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CAN EMINENCE IN STEAM PRODUCE MORE FEMALE ROLE MODELS? RECENT TRENDS IN PRIZES KNOWN AS THE NOBEL OR THE HIGHEST HONORS OF A FIELD

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ABSTRACT

Purpose

In many STEM fields, the intersectionality of gender and excellence is a frequently noted phenomenon, i.e., women are underrepresented in STEM in general and specifically, at the top. Role models presumably play a key part in closing this equity gap. However, these are not available in sufficient numbers. Many researchers have suggested better outreach to female talents by integrating the arts into STEAM. One possibility might be that such an integration would make more female role models available to STEAM talent pools. (82)

Design/methodology/approach

We explored the availability of potential role models for female talents by analysing the ten most prestigious awards in STEM and the arts over the past 42-plus years using a 2 X 2 X 2 X 10 hierarchical log-linear analysis. Variables were gender (female vs.

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male), award type (STEM or arts), award (ten different awards per award type), and time period (1980–2000 vs 2001–2021). Three research questions were investigated: (1) whether and to what extent gender gaps exist in Nobel Prizes and prizes known as the Nobel, or the highest honors of a field in STEM and in the arts, (2) whether gender gaps in Nobel Prizes and prizes known as the Nobel or the highest honors are equally distributed across individual STEM fields and across the individual arts domains, and (3) what trends emerge in the recipient pool of Nobel Prize winners and winners of prizes known as the Nobel or the highest honors. (156)

Findings/results

First, women do receive substantially fewer of the top awards, with a slightly larger gender gap in STEM than in the arts. Second, findings showed large differences in the probabilities with which each STEM or arts prize was awarded to women. Thus, differences emerge not only between STEM and the arts, but also within STEM and arts awards. Third, there were comparable significant increases in awards to women in both STEM and the arts after the turn of the millennium.

Originality/value

The prizes explored in this study were awarded between 1980 and 2021. Future researchers should explore whether the gains made at the turn of the millennium for female talent pools have or are in the process of calcifying as of the publication date of this article. While the researchers of this study did not focus on the nomination pool, a cursory look at 100 years of Academy Award nominations reveals that female talent was not being considered, and thus could not be awarded. Does this extend to the nomination pools of other eminence prizes? Additionally, there are still far too few non-stereotypical, female role models at the top tiers of arts domains that might "inoculate" against the male STEM stereotype. If the introduction of male talent into female gender-typed work or 'women's work' produces ever more eminence prizes for male talent, then a question of quality control has been raised and should be leveraged against talent pools, particularly in the STEM/STEAM domains where male talent dominates.

Implications for policy/practice

Introducing arts into STEM is not enough to bridge the achievement gender gap. Future studies might focus on whether eminence prizes are appropriate end-points of career development, particularly in the context of female talent development in STEM/

STEAM fields. Moreover, this paper discussed the effect of gender concurrence and eminence prizes: the effect of female role models on women. However, this effect can also extend to male talent pools. Future research on the effects of successful female role models in STEAM should therefore include effects on boys.

Keywords: STEM, STEAM, arts, Nobel Prize, gender, role model, talent development

關鍵詞：科學、技術、工程、數學、藝術、諾貝爾獎、性別、榜樣、人才發展

For decades, scholars have recognized that only a fraction of all talents develops their full potential (Feldhusen, 2006; Shavinina, 2009; Stoeger, 2009; Terman, 1954). This was largely considered to be a consequence of a general deficit in educational support. Indeed, across the globe most talents remain unidentified; if and when they are identified, talent support is rarely sufficiently responsive to their learning needs to the degree that enables the full development of talent. In recent years, there has been a significant gain in scientific and public awareness that this general deficit exists, but not for all groups equally. The support deficit does not impact all talent equally, rather it affects some disproportionately harder than others (Rutkowski et al., 2012).

