SF2A 2023
M. N'Diaye, A. Siebert, N. Lagarde, O. Venot, K. Baillié, M. Béthermin, E. Lagadec, J. Malzac, J. Richard (eds)

THE EFFECT OF GENDER STEREOTYPES ON ACADEMIC PERFORMANCE: HOW OUR TEACHING METHODS AFFECT GIRLS' SUCCESS

I. Vauglin[1] and R.-M. Ouazzani[2]

Abstract. Gender stereotypes have a strong impact on the academic performance of girls (and boys), at all levels of their school path. We aim at raising awareness on such biases, in order to prevent our teaching practices from perpetuating such stereotypes.

Keywords: gender stereotypes, education, gender equality

1 Introduction

At the wake of this third millennium, human societies are facing huge challenges among which climate changes, energy and water resources, pandemics, and the place of artificial intelligence. These challenges will require, at least partly, answers coming from progress in science and technology. We believe that all skills are needed to meet such huge challenges, and women have their role to play. However, girls' lack of interest in sciences has been a well-known problem for decades. While girls and boys are almost equally represented in the final year of high school, yet, as a representative example, women represent only a quarter of the members of the institutes of Astronomy and Astrophysics in France (Ouazzani et al. 2022). On the whole, the differences in educational choices between girls and boys hardly evolve over time. Equality between men and women is a major issue in the scientific fields of higher education and research; gender diversity in research teams leads to greater efficiency and more innovative teams. But the number of women in scientific and technological training and professions is still very low, and a cause for concern. The *Commission Femmes et Astronomie* of the SF2A organized a splinter session during the 2023 edition of its annual conference, which aim was to question the way we teach, which may be at the roots of poorer results and lower self-confidence among girls, increasing the risk of them dropping out of scientific education and careers. This proceeding tries to gather pieces of reflection which were presented then.

2 The shackles of stereotypes

Gender stereotypes are defined as "arbitrary characteristics based on preconceived ideas attributed to a group of people on the basis of their sex". It's an attribution of character traits that would determine the way individuals think and act according to their sex.

In 2015, not so long ago, an international study by the L'Oréal Foundation and Opinion Way highlighted the existence of such gender stereotypes affecting women in science. The survey shows that 67% of the 5032 Europeans questioned (50% women-50% men) believe that *"women do not have the required abilities to access high-level scientific positions"*. Why do they think this? Because they believe that *"women suffer from a lack of perseverance, rationality, practicality, rigor, scientific spirit and analytical skills"*.

[1] Univ Lyon, Univ Lyon1, Ens-Lyon, CNRS, Centre de Recherche Astrophysique de Lyon UMR5574, F-69230, Saint-Genis-Laval, France
[2] LESIA, Observatoire de Paris, PSL Research University, CNRS, Université Pierre et Marie Curie, Université Denis Diderot, 92195 Meudon, France

© Société Française d'Astronomie et d'Astrophysique (SF2A) 2023

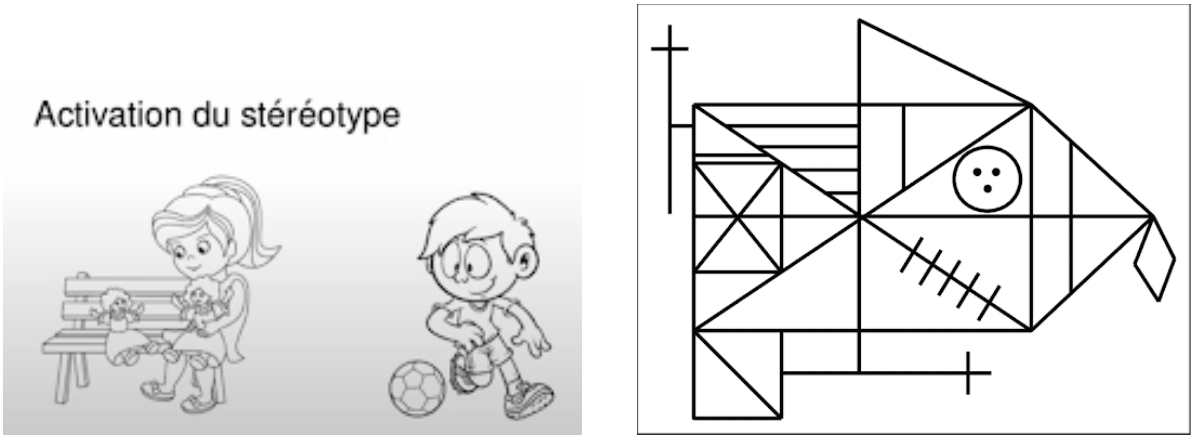

Fig. 1. Left: The colouring work assignment used for activation of the gender stereotype **Right:** The figure of Rey.

