Update Sciences & technologies

GENDER IN RESEARCH

Evaluation and knowledge production

Edited by
Laurence Guyard, Magalie Lesueur-Jannoyer and Angela Zeller

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Content

Introduction

Laurence Guyard, Magalie Lesueur-Jannoyer, Angela Zeller

In France, disparities between men and women are still prevalent in higher education and research, to a similar extent as that observed at the European level (Ministry of Higher Education and Research, 2023). The gendered structure of our societies is reflected at every level of the social organization and the academic system is no exception. The general observation is that there are fewer and fewer women the higher up the academic ladder one goes. This phenomenon can be explained by long-standing stereotypes, the invisibility of women's work in the academia, the 'boy's club' mentality of male-dominated networks and the fact that work-life balance is more complex for women, since domestic work still weighing more heavily on them than on men. Despite the emergence of various fields of research on gender—their goal being to deconstruct the ideas and preconceptions underpinning 'masculine' and 'feminine' identities, as well as the social roles that women and men are expected to play, which legitimise the domination of men over women and are justified by an inevitable biological and psychological determinism (Löwy and Marry, 2007)—stereotypes and inequalities persist. There is still a strong tendency to essentialize differences between women and men, perpetuating a (re) production of gender relations justified by a 'natural' distinction between women and men and introducing 'ideological' biases into the production of knowledge (Mathevon and Viennot, 2017). However, these differences cannot be reduced to a simple dichotomy between men and women: they should be seen as a complex and dynamic interaction between sex and gender (Springer *et al.*, 2012). The use of gender as a methodological and interdisciplinary tool counteracts these ideological biases and enriches research by creating a meeting space between different scholarly realms. However, aside from the social sciences, most of the research community is still reluctant, even sceptical, about using the concept of gender (Mathevon and Viennot, 2017) as a 'heuristic' (Marry, 2011) and methodological tool, even though calls to take gender and/or sex into account in research have been multiplying since the 1960s.[1]

Research into these issues remains challenging insofar as it questions our social organisation based on domination. Suspicions about the intentions of the researchers involved in these processes, such as those that sparked a debate in France in 2020, bear witness and underline the need to reaffirm the importance of social sciences founded on epistemological and methodological principles in terms of the insights they provide on society and its complexities (Jacquot and Ledoux, 2021).

1. http://genderedinnovations.stanford.edu/policy/timeline.html

Filling this knowledge gap is all the more pressing because the above inequalities persist, despite all the dedicated public policies implemented at national and European levels over the past twenty years or so. In the field of research and higher education, the French Act of 22 July 2013[2] was consolidated by the publication of an agreement on professional equality between men and women in the civil service in 2018, followed by the 2019 Act[3] relating to the transformation of the civil service, and Decree no. 2020-256 of March 2020 implementing Article 80 of that same Act. The goal of this legislation is to make it compulsory and binding for each institution to set up Gender Equality plans—with specific, purposeful actions and a proactive schedule—covering human resources management, the prevention of gender-based and sexual violence (GBSV) and the inclusion of sex and/or gender in research. These legislative measures are consistent with the policies and actions implemented by the European Union over the last two decades. To make its policies more effective, the European Commission has gradually shifted from gender equality to gender mainstreaming. This consists of institutionalising the incorporation of gender into public policy-making, as the notion of gender reveals the hierarchy between women and men more effectively.

In line with this gender mainstreaming approach and funded by the Horizon 2020 research and innovation programme, the Gender-SMART project, coordinated by the CIRAD[4] (French Agricultural Research Centre for International Development) and in which the French National Research Agency (ANR) was a partner alongside seven other European institutions, involved the development and implementation of Gender Equality Plans in research and funding organizations. The aim of these plans was to bring about lasting cultural and institutional changes in favour of gender equality, and to encourage scientific communities to take the sex and/or gender dimension into account in their research. For the ANR and the CIRAD, participating in this project was an opportunity to benefit from a structural framework and the support of technical partners with expertise in gender sociology (Institute of Sociology, Czech Academy of Sciences, ISAS, Czech Republic) and institutional change (Yellow Window, Belgium), in order to meet French statutory obligations. Following a self-assessment phase at each partner institution, action plans were drawn up and implemented. Guidelines on how to institutionalize gender equality in a sustainable way were also drawn up and published. During the course of the project, the potential for gender bias in the conduct of research and in its assessment not only emerged as an issue needing to be addressed through the future plans, but also highlighted the need for concerted action between the various stakeholders involved in research, to ensure coherence and thereby greater efficiency. This is how the ANR and the CIRAD came up with the idea of creating a space for scientists and funding bodies to exchange ideas and debate on this issue. The existence of gender biases in evaluation processes has already been demonstrated, whether for recruitment, promotion or funding allocation purposes and regardless of the scientific field (see Wennerås and Wold, 1997; Régner *et al.*, 2019). These biases highlight the gendered division of the academic world and contribute to perpetuating and reinforcing inequalities between men and women.

2. Act no. 2013-660 of 22 July 2013 on higher education and research.
3. Act no. 2019-828 of 6 August 2019 on the transformation of the civil service.
4. All the French acronyms are kept because they are known as such by the international and French communities.

While training and awareness-raising are decisive in countering gender bias, they are not sufficient. Indeed, potential gender biases in evaluation processes as well as the source of such biases still need to be systematically identified and measured. Given the complexity of the phenomena that can lead to unfair or discriminatory evaluation, the question of methodological approaches and tools is essential. However, it is important to remember that if these gender biases brought about by embedded and subconscious gendered representations can interfere in evaluation processes, they can also determine and influence scientific approaches.

Inspired by all these issues, the ANR and the CIRAD organized a symposium on *Gender in Research* in December 2020, with the aim of establishing a dialogue between scientists, funding agencies and research project evaluators. For the ANR, this event was also an opportunity to showcase the projects it funds on the topic of gender issues in evaluation and knowledge production processes, as well as to provide a platform for the scientists involved in its evaluation processes to share their experiences as chairpersons of the ANR assessment committees.

After an opening address by the French Minister for Higher Education and Research and an introduction by the ANR and the CIRAD management teams, the day began with morning presentations on gender issues in evaluation processes, followed by a round-table discussion with assessment committee chairpersons. The afternoon presentations focused on gender bias in knowledge production and were followed by a round-table discussion with other committee chairpersons.