Equity Gaps

Equity gaps in education are disparities in educational outcomes between groups that violate notions of equity (Ziegler et al., 2021). They exist in virtually all domains in which they have been explored. In this work, we focus on STEM (Science, Technology, Engineering and Mathematics). Indeed, equity gaps have been found in all STEM divisions; e.g., physics (ONG, 2005; van Dusen & Nissen, 2019), biology (Jones et al., 2010; Waldrop et al., 2015), chemistry (Apedoe et al., 2008), engineering (Smith, 2011), geosciences (Bernard & Cooperdock, 2018), computer science (DeGraff & Stump, 2018; Galla, 2018), mathematics (Paschal & Taggart, 2021; Wang et al., 2017), medicine (Cole, 1986), and pharmacy (Draugalis et al., 2014; Ragucci et al., 2014).

Equity gaps have also been found between a huge number of groups including ethnic groups (Johnson et al., 2017; Nguyen et al., 2018), gender (Ganley et al., 2018; Vásárhelyi et al., 2021), sexual orientation (Gottfried et al., 2015; Miller, 2018), countries (Cahalan, 2020; Liu et al., 2020), and special education groups (Morgan et al., 2015). In this work, we focus on gender.

Multiple types of gender gaps were identified; examples include opportunity gaps (e.g., Coleman et al., 1966), participation gaps (e.g., Shores et al., 2020), confidence gaps (Roche, 2019), and excellence gaps (e.g., Plucker & Peters, 2016). In this work, we focus on excellence gaps. Clark & Roberts (2019) define them as "the differences in rates of advanced achievement between various groups" (p. 1). They are supposed to exist nearly "in all areas of student activity" (Clark & Roberts, 2019, p. 1).

Finally, research shows that females are underrepresented in the upper performance segments. Although female and male talent share the same learning potential, the former is identified as talented less frequently (Petersen, 2013), and is underrepresented in many fields at top performance levels (Ceci & Williams, 2007; Meyer et al., 2015; Upson & Friedman, 2012) including in STEM (Lincoln et al., 2012; Stoeger et al., 2016). Some data may illustrate the gender gaps in top positions. For example, in the economy only 15% of CEOs at Fortune 500 companies were female in 2022 (Buchholz, 2022). Globally women represent just 27% of all manager positions (World Economic Forum, 2021). Among billionaires, the male-female ratio worldwide is about 9 to 1 (Wai & Kanaya, 2019). Regarding political empowerment, according to the 2021 Global Gender Gap Report and across 156 countries covered therein, women hold only 26% of 35,500 parliament seats and only 23% of more than 3,400 minister appointments worldwide. Shockingly, 81 countries have never had a woman as the head of state (World Economic Forum, 2021). The picture is similarly unbalanced in academia and research. According to the latest statistics from the National Center for Science and Engineering (2021), only in the social sciences do women receive the same number of doctorates as men, although their much larger share among students immediately puts this equality into perspective. In contrast, they received only 32% of the doctorates in economics, 22% in computer sciences, 25% in engineering, 28% in mathematics and statistics, 34% in earth and physical sciences, and 21% in physics.

The "eminence gender gap" (Eagly & Miller, 2016) or “gender-brilliance stereotype” (Storage et al., 2020) is aggravated in STEM by a Matilda Effect, i.e., equal achievements of females are recognized less frequently than achievements of males such as in the allocation of scientific prizes (Lincoln et al., 2012; Williams & Ceci, 2015). Even when women do succeed in pursuing careers in science, their achievements are less likely to be recognized (Sá et al., 2020), as shown for example, by relatively infrequent citations (Jadidi et al., 2018; Huang et al., 2020). For example, Vásárhelyi et al. (2021) report that only 16 to 17% of mentions in online publications in physics, mathematics, astronomy, and engineering were of female authors. Even in psychology, with the highest rate of female authors mentioned at 47%, parity is not achieved.

