. Further research would be needed on the difference between the two complementary stereotypes activated at the implicit level.

While results are mixed and did not allow to draw any general conclusions, the experimental findings clearly indicate that the issue of the underrepresentation of men in humanities deserves careful attention and would require a contextualised approach. While participants were aware of the gender gap in both sectors, female students were convinced that the gap was wider in the humanities field compared to the STEM field (see descriptive statistics in the Appendix). However, the width of the gender gap in Italy is similar in the two sectors. Among the students who graduated in 2020 in Italy 62% were female in the humanities field, 84% in modern languages and 81% in psychology. On the contrary, men represented 86% of those graduating in IT, 50% in math, 70% in physics and 74% in industrial engineering (AlmaLaurea, 2021). Interestingly, whenever asked about what they believed were the causes underlying these gender differences, 48% of students gave more credit to social-related factors in the case of differences in STEM, whereas only 14% shared this opinion for differences in humanities. In the latter case, regardless of their gender, students mostly believed that biological-related characteristics were responsible for such a difference.

This is relevant as, while women suffer from a social penalization when entering the STEM field, men's underrepresentation is rather attributed to biological – so immutable – causes. As suggested by Croft, Schmader & Block (2015, p. 361), 'the threat of identity misclassification or risk of losing status might mean that the costs of behaving counterstereotypically are even more pronounced for men than they are for women'. This difference in the gender gap's perception could contribute to explaining why female students assigned to the gender parity condition gave more credit to social pressure as a cause of the gender differences in STEM, while we did not observe anything similar for the gender differences in humanities. Here, further research would be needed on whether exposure to role models may also affect men's attitudes toward female-dominated sectors.

This said this study has various limitations. First, the sample size is relatively small given the number of treatment and control groups with all problems in detecting a small effect size, especially for the male sample. Furthermore, the experiment was conducted online, a setting that limits researchers' control over participants. To limit the risk of including participants who did not see the videos, an attention test was included. However, performing well-controlled lab or field experiments during a global pandemic was not feasible. Furthermore, online experiments do have some advantages, e.g., higher ecological validity, the possibility to reach a sample with more demographic diversity, and reduced logistical constraints (van Steenbergen & Bocanegra, 2016).

The results could reflect the instruments' limitations. As previously mentioned, there are well-known arguments against the validity of the Implicit Association Test, which were partly solved by the use of an improved algorithm for the final score (Greenwald, Nosek & Banaji, 2003). Unfortunately, this test does not allow us to disentangle the two associations – men/STEM and women/humanities. Furthermore, both the perception of gender imbalance and gender stereotypes can be affected by numerous factors, ranging from family characteristics, personal networks, school and teachers' attributes, and personal experience. While randomization should account for these confounding factors, results may still at least partially reflect this heterogeneity. Finally, the experiment is subject to the typical limitations related to an experimental design, e.g., the fact that people might not react uniformly to the treatments, the impossibility of isolating operational and experimental properties, the difficulty in extending to real life an artificial situation such that of the experiment.

Conclusions

To conclude, while policymakers and the public usually see role models as an effective solution for the underrepresentation of women in STEM, results from academic research are controversial. As suggested in this study, the risk of a subtyping effect after exposure is possible, with detrimental and unintended consequences for participants. The documented heterogeneity in previous studies on role models might be attributed to the various essential characteristics that role models should possess to be effective and, more importantly, whether a person can represent a role model for young people is strongly subjective.

The study highlighted two further issues that are worth noticing when studying the gender gap in STEM. The first is that we should not consider all fields included in the acronym STEM as equal. While they all share a certain math orientation, these sectors are actually quite different, both in the gender imbalance and in how they are perceived by people. Some sectors have actually reached gender parity, while others are still quite far from that objective. More attention should be thus paid when dealing with STEM as a whole sector.

The second issue is that people may have a different perception of the gender imbalance in male- and female-dominated fields. As found in this study, for instance, female students on average perceived the humanities as characterised by more gender imbalance than the scientific sectors. What's even more important is that different from the gender gap in the STEM sector, that in the humanities was perceived by the majority of students, regardless of gender, as related to biological rather than social factors. Since biological factors are frequently associated with immutability (Dar-Nimrod & Heine, 2011), this is relevant and could hold crucial implications in contexts influenced by stereotypical beliefs (De Gioannis, 2023). As found by Dar-Nimrod and Heine (2006), female college students informed that gender differences in math are due to genetic causes underperformed in a math test those who were told that these differences either do not exist or are due to experiential causes. In this study, the exposure to counterstereotypical or stereotypical exemplars seemed to affect the attribution of the gender gap to biological rather than social causes, but the effect was mixed based on the participant's gender.

Future research should focus on understanding when and how role models' interventions are beneficial to women, but also men in female-dominated sectors. Furthermore, a comprehensive understanding of this topic can be achieved by integrating elements such as perceived gender imbalances and attributions of gender gaps to biological and social factors. These less-explored perspectives hold the potential to significantly broaden our comprehension of this intricate issue.

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