Initially planned as a face-to-face event, the Covid-19 pandemic meant that the symposium had to be reorganized and held remotely. It brought together 500 people over the course of the day. The attendees, mostly women (80%), included scientists from a wide variety of disciplines and institutions, research support and communication professionals, journalists and politicians. In view of the interest generated by this symposium and the wealth of conference papers, all of which filled gaps in the literature and expertly demonstrated the complexity of the mechanisms leading to the (re)production of inequalities. Therefore, it quickly became clear that we needed to gather these works and thoughts into a single publication to keep the momentum going and communicate beyond the event. Unfortunately, not all papers could be included in this book, as they have already been published elsewhere or are forthcoming.[5] However, additional contributions have been added to provide further food for thought.

This book is novel in that it brings together contributions from both scientists and funding agencies to reaffirm the importance of coherent action and, above all, the idea that everyone involved in research can address gender issues. We have organized the contributions into three parts, which was not an easy task given their diverse nature. Indeed, as the contributions come from scientists as well as funding bodies, there is a wide variety of contexts, registers and analyses. Nevertheless, a common thread remains in that they all bear witness to the complexity of the subject of inequalities. In the first part, two funding agencies and a research project address the issue of gender bias in

5. Delphine Martinot, *Pourquoi la meilleure réussite scolaire des filles ne se traduit-elle pas par une meilleure représentation des femmes dans les disciplines universitaires et les carrières socialement prestigieuses ?* ANR GENIM project, Régner *et al.*, 2019; Michal Raz, *Les Transformations des savoirs et des pratiques biomédicales autour de l'intersexuation en France*, EHESS.

assessment processes. The second part contains a researcher's contribution on gender studies in the field of development, another one recounting an experiment conducted at the ANR and a last one exploring resistance within the context of a research project. All three analyse the obstacles to including a sex and/or gender dimension in research, while reaffirming its necessity as a means of preventing gender bias in the production of knowledge. The third and last part consists of three research projects, one showing the scientific discoveries that can be made by introducing the question of sex determination, and two others, based on reflexive feedback, discussing what is at play when this question is introduced in the field of agriculture and food.

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Part I

Assessment and potential gender bias

For over twenty years, studies have shown the presence of persistent gender biases in the academic world in general and, more specifically, in evaluation processes, whether for research funding allocation, recruitment or promotion (see Wennerås and Wold, 1997; Régner *et al.*, 2019). These biases can have a lasting effect on the careers of female researchers. That's why, as key players in the research landscape, in that they organize funding allocation processes through peer review, funding agencies are increasingly introducing measures to remove potential gender biases from their processes. Among other things, these measures are consistent with commitments made and formalized in action plans or charters. In practice, they lead to the defining and publishing of qualitative assessment criteria, as well as the analysis of application and selection data, the goal being to identify and measure these biases to then implement measures to correct them.

The first two chapters of this part illustrate these commitments and present the results of analyses carried out initially by the French National Research Agency (ANR), and then by the FRS-FNRS, the funding agency in French-speaking Belgium. The third chapter details the findings of the GIGA project, which analysed each stage of the assessment process for the EUROCORES (European Collaborative Research Scheme) programmes, to identify precisely where, when, by whom and according to which criteria gender bias may be introduced into the process.

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Chapter 1

Gender and assessment of project-based research: the ANR's commitments and measures

Laurence Guyard

Project-based research funding and assessment issues

The science policies rolled out since the beginning of the twentieth century have made science strategically important and defined the systems for allocating resources to researchers for their work. From the outset, countries such as the United Kingdom, the United States, Germany and Japan opted for project-based research funding, with the creation of funding agencies.

In France, as the founding of the CNRS (National Centre for Scientific Research) in 1939 shows, the decision was taken to set up organizations that would finance their research laboratories and pay the salaries of their researchers (Gingras, 2014). Things only began to change in the 2000s, in the wake of the Lisbon Strategy and its goal of making the European Union the most dynamic and competitive knowledge-based economy in the world by setting research and innovation spending at 3% of GDP for every Member State. At the time, France created institutional mechanisms such as the competitiveness clusters of 2004. However, the real turning point came with the creation of the French National Research Agency (ANR) in 2005, which placed project-based research funding at the heart of the French system.

According to the French decree of the 1st August 2006, amended on the 24th March 2014, the role of the ANR is to support excellence in French research, whether fundamental or 'targeted' (aimed at supporting public policy-making), conducted within a national, European or international public-private set-up. It has therefore become a major player in the French research system and a privileged observatory of project-based research practices, on which it has a duty to report. The agency has a specific budget dedicated to funding the research projects selected. Initially set at 669 million euros in 2005, this budget rose to 834 million in 2008 before gradually falling to 527 million by 2015, calling into question the very existence of the agency in view of the low project selection rate. Subsequently, a new phase of growth brought the budget to 780 million by 2020. This growth then accelerated with the passing of the 2020 Research Programming Act and the release of a stimulus package in the same year, bringing the budget to 1.1 billion

euros by 2022. While some agencies carry out their own research programming, the Ministry of Higher Education and Research has the final say on the ANR's research programme, which is drawn up based on National Research Strategy (SNR) guidelines, in conjunction with European and international research funding initiatives. Programme Steering Committees (CPPs) provide guidance for drawing up the ANR's annual Action Plan, which is structured around four key areas—each with their own budget—, funding instruments and calls for proposals. The generic call for proposals (AAPG) is the agency's main call, mobilizing five funding instruments to support individual research projects led by young researchers (JCJC), ambitious research projects led by a team (PRME), collaborative research projects between public entities in a national (PRC) or international (PRCI) context, and collaborative research projects between public and private entities creating a bridge to the business world (PRCE). The policies pursued over the past fifteen years have sought to bring public and private research closer together, encouraged researchers to set up businesses around innovations resulting from public research, and supported the development of local research and innovation ecosystems (Damerval, 2022). The ANR's Action Plan also includes specific calls to support such partnerships. Others are geared towards Europe and the rest of the world, as part of multilateral programmes and strategic bilateral partnerships.

The researchers targeted by these calls respond by submitting a research project proposal individually or as part of a consortium. These proposals are then submitted for peer review by scientific assessment committees, with additional expert opinions provided by peers in the fields concerned by the proposals and external to the committee.