The Eminence Gender Gap in STEM

The urgency of STEM gender advancement is widely recognized (Benavent et al., 2020; European Institute for Gender Equality, 2021; Poggesi et al., 2020; UNESCO, 2015). Although the situation has improved somewhat in recent years, girls and women are still less likely to choose STEM majors and careers in most countries, especially in disciplines such as engineering and computer science (Wang & Degol, 2017; World Economic Forum, 2021). However, to the best of our knowledge, the underrepresentation of women in top STEM positions has not yet been considered as an intersectionality phenomenon (Cho et al., 2013; Cole, 2009), i.e., they are affected by both the gender gap in STEM and the gender excellence gap. Therefore, to bring about change, two disadvantages rather than one or the other, need to be addressed. This means that successful strategies to close the gender gap in STEM do not automatically imply that the gap will also close at the upper echelons of achievement in STEM. Mutatis mutandis, it also does not imply that successful strategies to close the eminence gender gap will also work in STEM.

One possible strategy for addressing intersectionality is to use interventions that are successful in addressing both the gender gap in STEM and the eminence gender gap. In fact, there appears two promising starting points: The negative stereotypes women face and the lack of role models.

Research has repeatedly found that STEM fields are associated with characteristics such as brilliance, self-centeredness, and analytic strength (Bian et al., 2017; Cejka & Eagly, 1999; Leslie et al., 2015; Storage et al., 2020). These characteristics are more strongly connected to the stereotypical male than the stereotypical female (Ellemers, 2018). In light of this, the hope of Gladstone and Cimpian (2021) and many other researchers seems plausible: “the use of role models is often billed as the one-stop solution for increasing diversity in STEM” (p. 1). Indeed, the importance of role models in STEM has been widely demonstrated (Cheryan et al., 2009; van der Vleuten et al., 2018, 2020). Successful interventions have been developed that expose women to non-stereotypical, successful female role models in STEM (Cheryan et al., 2013; Rosenthal et al., 2013). However, these role models do not yet exist in sufficient numbers. One interesting possibility, however, is the recent transition from STEM to STEAM.

STEAM and the Narrowing of the Eminence Gender Gap in STEM

The STEAM movement is a relatively new branch in education (Khine, 2019; Perignat & Katz-Buonincontro, 2019). It augments STEM with the acronym "A" in reference to the arts and creativity (Conradty & Bogner, 2020; Herro et al., 2017). As a pedagogical tool for teaching non-arts subjects, it shows “promise for learning and retaining academic content, transferring knowledge to other domains of learning, and developing creative thinking and problem-solving skills” (Hardiman & JohnBull, 2019, p. 2). At its essence, the general approach is embedding arts-based activities such as music, drama, dance, or theater into conventionally taught STEM lessons. There are numerous promising ways in which a teacher can authentically connect the arts to the curriculum they teach (De la Garza, 2019; Duo-Terron, 2022). Research shows that arts-integrated science instruction benefits students´ learning in STEM in many ways including the strengthening of long-term memory for science content (Hardiman et al., 2014, 2019); motivation and interests (Conradty & Bogner, 2020; Kong et al., 2014; Kong & Huo, 2014, Rule et al., 2016); self-efficacy (Conradty & Bogner, 2020; Kong et al., 2014; Kong & Huo, 2014); and cultivation of achievements (Yee-King et al., 2017).

Interestingly, several authors have argued that integrating the arts in STEM can help close the gender gap in STEM (Colucci-Gray, 2019; de Vries, 2021; Marín-Marín et al., 2021; Ng & Fergusson, 2020; Oliveros-Ruiz, 2019; Tan et al., 2020). It is assumed that the integration of the arts – where girls' interests and self-efficacy are higher than in STEM coupled with the transdisciplinary, interdisciplinary, and multidisciplinary teaching process in particular – is more accommodating to girls (Bassachs et al., 2020; Marín-Marín et al., 2021). The latter assumption is also consistent with recent findings in expertise research that multidisciplinary practice, rather than early specialization, predicts world-class performance (Güllich et al., 2022). However, although we believe these assumptions are quite plausible, to the best of our knowledge, detailed empirical studies supporting these suppositions are still lacking (Colucci-Gray et al., 2019).