2.1 The impact of stereotypes in elementary school

A study by Neuville & Croizet (2007) was carried out on 79 CE2 children (34 boys, 45 girls aged 7 to 8), who were given arithmetics tests. Before taking the test, half the participants were given a coloring work that would activate the gender stereotype -typically a picture containing a scene were the characters would be illustrative of stereotyped behaviour, see fig. 1-, while the other half were given a neutral coloring work. The girls in the stereotype-activated group performed worse at the arithmetics test than the boys of their group, but also significantly worse than the girls in the other group for whom the stereotype had not been activated. The simple stereotype threat (*girls aren't good at science*) acts on the girls by "forcing them to confirm it" and thus leads the girls to perform below their real abilities in arithmetics.

2.2 The impact of stereotypes in middle school

The same year, Huguet & Regner (2007) carried out a study on 450 middle-school students. The task was to memorize and reconstruct Rey's figure - i.e. a drawing of a complex geometrical form, see fig. 1-. All the pupils took exactly the same test, under the same time conditions, corrected in the same way, by the same correctors (marked out of 44), the only difference being that half the pupils were told they would be taking a geometry test, while the other half were told they would be taking a drawing test. The girls who thought they were taking a geometry test didn't pass -with an average grade of 20.7-, while those who thought they were taking a drawing did -with average grade of 25.4-. As for the boys, while they got graded 23.7 in average when they thought they were taking a geometry test, they dropped to an average of 22.4 -i.e. 3 points lower than the girls!- when they thought they were taking a drawing test. Here again, the exercise presented as a geometry test activates, for the girls, the negative stereotype of which they are the target of, as well as the fear of confirming it. This fear represents an additional stress for the girls, which the boys don't have to deal with. The activated stereotype acts as a pressure on girls, leading to a drop in their performance compared to their results when it's not activated. It also affects boys, since their performance drops when they think they're doing artistic work.

The stereotype therefore has an impact on performance, starting in the earliest stages of primary and secondary school, in both good and bad pupils.

2.3 The impact of stereotypes at university

In 1999, Spencer et al. (1999) demonstrated an equivalent negative impact on students at the University of Michigan. A group of 67 students (36 women and 31 men) selected for being good at mathematics were offered to take a maths test presented as difficult. Half the group were told that previous results at this test had shown a difference in performance between women and men (the stereotype-activated group), while the other half were told that previous results showed that men and women performed equally well. As at younger age (see Sect. 2.1 and 2.2), the women in the stereotype-activated group performed worse than the men, while those in the non-stereotype-activated group performed on a par with the men. We can therefore see that, at all levels,

gender stereotypes affect the academic performance of girls and women, and sometimes boys and men when the counter-stereotype is activated.

A large number of studies have demonstrated the power of stereotypes on the groups they target. For example, still at university level, but concerning stereotypes which affect African-Americans, Steele & Aronson (1995) studied the stereotype that African-Americans are less skilled intellectually than other ethnic groups. They worked on standardized tests of verbal intelligence, used in the US for university admissions. They found that when the test was presented as a test of intelligence, the performance of black students was lower than that of white students (8.5 versus 12), but when the same test was presented as a problem-solving task, the performance of the two groups of students was similar (12.1 for black students versus 12.4 for white students). Again, as for women and maths, the authors highlight the negative stereotype the African-Americans suffer from, and the fear of confirming the stereotype, adding further stress that leads them to hinder their results.

2.4 And everywhere else

Bourguignon et al. (2007) have shown that implicit stereotype threat also operates outside the school context, more specifically, they have studied a group of 115 unemployed persons. The stereotype related to this group is that they are "lazy, apathetic and incompetent", and the unemployed persons are fully aware of this image projected on them. The study was based on tests including reading and understanding tasks and willingness to seek employment, and were presented either with the unemployed self-stereotype highlighted, or with the adult category mentioned. Again, participants for whom the unemployed stereotype was activated performed worse in reading understanding and expressed less job-seeking intentions than those for whom the adult category was mentioned. The activation of the stereotype associated with unemployed persons has negative consequences for their attempts to reintegrate the workforce. The power of stereotype threat generates stress, which in turn hinders their professional reintegration.