Peer review plays a key role in this system. It was originally set up to guarantee an assessment process that was independent from the institutions employing scientists, as recommended by Polanyi as early as 1962 in his *Republic of Science*. Now, it is internationally recognized and accepted as an integral part of the scientific production process and a way of guaranteeing research integrity (Biagioli, 2002). Introduced in the seventeenth century by the academies of science to manage the publication system independently, away from socio-political interests, peer review as a principle has developed and adapted to the needs of science, becoming a co-product of the social organization of science (Zuckerman and Merton, 1971). Peer review creates a continuous loop, enabling peers to build on each other's work. Those being evaluated benefit from the reports and opinions of the evaluators to take their work to the next level. As for evaluators, by learning about the creative ideas of their peers, they can improve their own work and become more creative themselves. In a sort of virtuous circle of scientific emulation, peer review enables the highest levels to be attained (Zuckerman and Merton, 1971). It acts somewhat as a disciplinary system disciplining disciplines in the Foucauldian sense, with researchers disciplining each other in turn (Biagioli, 2002). However, if this assessment process is not sufficiently supervised, it can be highly arbitrary, as shown by the potential or actual abuses described in numerous studies. The main risk comes from imprecise or undefined assessment criteria, which lead to interpretative bias. A quantitative assessment has been introduced in funding agencies, where figures have long been regarded as objective, to keep exchanges in check and progress more rapidly towards a collective decision. Otherwise, following the example of the National Science Foundation (NSF, USA), bibliometrics was used from the early 1970s to ensure that selected projects were led by the best scientists (Gingras, 2014). Diverted from their

original purpose to provide supposed objectivity, bibliometric indicators and their use in the evaluation process have transformed 'the pressure to publish into a strict imperative' (Stengers and Drumm, 2017).

In addition, the notion of excellence driven by managerial culture (new public management) encourages researchers to be hyper-productive. They need to be ever more prolific, especially in terms of publication, ever more internationally mobile and ever more competitive in the race for research credits (Dubois-Shaik *et al.*, 2019). Scientists are caught up in a paradoxical situation where they need to perform as individual researchers, but are also assessed on their ability to join networks and take part in prestigious collaborative research projects (Jouvenet, 2011). Institutional pressure on researchers was already high in the last century, with 'greedy institutions' (Coser, 1974) expecting total commitment and involvement from researchers. It is intensified now that that institutions have entered a battle for positioning in the research area and that laboratories have begun a competition for funding. If researchers want to meet the criteria for excellence, they must provide evidence of their performance, which includes scientific production, awards, funding, mobility and participation in collaborative projects at national and, above all, international levels.

Not all participants are on an equal footing in this competitive arena, for women the game is much tougher, as the criteria for excellence are still much more favourable to men. Women may find it much harder to meet expectations in terms of scientific production and mobility at the right time, especially internationally, due to maternity and the unequal division of domestic work, which still weighs more heavily on women than on men (Puech, 2005). The recent Covid-19 health crisis has been a powerful example of these inequalities, even as it reinforced them (Chasserio and Bollaert, 2020). Furthermore, and for the same reasons, women find it more difficult to take part in conferences, which accentuates the invisibility of their work and hinders their ability to network. However, the fact that there are fewer and fewer women the higher up the academic ladder one goes is not solely linked to these objective individual constraints. Social influences are also at play—with motherhood more or less seen as duty—as are gender stereotypes more generally. For example, the image of the 'good' mother totally devoted to the care and education of her children suggests that being a mother and having a career, especially in a profession that is above all a 'passion', in a 'greedy' sector like research, is incompatible, if not impossible. Such images not only lead many women to forgo having children (Marry and Jonas, 2005), but also result in biases in the assessment of female candidates, as women are considered as mothers by default and therefore potentially less available. For those who have had children early in their careers, motherhood may have had an impact on their scientific output, which means they are often considered less productive and, consequently, less successful. These stereotypes are abundant. Youth is another good example. It is seen as a sign of vigour and ambition in a man, whereas in a woman, it is associated with weakness and immaturity. The real issue is that these stereotypes are often unconscious, and that is why they can interfere with selection processes. Although relative gender parity is systematically sought in assessment committees, it does not mean that gender bias is absent. Indeed, the absence of gender bias is primarily correlated with the degree of belief in the existence of such biases (Régner *et al.*, 2019), regardless of the gender of committee members.

⏩ The ANR's commitments and programmes

In light of the literature on the challenges of evaluation processes, and at a time when the spotlight is on scientific integrity and the social responsibility of sciences, funding agencies—including the ANR—that have joined European and international collectives, such as Science Europe,[6] CoARA[7] (Coalition on Advancing Research Assessment) and The Global Research Council[8] (GRC), have set the ball rolling to think about how to update research evaluation processes, especially by defining more qualitative and inclusive criteria. The signing of the San Francisco Declaration (DORA) by the ANR in 2018 is proof of its commitment to stop using bibliometric indicators to evaluate the research proposals it receives. However, to guarantee the robustness of these processes, since its creation, the agency has progressively defined and enriched a general framework of principles, and rolled out a set of measures to guide it in fulfilling its commitments.

Controlled and certified selection processes

To guarantee the effectiveness of its actions and the quality of project selection, quality control measures have been applied by the ANR since 2007. As part of this approach, the agency has received an ISO 9001 certification for its selection processes. Awarded in 2008, this certification has since been renewed. It covers all stages of the selection and monitoring process, from the submission of projects in response to a call for proposals, to selection, contracting and project closure. This certification also guarantees that the selection process complies with international selection principles: impartiality, fair treatment, confidentiality, ethics and transparency. These principles are also enshrined in the agency's code of ethics, which was revised in 2018 to include scientific integrity and gender equality. This charter sets out the general purpose, the principles and the rules guiding the action and behaviour of internal and external staff taking part in its activities. Each project evaluator undertakes to respect them and to declare any relationship which, depending on its nature and strength, could constitute a conflict of interest in the context of the evaluation. The ANR pays particular attention to these conflicts of interest and carries out a systematic check for any potential relationships before soliciting peers, since such conflicts are a major source of bias and unfair treatment. To communicate more clearly on the coherence of its policy on ethics, scientific integrity and professional conduct, the ANR published a reference document in 2023, setting out the principles and procedures for implementing them. The document includes a detailed description of the procedure for managing conflicts of interest.

Assessment committees are set up and operate in keeping with a certified procedure. Committees are made up of a board, comprising a chairperson recruited through a call for candidates, and vice-chairpersons appointed by the ANR based on proposals made by the chairperson. French or foreign scholars complete the panel to cover the research fields associated with the committee. Their names are put forward by the board and they are appointed by the ANR. The term of office for all committee members is one year, renewable twice. When setting up these committees, care is taken to ensure a balance

6. https://scienceeurope.org/
7. https://coara.eu/
8. https://globalresearchcouncil.org/

in terms of affiliation, geographic origin and parity. To carry out the evaluation, the committees also call on external French or foreign experts who are specialists in the fields concerned by the projects. Their names are put forward by committee members and they are invited to participate by the agency, provided there is no conflict of interest. These experts review projects independently, without discussing them with the committee. Since the 2019 edition of the AAPG, these expert assessments have been sent to project sponsors, who have the right to reply and point out any factual errors they may contain to the committee. Evaluation committees meet in plenary sessions to examine projects on a collegial basis, drawing on the assessments made by two committee members, the external expert reports and, where appropriate, any responses to the expert reports. Tools for managing these plenary sessions are used to monitor the time allocated to each project, manage conflicts of interest and view the score curves for each evaluator.