The stereotypes that literature and the arts are female domains while STEM is a male domain is well documented in natural language and corpora (Charlesworth et al., 2021; Nosek et al., 2002a, 2002b; Peng et al., 2021). This strengthens the field's claim that a smooth integration of arts into STEM might be beneficial for girls. In essence, under the umbrella of STEAM, non-stereotypical, female role models from the top tiers of arts might also "inoculate" against the male STEM stereotype (Dasgupta, 2011; Dennehy et al., 2018). But do these role models in the arts also exist in the top tiers of artistic achievement?

The Current Research

Nobel Prizes and prizes known as the Nobel, or the highest honors of a field receive immense attention. They reveal which individuals are internationally regarded as the best in their field. Without a doubt, they also serve as a guide to how and who reaches eminence in a field and can, as a result, act as role models of success within it (Frischeisen, 2018). Natalie Matosin (2021) asserts, therefore, that a lack of leading females means a lack of female role models. Accordingly, in our study, we focused on the top ten awards in STEM and in the arts. We pursued three research questions.

In the first research question, we are interested in whether and to what extent gender gaps exist in Nobel Prizes and prizes known as the Nobel, or the highest honors of a field in STEM and in the arts. In STEM, we expect the well-known gender gap to the disadvantage of females. We also expect a gender gap in the arts because of the eminence gender gap. However, it may be reduced there because of the much less pronounced male image of the arts. Nevertheless, caution is warranted here. For example, "creative" is a male-typed trait (Proudfoot et al., 2015); a profession such as musician is more likely to be perceived as male (Charlesworth et al., 2021). All in all, we expect the results of the analyses will shed light on whether the arts can proliferate role models to STEM in an integrated STEAM education.

In our second research question, we are interested in whether gender gaps in Nobel Prizes and prizes known as the Nobel or the highest honors are equal across individual STEM fields and across the individual arts. Indeed, female underrepresentation is not the same in all STEM fields (Cimpian et al., 2020). For example, female underrepresentation in bachelor degrees in the United States in engineering, computer science, and physics is most pronounced in STEM fields (< 20%). The situation is already much better in mathematics and chemistry (± 40%), and women even slightly outnumber men in biological sciences (± 55%; Cheryan et al., 2017). Consequently, Veldman et al. (2021) criticize that previous research often either collapsed all STEM subjects or treated them as isolated subjects. Yet the large variances suggest field-by-field considerations. Such variances are also found in the arts (Alexander, 2020; Gan et al., 2014; Korsmeyer, 2004; Topaz et al., 2019). Thus, the detailed consideration of individual fields should allow for indications of whether certain fields in the arts (and STEM) may be better suited to exposing women to top-tier female role models in an integrated STEAM education.

In the third research question, we are interested in trends in Nobel Prizes and prizes known as the Nobel or the highest honors. Evidence suggests that the situation of women in STEM has improved, although they remain less likely to choose STEM majors and professions, especially in disciplines such as engineering and computer science (Meinck & Brese, 2019; Wang & Degol, 2017; World Economic Forum, 2021). Similarly, female representation in top positions appears to be improving (Ziegler et al., 2020). Noting encouraging trends in closing equity gaps in awards would be interesting from a pedagogical perspective. After all, even if equity gaps were still found, the development of role model interventions in the top tiers of STEAM might then, be a worthwhile future investment.