3 Awareness and stereotype falsification, a way to reduce the impact of stereotypes

Public education for all women is still a recent phenomenon. When we look at the history of women's education in France, we find that women were excluded from the education system until 1836. It was not until 1924 (less than 100 years ago) that women had the right to take the *Baccalauréat* -the high school diploma which gives access to university- hence keeping them out of the higher education system. Even then, many *grandes écoles* -elite higher education schools leading to business , public administration, and engineering jobs- remained closed to women for a long time. The prestigious *Ecole Polytechnique* was not admitting women until 1972 (50 years ago). It wasn't until 1975 that the *Haby* law made co-education compulsory, requiring the same teaching for boys and girls from kindergarten to 3rd grade. Prior to this law, textbooks and teaching was different for girls and for boys, and specifically the science ones. Hence, the idea that women are equally skilled and talented for sciences as men is still recent, and is not always a given. Therefore, girls and women still face images and messages which lead them to activate the stereotype that they are not good at sciences.

This is regularly reflected in the content of advertising campaigns. The French Ministry of Education (MEN) itself provides examples in its communication, with two posters for a recruitment campaign put up in May 2011 (see Fig. 2). The message is clear: men and women have received the same training, but a woman will find the job of her dreams, while a man has found a position that matches his ambitions. An equivalent campaign carried out by the *Institut National Supérieur du Professorat et de l'Education* -INSPE, French teachers' training school- in 2023 shows that things have not changed much in 12 years. Women are good at teaching at primary school, with small children, while men are more likely to teach in secondary school. Here again, even if they are provided with the same training, they don't have the same careers. It gives cause for concerns when the institution which is training the teachers, itself, conveys messages that are prompt to activate stereotypes.

So what can we do, as actors of the higher education system, and members of the scientific community? First of all, we, and our institutions (scientific institutes, universities, etc...), should screen our communication in order to remove totally stereotypical messages from all the contents we produce and broadcast. Various tools have been developed to do so, among which this guide for a stereotype-less public communication -in French-, edited by the higher council for equality*.

*see https://www.haut-conseil-egalite.gouv.fr/stereotypes-et-roles-sociaux/actualites/article/aujourd-hui-sort-en-librairie-le

Fig. 2. Left: Posters of a teacher recruitment campaign by MEN in 2011 **Right:** similar campaign by INSPE in 2013.

Also, in the classrooms, there are ways and techniques which one can apply when teaching so as not to activate gender stereotypes, and therefore reduce their impact on the performances of our female students. This set of techniques can be related to nudging. This concept comes from behavioral sciences: the idea is to propose adaptive designs of the environment, as ways to influence the behavior and decision making of groups of individuals ("Nudge Theory", Wikipedia). Applied to our problem, such strategies can help to counter-balance the negative impacts of stereotypes. It is called the stereotype falsification. It can take very simple forms, and be easy to implement in our daily teaching practices. Thanks to science historians, the works of female scientists are more and more coming out of the shadow. Therefore, one way to proceed is to try to cite female researchers (in a visible manner) and their results as often as possible when lecturing. Another way is to explicitly assert, for instance during the first day of class, when introducing yourself and the course, that you consider that men and women are equally skilled to thrive in sciences. We can take example from this maths teacher in a secondary school of the Grenoble Academy who has written above the blackboard in her classroom, in large letters, clearly visible to the whole class, "in mathematics, there is no difference in performance between women and men". Simple, easy and effective: her female students have some of the highest maths grades in the school.

4 Conclusion

Collecting a series of scientific studies, we have shown that diverse works in cognitive and behavioral sciences demonstrate that stereotype activation has deleterious effects on girls' performances in sciences, at all age. The anxiety generated by the implicit stereotype threat creates a pressure that leads to a drop in performance. To help girls and female students succeed in their school and career paths, we, teachers must be careful to give them the same conditions and resources as others. To do this, we must be careful not to activate gender stereotypes in our discourse, particularly before and during examinations.

IV and RMO thank all the members of the *commission femmes et astronomy* for their work and the organisation of the splinter session. A particular thank you goes to Marie-Blanche Mahourat for her contribution. They also warmly thank all the participants of the session, and specially Caroline Bot for having helped moderating the lively debates.

References

Bourguignon, D., Desmette, D., Yzerbyt, V., & Herman, G. 2007, Revue internationale de psychologie sociale, 123

Huguet, P. & Regner, I. 2007, Journal of educational psychology, 545

Neuville, E. & Croizet, J.-C. 2007, European journal of psychology of education, 307

Ouazzani, R. M., Bot, C., Brau-Nogué, S., et al. 2022, in SF2A-2022: Proceedings of the Annual meeting of the French Society of Astronomy and Astrophysics. Eds.: J. Richard, ed. J. Richard, A. Siebert, E. Lagadec, N. Lagarde, O. Venot, J. Malzac, J. B. Marquette, M. N'Diaye, & B. Briot, 23–28

Spencer, S., Steele, C., & Quinn, D. 1999, Journal of Experimental Social Psychology, 4

Steele, C. M. & Aronson, J. 1995, Journal of Personality and Social Psychology, 797