Evaluation is carried out based on criteria defined, specified and revised by the researchers themselves—who are employed by the ANR—in consultation with committee members, through surveys systematically carried out with them at the end of the selection process, and with committee chairpersons as part of a feedback process formalised by an annual meeting before the next call process begins. These three criteria are designed to assess the relevance and epistemic rigour of the proposed research, its innovative nature from a scientific point of view, the skills of the researchers who propose to carry it out and the social responsibility aspect—its social, economic or environmental impact. These criteria are published in a guide for evaluators and potential candidates. This instructional guide specifies what is expected for each of these criteria, breaking them down into sub-criteria. This is in keeping with DORA guidelines on transparency. In addition, the guide reminds applicants and evaluators that the evaluation is carried out strictly on the basis of the documents submitted and the information provided on the proposal submission website by the closing date and time for the call. Committee members are thereby presented with a research proposal—with the number of pages varying depending on the call or the stage of the selection process—as well as the accompanying résumés (CVs) completed online. In line with DORA, these résumés can only list five publications, which applicants must comment so that the evaluators can make a qualitative assessment. However, tabs are available to indicate any other form of scientific production, as well as administrative and teaching responsibilities and career breaks.

Like other funding agencies, the ANR has set up a system for observing committee plenary sessions to ensure that the process is robust and its rules and principles are respected, if necessary, areas of improvement are identified and corrective actions taken.

In order to provide the best possible support for scientists taking part in the evaluation process, they are given training on the operational details of the process as well as on the rules and principles governing evaluation, which they undertake to respect.

Quality, transparency and fairness are therefore of primary concern for the ANR. They are the three values that characterize the agency and should constantly guide its actions according to the self-assessment process carried out for the HCERES (High Council for the Evaluation of Research and Higher Education) in 2019. Clearly set out in its target and performance agreement, these three values are all equally important in the agency's commitment to professional equality between men and women.

A Gender Equality Plan

In keeping with its letter of commitment to equality sent to the office of the Minister for National Education, Higher Education and Research in December 2016, the ANR included its commitment to gender equality in its action plan in 2017. It then added it to its Deontology and Scientific Integrity Charter in 2018, as one of its fundamental principles. A gender equality officer was also appointed with the task of implementing a Gender Equality Plan within the agency.

To comply with changes in national legislation and the Civil Service Transformation Act adopted in 2019, the agency drew up its first Gender Equality Plan, for the 2020–2023 period. To this end, the agency benefited from the support of the European GenderSmart project,[9] of which it was a partner. Following an appraisal of the situation carried out in the first half of 2019, the plan, structured around three pillars, was an opportunity to formalize the ANR's commitment in a clear way.

A monitoring committee bringing together all the management teams involved was set up during the second half of 2019 to implement and monitor the actions included in the plan.

At the time, the agency also started working towards obtaining the Professional Equality label from Afnor[10] (a French certifying organisation) to boost the implementation of actions and sustain its commitment, gain recognition for its drive and commitment to meeting current statutory requirements in terms of equality, and retain its employees and attract new talent. The label was awarded to the ANR in May 2023.

While the aim of this Gender Equality Plan is to spread a culture of equality within the agency itself, its purpose is also to make an active contribution to reducing inequalities between men and women in higher education and research. Actions have therefore been defined and included in a section dedicated to research funding in the plan. These actions complement and reinforce the general framework of rules and principles described above, to guarantee the inclusive and fair nature of the selection process, as well as to encourage more women to respond to calls for proposals and participate in the agency's assessment activities. However, they also aim to give greater visibility to women in science and promote their work. In support of this, the ANR makes the most of the International Day of Women and Girls in Science on the 11th of February and International Women's Rights Day on the 8th of March to communicate about the women who have participated in selection processes as chairwomen or have received ANR funding. To mark the occasion, the agency has created a collection of portraits of these women, which is enriched each year and available on its website and on YouTube.

Following the training received by the agency's executive committee from Yellow Window (a GenderSmart project partner) on potential gender bias in the drafting of calls for proposals and in assessment criteria for research projects, one of the first initiatives taken was to revise the wording of calls to ensure that they target both men and women and that the latter feel concerned by these calls and feel as legitimate in responding to them as men. To support and accompany the agency's staff in their drafting work and, more broadly, in other forms of communication, a guide to inclusive communication without gender stereotypes has been published (ANR, 2022).

9. Presented in the introduction to the book. Project website: http://gender-smart.eu/
10. https://www.afnor.org/

The agency is also attentive to the social realities of women and aware of the impact of maternity on their career paths. The arrangements already made under the generic call for proposals have been revised, reinforced and extended to the other calls. For example, young female researchers benefit from an additional year's eligibility per child for certain funding instruments.

Wherever possible, call schedules are drawn up so that the closing date for submissions does not fall at the end of a school holiday, as women are still predominantly in charge of childcare, whereas men can take advantage of their time off to write their proposals. The Covid-19 health crisis was a powerful reminder that the division of family and domestic responsibilities is still highly unequal.

It is important for women to be part of evaluation committees so that they can enjoy the same benefits as men (in terms of networking, enhancing their résumés and gaining a better understanding of how a committee works and what is expected of them, to increase their chances of success in responding to a call for proposals). That is why more effort has been made to ensure parity within committees. Having both women and men on these committees is important as it offers greater openness to scientific approaches that may be gender-differentiated.

As mentioned above, parity does not guarantee the absence of gender bias in evaluation processes. Specific training courses on the notions of gender, sex and parity have therefore been set up. They are open to ANR staff as well as committee chairs. The main point to look out for is that gender bias does not creep into the selection process. The aforementioned monitoring of evaluation committees has also been reinforced as a means of ensuring this.

Analysis production

Identifying potential gender biases in selection processes also includes the important step of analysing application and selection data. This analysis is also a way of checking that all the measures put in place are working effectively and guarantee the robustness of the process.

Data needs to be stable before analysis, which requires a significant amount of work on reliability, as application and selection data is declarative and drawn from the various information systems set up for project submission and evaluation. Since 2015, this work has focused on the generic call for proposals, given its importance in terms of budget (almost 80% of the agency's funding budget is allocated to it) and number of projects (just over 6,000 projects submitted for each edition, and, more specifically, 1,497 projects funded for the 2023 edition, with a selection rate of 24.3%).