Method

In our study, we included the top ten international awards for STEM and the (contemporary) arts that offer winners near absolute distinction in their respective fields, from 1980 to 2021 (see Appendix Table 1). Our selection accounted for four criteria. (1) Restrictions: The award is open to candidates regardless of factors such as nationality or gender. (2) Fields: By 'the arts', we refer to the visual arts (e.g., architecture, ceramics, painting, photography), literary arts, and the performing arts (e.g., dance, music, theater). With regard to STEM, beside the classical fields such as Biology, Chemistry, Mathematics, we also include applied sciences (e.g., the Charles Stark Draper Prize and the ACM A. M. Turing Award for engineering and the computer sciences; Brown, 2011). (3) Time period: Since we wanted to compare two equal periods – before the turn of the millennium and after the turn of the millennium – all awards should have been granted no earlier than 1980, with the notable exception of the Praemium Imperiale and its now overwhelming importance across the arts. (4) Award frequency: To be able to track awards over time and in a manner that is as differentiated as possible, as well as to obtain the necessary test power, only awards that are presented annually were considered. An exception was the Fields Medal in mathematics, which is awarded to four recipients every four years. Since it is by far, the most prestigious award in mathematics, we decided to alphabetically assign, in ascending order the four winners to the four years of an award cycle. As it turned out, it did not matter which assignment method would have been chosen. (5) Prestige: Prestige associated with an award is obviously a construct that is notoriously controversial. However, it connotes wide or universal acclaim on the basis of perceived achievement. Additionally, when something is said to have accrued prestige, it becomes a benchmark against which similar other things are measured (Labov, 2006). For example, the Nobel Prizes – of which there is no award in maths – and the Fields Medal indicate high achievement. Nonetheless, it is the quadrennial Fields Medal that is known as the 'Nobel Prize of Math' (Castelvecchi, 2020; The Associated Press, 2006; Ross, 1995). Indeed, the Nobel Prizes are prestigious, and are selected as the standard against which we – in this paper – distinguish the highest honors afforded to arts practitioners to draw meaningful conclusions about high achievement around the world. That is to say, the prizes for arts are themselves the 'Nobel Prizes' of a given arts category. For example, the Pritzker Architecture Prize is widely considered the Nobel Prize of architecture (Aridi, 2019; Endicott, 2012; Harmata, 2020).

Statistical Analyses

We assessed our three research questions using a 2 X 2 X 2 X 10 hierarchical log-linear analysis. The four independent variables were gender (female vs male), award type (STEM or arts), and award (ten different awards per award type). As a fourth variable to provide information about possible change, we dichotomized the years of the award into the years of the last millennium (1980-2000) and the current millennium (2001-2001). The goodness-of-fit could not be calculated because this model is a saturated model. To test effects for significance, we used backward elimination statistics (Vermunt, 2005). Though the assumption of expected cell frequencies was not met, this will not increase the likelihood of Type I error; however, it is expected to decrease the overall power of the analysis (Tabachnick & Fidell, 2012). We will address the latter point in the discussion section.

Results

We pursued three research questions: First, we wanted to know whether and to what extent gender gaps exist in the highest awards bestowed in STEM and in the arts. We hypothesized the well-known gender gap to the disadvantage of females in the STEM fields. However, we also expected to find evidence for the eminence gender gap: a gender gap in the arts. The cross-tabulation of different prize types and genders for the time periods from 1980 to 2000 and 2001 to 2021 is summarized in Appendix Table 2. Overall, in the 42-year period covered, women in STEM received a total of 29 of the 655 awards, which is only 4.4%. In the last millennium, however, only 7 out of 299 winners were women (2.3%). After the year 2000, there were 22 female winners out of 356 (6.1%). The percentages are higher in the arts, where a total of 86 out of a total of 1039 awards were given to women (8.3%). Again, across the arts fields, a higher percentage of awards went to women before 2001. By the turn of the century (1980-2000), women received 3.9% of arts awards, or 18 wins out of 469 total (arts) prizes. This trend continued into the new millennium, where 11.9% or 68 out of 570 total (arts) prizes were awarded to women. These statistics are thus, far from gender balanced. Applying backward elimination statistics, we found a significant main effect for gender, χ^2 (1) = 847.12, $p < .001$. However, the main effect was qualified by a significant interaction of gender and award type, χ^2 (1) = 36.18, $p < .001$. The gender gap is even larger in STEM.

In our second research question, we were interested in whether gender gaps are equal across individual STEM awards and across the individual arts awards. By way of a re-application of backward elimination statistics, we did indeed find a significant 2-way interaction of awards and gender, χ^2 (9) = 24.51, p = .004. However, the 3-way interaction between awards, gender, and award type was ultimately, not significant, χ^2 (9) = 0.50, p = .50. Thus, in both domains: arts and STEM, there were equal differences in the likelihood of individual prizes being awarded to women. In STEM, the two prizes with the highest proportions of women winners were the Nobel Prize Medicine (11.2%) and the ACM A.M. Turing Award (6.7%). In contrast, there were three prizes that were either not awarded at all (W. Wallace McDowell Award) or only once awarded to a woman during the time period considered (Fields Medal, Honda Prize, Timoshenko Medal). In the arts, about a quarter of the winners of three prizes were women (Nobel Prize Literature, Praemium Imperiale Sculpture, Praemium Imperiale Film/Theatre), although there were three prizes for which women received less than 10% (Ernst von Siemens Music Prize, Praemium Imperiale Architecture, Academy of Motion Picture Arts and Sciences Award).

Our third research question addressed the possibility that more awards were given to women after the millennium. Indeed, this was the case, as evidenced by the significant 2-way interaction of gender and time period, χ^2 (1) = 23.91, $p <$ .001. However, the time trend extended equally to both domains, as indicated by the non-significant 3-way interaction of gender, award type, and award year, χ^2 (1) = 0.13, p = .72.

Discussion

Despite multiple efforts, talented women in STEM are underrepresented in the upper achievement segment (Benavent et al., 2020; European Institute for Gender Equality, 2021; Poggesi et al., 2020; UNESCO, 2015). One difficulty in changing this unsatisfactory situation is presumably that they are not only affected by the equity gap in STEM, but also by an excellence gap (Eagly & Miller, 2016; Storage et al., 2020).

To improve the situation of women in STEM, many scholars have suggested an extension that includes the arts: STEAM (Colucci-Gray, 2019; de Vries, 2021; Marín-Marín et al., 2021; Ng & Fergusson, 2020; Oliveros-Ruiz, 2019; Tan et al., 2020). As the importance of role models in STEM has been widely demonstrated (Cheryan et al., 2009; van der Vleuten et al., 2018, 2020), exposing women to non-stereotypical, successful female role models seems to be a promising intervention strategy (Cheryan et al., 2013; Rosenthal et al., 2013). However, as role models do not yet exist in sufficient numbers in STEM, an interesting possibility might be to piggyback on arts role models in an integrated STEAM education.

Results are consistent with our estimations in research questions 1 and 2. We expected to see a significant gender gap in STEM to the disadvantage of female talent. In 42 years of STEM awards (1980-2021), 95.7% of award recipients have been male. Indeed, in 42 years of STEM awards, the Nobel Prize committee has not selected a single female winner in the category of Physics. We also expected a gender gap in the arts because of the eminence gender gap. We hypothesized that said gap would be narrower than in STEM because the arts are considered less stereotypically male (Ellemers, 2018). Indeed, the gender gap in the top arts awards is somewhat less pronounced than in the top STEM awards. Nevertheless, in 42 years of arts awards, 85.2% of award recipients have been male. More specifically, between 1980 and 1990, a woman on the verge of eminence was more likely to find prestige in STEM than in any arts field: from 1980 to 1990, there were no female recipients among any of the artist winners across the ten arts awards. These low numbers of winners in the arts make it seem rather unlikely that an integrated STEAM education could contribute to narrowing the gender gap at the top tiers of STEM. This concern is quite realistic because the effects of counter-stereotypical role models is by no means straightforward (Betz & Sekaquaptewa, 2012; Chhaochharia et al., 2022; González-Pérez et al., 2020). While there are more female role models in arts than in STEM, they are still clearly in the minority in the highest achievement segment and thus, there is a real possibility that their exposure also confirms the traditional stereotype of successful men. In this respect, paradoxically, the inclusion of female role models from the arts in STEAM could result in the stereotype of the successful male becoming further entrenched, as even in the arts – which is more associated with femininity – men dominate the top ranks. Therefore, further research should keep this unpalatable possibility in mind, paying particular attention to the factors known in the literature to be associated with successful counter-factual models and specifically, looking for others. Another problem is the high variability among the arts and the STEM prizes. Consider that within the context of the 20 awards presented in this paper, female talent is more likely to receive a Nobel prize in Medicine than in any other STEM field and likewise, a Praemium Imperial in Sculpting than in any other arts field. As of the publication of this paper, women are more likely to win a Nobel Prize in Medicine than the Ernst von Siemens Music Prize, the Praemium Imperial in Architecture, or the Academy Award for Best Director. In fact, female talent is more likely to find eminence through the ACM A.M. Turing Award which -outside of the Nobel Prizes- carries the largest purse (the prize money is 1,000,000 USD) than she is likely to receive an Academy Award for Best Director (see Appendix Table 2). Therefore, when importing role models from the arts into STEM in an integrated STEAM education, careful attention must be paid to which of the arts practices can appropriately produce role models for up-and-coming talent, for the variance is still very large.