The generic call for proposals is ideal for observation because it covers all scientific disciplines and includes 56 research areas within the main academic fields (environmental sciences, material and engineering sciences, life sciences, humanities and social sciences, digital sciences, mathematics and its interactions and subatomic physics, sciences of the universe and earth sciences) and cross-disciplinary fields (sustainability science, 'One Health', ecological and environmental transition, energy transition, technological transitions, digital transformation, transformation of socio-technical systems). Each of these 56 research areas has its own scientific evaluation committee. In addition, as mentioned above, this call for proposals comprises five funding instruments. It is therefore open to most researchers.

The statistical analyses carried out since the 2015 edition have been published in a report[11] that is updated every year and published on the agency's website. The data used for the 2022 and 2023 editions are now available on dataANR.[12] Publishing these analyses is in line with the ANR's concern for transparency and, at the same time, it provides scientific communities with a glimpse of the practices of male and female researchers in response to this call for proposals, so that they can take the practices on board and contribute to changing them.

The results of these analyses are very encouraging indeed. We can see that this call for proposals mirrors the proportions of men and women in the higher education and research workforce (one third of the women and two thirds of the men), both in terms of the projects submitted and the composition of the committees. These results therefore suggest that, like men, women feel concerned by this call and feel legitimate in responding to it, and increasingly so as the proportion of projects submitted by women has been rising steadily since 2015—from 29.3% to 34.5% in 2023. This increase indicates that a positive dynamic is well underway (Figure 1.1).

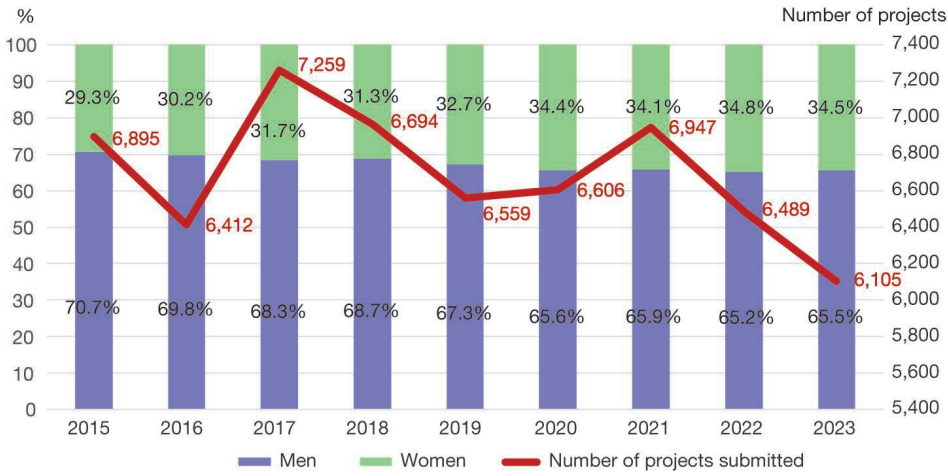

Figure 1.1. Distribution of projects according to whether the coordinator is a woman or a man (projects submitted in phase 1, AAPG 2015-2023, JCJC-PRC-PRCE-PRME).[13]

The increase is similar in terms of committee members (Figure 1.2).

The differences between scientific fields shown in the results again mirror the proportions of men and women employed in higher education and research. Unsurprisingly, women coordinate more projects in the humanities and social sciences than in the digital sciences and mathematics.

11. Femmes et hommes de science. Évolution de la proportion des femmes et des hommes à la coordination de projets: AAPG 2015-2023, ANR, 8th March 2024. https://anr.fr/fileadmin/documents/2024/ANR-Femmes-Hommes-AAPG-2015-2023.pdf
12. https://dataanr.opendatasoft.com/pages/accueil/
13. Published on the ANR website on 8 March 2024: https://anr.fr/fileadmin/documents/2024/ANR-Femmes-Hommes-AAPG-2015-2023.pdf

However, although women make up a large proportion of the workforce in the biology and health sector (64%), they only coordinate 37.6% of the projects submitted. This discrepancy is probably due to the division of responsibilities within teams, which undoubtedly needs to be renegotiated (Figure 1.3).

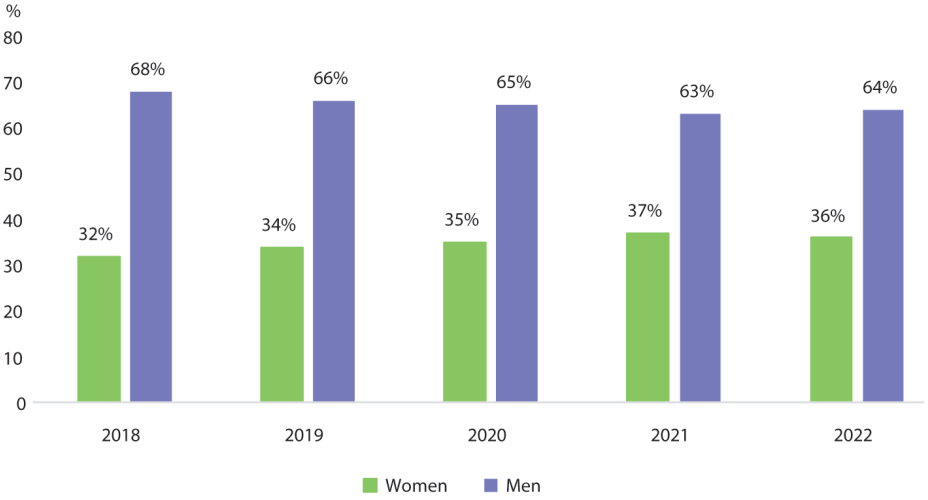

Figure 1.2. Changes in the composition of the 56 AAPG committees between 2018 and 2022.

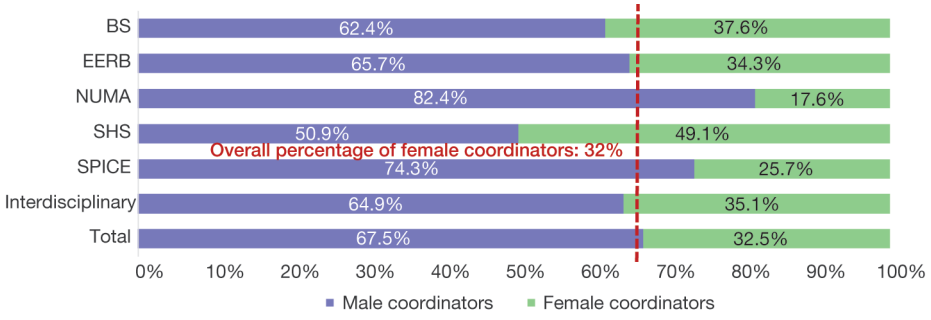

Figure 1.3. Distribution of men and women coordinators across the main scientific fields (projects submitted in phase 1, AAPG 2015-2023, JCJC-PRC-PRCE-PRME).[14]

BS: Biology and Health; EERB: Environment, Ecosystems, Biological Resources; NUMA: Digital Science and Mathematics; SHS: Humanities and Social Sciences; SPICE: Physics, Engineering, Chemistry, Energy.

There are clear differences in the makeup of evaluation committees between the various scientific fields, with more women as committee members in the humanities and social sciences than in mathematics, but the overall proportion of women is higher than that of women working in higher education and research (Figures 1.4 and 1.5).

14. Published on the ANR website on 8 March 2024: https://anr.fr/fileadmin/documents/2024/ANR-Femmes-Hommes-AAPG-2015-2023.pdf

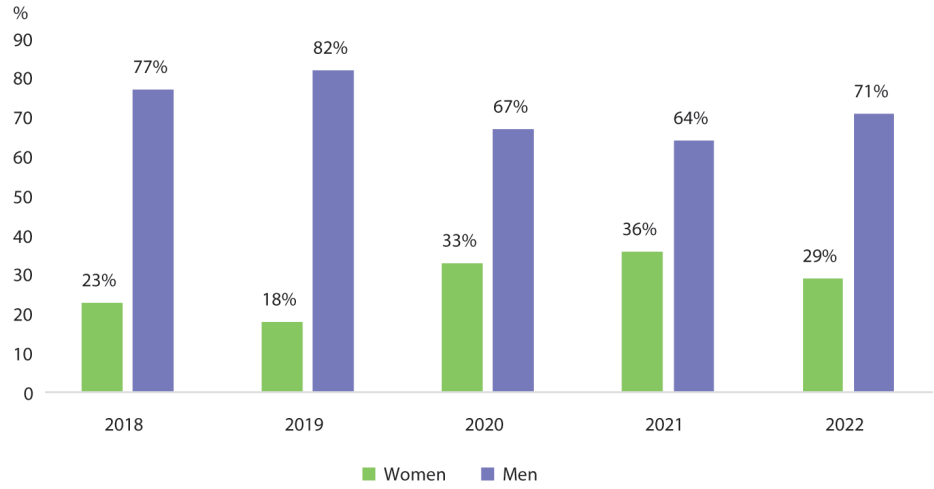

Figure 1.4. Changes in the composition of AAPG mathematics committees between 2018 and 2022.

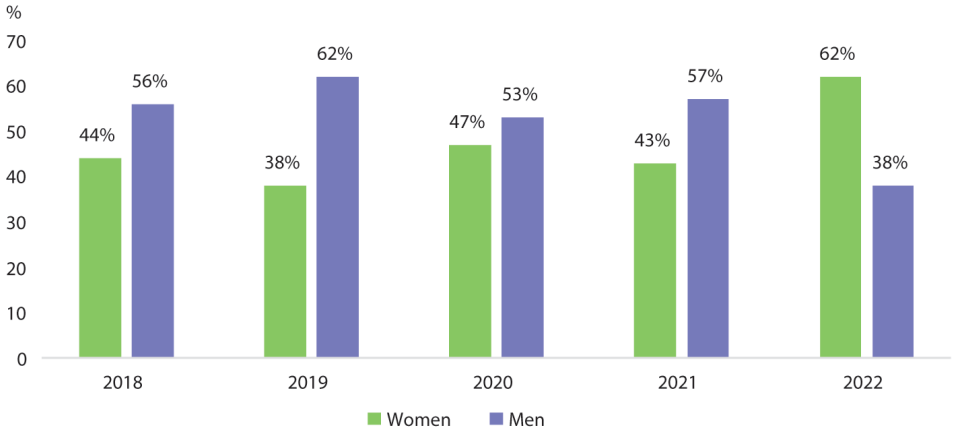

Figure 1.5. Changes in the composition of AAPG contemporary society committees between 2018 and 2022: statuses, dynamics and transformations.

The change in success rates across the entire call for proposals shows no obvious or alarming gap between women and men. It indicates that the budget increase granted to the agency through the 2020 Research Programming Act had a very significant impact on rates from the 2021 edition onwards, and that it has been equally beneficial to women and men, with an identical success rate of 25% in 2022 (Figure 1.6).

In contrast, the analysis by funding instrument shows variations in success rates for women and men between instruments as well as within each instrument, depending on the edition. The variations within the JCJC and PRCE instruments show more success rates for women as of the 2020 edition (Figures 1.7 and 1.8), which is the year in which gender training was introduced for committee chairs, and the résumé (CVs) to be completed online by candidates were modified, notably with the introduction of a tab dedicated

to career breaks. It is also worth noting that from 2020 onwards research organizations and institutions rolled out Gender Equality Plans. These results suggest that gender is not a discriminating variable, especially as the agency asks its committees not to engage in positive discrimination.

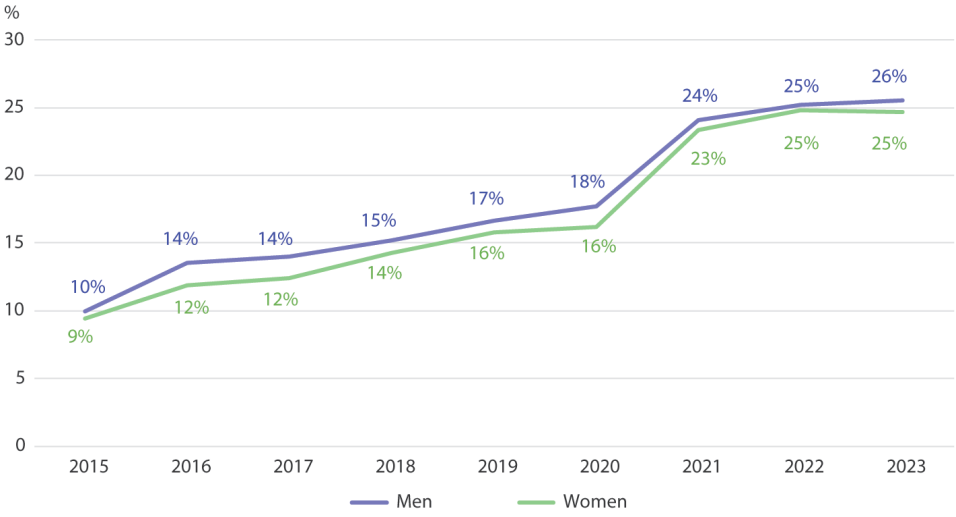

Figure 1.6. Success rate of projects selected under the AAPG from 2015 to 2023.[15]