For the third research question, we found that, encouragingly, the proportion of women in awards in STEM and the arts increased since the turn of the millennium. The increase did not differ significantly, but the female share in the arts tripled from a higher baseline of 6.5% to 21.5%, while in STEM, the female share of awards has not even doubled – from 3.8% to 6.2%. Due to the limited number of awards given in the period under consideration and that the assumption of expected cell frequencies was not met (Tabachnick & Fidell, 2012), the overall power of the analysis could be insufficient to detect differential improvements. Nonetheless, a highly interesting point that deserves further research is the assumption that in the arts, the number of excellent role models could grow faster than in STEM. Indeed, in an integrated STEAM education, the reasons for this stronger growth could provide clues as to where promising starting points in the STEM section can be found. However, the lack of female top models and the rather slow proliferation of new role models at the top tiers raise the fundamental question of whether to better focus on models at other career stages. There is evidence that successful models are still within reach of observers with a perceived identity compatibility (Drury et al., 2011; Lawner et al., 2019; Shin et al., 2016). Particularly in the arts, suitable models for the next career stage are available in greater numbers than in STEM. Perhaps, therefore, there should be a rethinking of the role models selected and a refocusing from exceptional to attainable models.

While female representation in STEM is improving, seminal work across the field of talent development suggests that female talent is concentrated toward the beginning of the STEM pipeline, eventually and significantly narrowing at the tail end (van den Hurk et al., 2019). That is to say, women are exiting STEM fields before they reach eminence (Liu et al., 2019; Raabe et al., 2019; Witteveen & Atte-well, 2020). This is important because while in principle, a non-degreed talent can receive a Nobel Prize – the prize is awarded for quality of work – in 120 years, and out of 975 laureates, only one non-degreed person has ever received the honor: Marie Curie for her PhD thesis in 1902 (Curie, 1961; Wolke, 1988). While our research only looked at excellent models at the peak of their career, during which talents received the highest prize in their field, future studies might also look at the trajectories of career development in the lived experiences of these excellent models. These very models are needed not only as examples of end points of career development, but also at each change or transition upward on the ladder of eminence: at the very points at which members of at-risk groups are in danger of letting go of the rung on the ladder toward the top.

Finally, we want to focus on an aspect that has not received enough attention in research so far. We, too, have only discussed the effect of female role models on women. However, their effect can of course also extend to men. However, the intended effects in view of the male hubris, female humility effect (Furnham et al., 1999) could be contradictory (Reilly et al., 2022). While an empowering effect on female observers is desired, a more realistic view of one's own potential relative to female potential that also extends to male observers is welcomed. Future research on the effects of successful female role models in STEAM should therefore include effects on boys. If women are to realize their STE(A)M potential, it is not only crucial that they believe in themselves; men, who act as gatekeepers in many places, must also learn to assess the potential of both genders fairly.