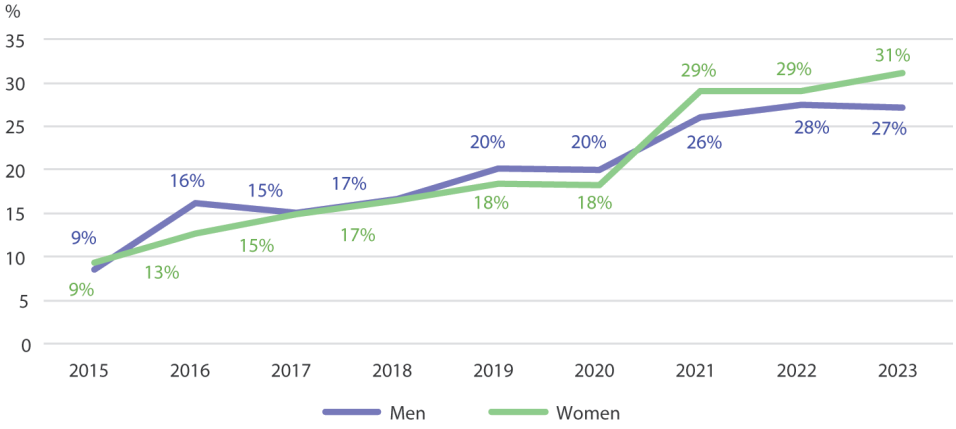

Figure 1.7. Success rate of JCJC projects selected under the AAPG from 2015 to 2023.

15. Published on the ANR website on March 8, 2024: https://anr.fr/fileadmin/documents/2024/ANR-Femmes-Hommes-AAPG-2015-2023.pdf

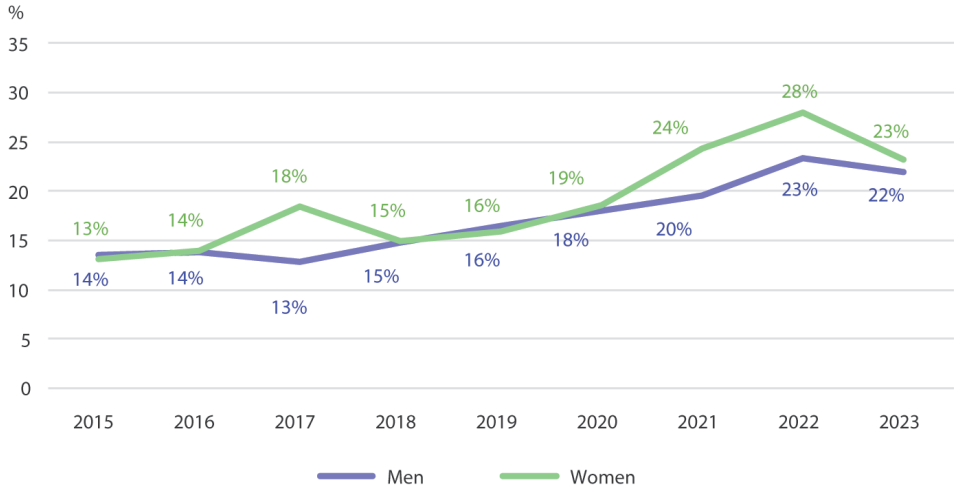

Figure 1.8. Success rate of PRCE projects selected under the AAPG from 2015 to 2023.

However, for the PRC instrument, the gap between the success rates for women and men persists over the entire period, and is sufficiently marked to raise questions (Figure 1.9).

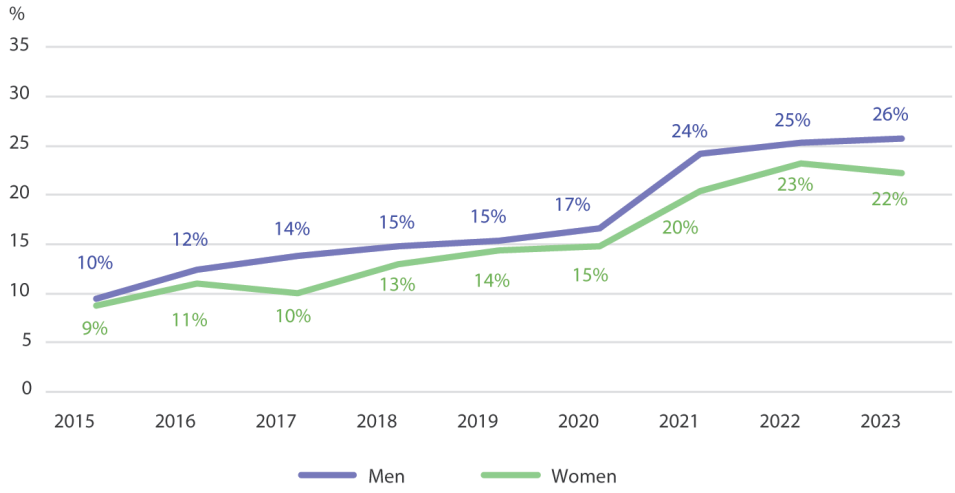

Figure 1.9. Success rate of PRC projects selected under AAPG from 2015 to 2023.

These results are difficult to interpret and call for further analysis by cross-referencing gender data with other indicators such as status, age and scientific field. They bear witness to the complexity of the issue of gender biases and the difficulty of identifying them solely on the basis of the quantitative data available to a funding agency. Furthermore, many external factors can upset delicate balances and/or reinforce inequalities. The Covid-19 health crisis was a case in point.

As a funding agency, it is important to measure the impact of unexpected events on activities. This was possible in the case of the Covid-19 Flash call. This call was singular in that it was launched from the 6th to 23rd of March 2020, in an unprecedented context

and in response to an urgent need for knowledge in the fields of biology and health, as well as that of the humanities and social sciences. The goal of the Covid-19 Flash call was to develop the following four research themes: ethics and the humanities and social sciences associated with the response; epidemiology and translational research; pathophysiology of the disease; prevention and control of infection. This call for projects disrupted research time frameworks, which clashed with health, political, economic and media time frameworks. Furthermore, researchers had to respond to the Covid-19 Flash call for proposals in the days following its launch, during a general lockdown. Today, studies show that this lockdown had a very different impact on men and women. In the field of research, these differences are reflected by the fact that women were less scientifically productive, especially in terms of publications, whereas there was an increase in publications for men (Figure 1.10). Indeed, analyses have shown that projects led by women accounted for only 27% of all projects submitted.[16]

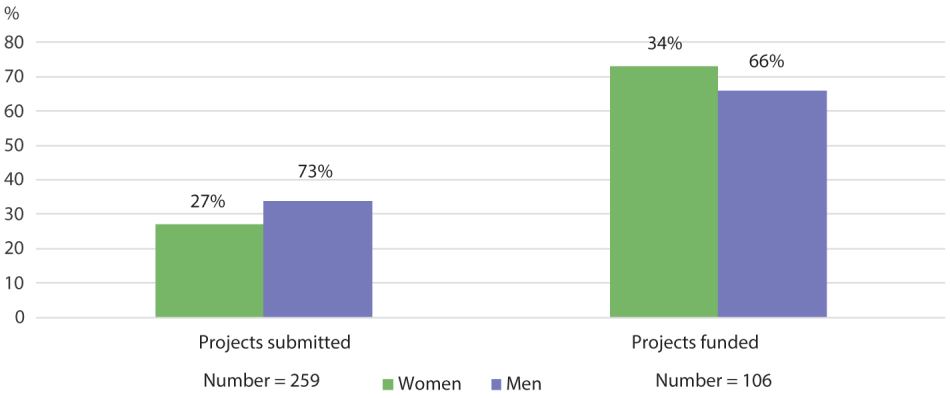

Figure 1.10. Breakdown by women and men of projects submitted and funded during the Covid-19 Flash call, 2020.