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Appendix

Table 1

International Prestige Awards in Science, Technology, Engineering, Arts, and Mathematics (STEAM)

AWARD	FIELD	SINCE	PRIZE MONEY (USD)
STEM 'Nobel Prizes'			
Nobel Prize Chemistry	Chemistry	1901	1,103,435.00
Nobel Prize Medicine	Medicine	1901	1,103,435.00
Nobel Prize Physics	Physics	1901	1,103,435.00
Fields Medal	Mathematics	1936	11,829.32
Charles Stark Draper Prize	Engineering	1989	500,000.00
ACM A.M. Turing Award	Computer Science	1966	1,000,000.00
Honda Prize	Ecotechnology	1980	86,860.00
W. Wallace McDowell Award	Information Technology	1966	2,000.00
Timoshenko Medal	Applied Mathematics	1957	2,500.00
Dannie Heineman Prize	Astrophysics	1980	10,000.00
The Arts 'Nobel Prizes'			
Nobel Prize Literature	Literature	1901	1,103,435.00
Hasselblad Foundation International Award	Photography	1980	110,448.00
Ernst von Siemens Music Prize	Music	1974	283,947.50
Pritzker Architecture Prize	Architecture	1979	100,000.00
Praemium Imperiale Painting	Painting	1989	129,966.75
Praemium Imperiale Sculpture	Sculpture	1989	129,966.75
Praemium Imperiale Architecture	Architecture	1989	129,966.75
Praemium Imperiale Music	Music	1989	129,966.75
Praemium Imperiale Film/Theatre	Film/Theatre	1989	129,966.75
Academy of Motion Picture Arts & Sciences Award	Best Director	1929	0.00

Note. The Fields Medal and the Charles Stark Draper Prize take place quadrennially and biennially, respectively. However, more than one winner is typically selected: four winners for the Fields Medal and two for the Charles Stark Draper Prize.

Table 2

The cross-tabulation of different prize types and genders

	STEM										
	1980-2000			2001-2021			Sum				
Item	M	F	Sum	M	F	Sum	M	M %	F	F %	Sum
Nobel Prize Chemistry	42	0	42	49	4	53	91	95.8%	4	4.2%	95
Nobel Prize Medicine	42	4	46	45	7	52	87	88.8%	11	11.2%	98
Nobel Prize Physics	47	0	47	55	2	57	102	98.1%	2	1.9%	104
Fields Medal	21	0	21	15	1	16	36	97.3%	1	2.7%	37
Charles Stark Draper Prize	25	2	27	44	1	45	69	95.8%	3	4.2%	72
ACM A.M. Turing Award	25	0	25	31	4	35	56	93.3%	4	6.7%	60
Honda Prize	20	1	21	24	0	24	44	97.8%	1	2.2%	45
W. Wallace McDowell Award	20	0	20	21	0	21	41	100.0%	0	0.0%	41
Timoshenko Medal	21	0	21	20	1	21	41	97.6%	1	2.4%	42
Dannie Heineman Prize	29	0	29	30	2	32	59	96.7%	2	3.3%	61
Sum	292	7	299	334	22	356	626	95.6%	29	4.4%	655
	ARTS										
	1980-2000			2001-2021			Sum				
Item	M	F	Sum	M	F	Sum	M	M %	F	F %	Sum
Nobel Prize Literature	18	3	21	14	7	21	32	76.2%	10	23.8%	42
Hasselblad Foundation International Award	18	2	21	16	6	22	34	81.0%	8	19.0%	42
Ernst von Siemens Music Prize	24	0	24	18	3	21	42	93.3%	3	6.7%	45
Pritzker Architecture Prize	22	0	22	21	6	27	43	87.8%	6	12.2%	49
Praemium Imperiale Painting	13	0	13	16	4	20	29	87.9%	4	12.1%	33
Praemium Imperiale Sculpture	10	3	13	15	6	21	25	73.5%	9	26.5%	34
Praemium Imperiale Architecture	11	1	12	20	2	22	31	91.2%	3	8.8%	34
Praemium Imperiale Music	11	1	11	17	3	20	27	87.1%	4	12.9%	31
Praemium Imperiale Film/Theatre	11	1	12	12	7	19	23	74.2%	8	25.8%	31
Academy of Motion Picture Arts and Sciences Award (Academy Award)	21	0	21	19	2	21	40	95.2%	2	4.8%	42
Sum	159	11	170	168	46	214	327	85.2%	57	14.8%	384
Total	451	18	469	502	68	570	953	91.7%	86	8.3%	1039