However, the discrepancy observed between men and women at submission could probably be explained by men being more willing to submit a project regardless of its maturity, whereas women only allow themselves to do so once they are certain of the rigour and robustness of their proposal. Although this hypothesis is supported by the fact that the success rate for women (51%) was significantly higher than that for men (37%), caution is required in the absence of additional data.

The results of these analyses clearly demonstrate that a more in-depth interpretation requires access to a wider range of data. Publishing the results is therefore essential, so that communities can access them and use them to decide which actions are best for their specific situation, such as renegotiating the division of responsibilities. Because, after all, the data presented concerns both men and women involved in project coordination. There may be fewer women coordinators, but this does not mean they are not involved in projects, just that they are less visible.

It is therefore crucial to continue analysing data and publishing the results. Similarly, we need to continue and step up training for evaluators and raise awareness across scientific

16. Analysis published on the ANR website on 8 March 2021: https://anr.fr/fileadmin/documents/2021/Analyse-F-H-Flash-Covid_08mars2021.pdf

communities by creating regular opportunities for discussion, such as the 'Rendez-vous de l'ANR'. These and other initiatives will be included in the ANR's second Gender Equality Plan, currently being drawn up. Maintaining commitment through a second plan is essential because gender stereotypes are difficult to deconstruct, especially as varying degrees of conscious or unconscious resistance may stand in the way, and it always takes time for changes to take root.

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Chapter 2

Gender and evaluation: analysis of a funding agency

Juliane Farthouat, Sarah Itani, Audrey Ségerie, Laurène Vuillaume, Véronique Halloin, Raphaël Beck

⏩ FRS-FNRS, the research funding agency in French-speaking Belgium

The question of gender in scientific research is a key science policy issue for a funding agency, whose aim is to fund researchers through public grants and fundraising.

The Fund for Scientific Research-FNRS (FRS-FNRS) is the funding agency for fundamental research in the French-speaking part of Belgium, the Wallonia-Brussels Federation (WBF). With an annual budget of around 220 million euros, the FRS-FNRS finances research in all scientific fields, mainly at WBF universities.[17] Historically, it was one of the first ever research funding agencies in Europe, founded at the beginning of the twentieth century (1928) following the famous speech delivered by King Albert I in Seraing on October 1927. Although the FRS-FNRS was set up as a charitable foundation, with donations from industrialists and philanthropists, it is now almost 90% publicly funded. The founding principle of the agency was to promote science and scientific careers by providing financial support to scientists.

The Fund has a wide range of funding instruments at its disposal. Most of these are grants and fellowships, which pay the salaries of researchers at all career stages (doctorate, post-doctorate and permanent positions). The FRS-FNRS is the employer of around 1,800 researchers (including almost 400 permanent staff) working at WBF universities. The Fund also allocates credit and project funding to enable scientists to carry out their research. It finances aspects such as operating, support and equipment costs, as well as personnel costs in some cases. Various calls for proposals are organized each year, resulting in over 2,000 applications and more than 5,000 remote evaluations. The overall philosophy of the FRS-FNRS is to apply a bottom-up approach: for most of the calls for proposals and funding instruments, the Fund responds to demand and finances research in all scientific fields, with equivalent success rates across all major scientific

17. The universities in the WBF region are the University of Louvain, Université libre de Bruxelles, the University of Liège, the University of Mons, the University of Namur and Saint-Louis Bruxelles University, which recently merged with the University of Louvain.

fields. The only selection criterion is scientific excellence. Lastly, the Fund also finances international collaborative projects, as well as international mobility and knowledge dissemination activities.

⏩ Current assessment procedures and their analysis

Like most other research funding agencies, the FRS-FNRS is not able to fund all the applications it receives, including some judged to be of very high or excellent quality.[18] It needs to align success rates with its budgetary constraints. These rates vary from one call for proposals to another, and from one funding instrument to another, depending on the decisions of the board of directors (BoD). Rates range from around 10% (for permanent position applications) to 65% (for research credits). The Fund therefore sets up evaluation processes aimed at selecting the best applications out of all those received, using predefined criteria known to the applicants. Evaluation is based on peer review processes organized as part of a transparent procedure that meets international standards for research evaluation (European Science Foundation, 2011; Science Europe, 2020). The Fund therefore calls on experts it qualifies as legitimate, in that they have no potential conflicts of interest (neutrality) and that they have the scientific legitimacy and experience required to evaluate the funding applications received. The evaluation process is generally divided into two stages. The first one consists of remote evaluations carried out independently by several international experts (i.e. not affiliated to one of the WBF universities), who are pre-selected by FRS-FNRS scientific advisors before being approved by the chairs of the Fund's scientific committees. The second stage consists of meetings held by subject-specific scientific committees composed exclusively of researchers, who carry out the final evaluation and ranking of funding applications. The board of directors takes the final award decisions based on the assessment reports and rankings submitted by the committees. Applicants receive the remote assessment reports, as well as a final assessment report written by the scientific committee that evaluated the application. The reports are anonymous. It should be noted, however, that the composition of the scientific committees is public knowledge, as it is published on the Fund's website.

The evaluation criteria, known to applicants before they submit their funding applications, may vary from one instrument to another. However, they generally consist of three elements: the quality of the applicant, the quality of the project and the quality of the research context. Although bibliometric indicators are collected via the form, candidates may find their encoding irrelevant to their field of research, in which case they can choose not to provide this data. In any case, bibliometric indicators are evaluated quantitatively and qualitatively, as there is a section on the application forms where candidates can describe their publication strategy. Applicants are also informed that the evaluation will not be based solely on these indicators—they are just one of several pieces of information that evaluators may need to consider. The FRS-FNRS is committed to applying good scientific research assessment practices, and regularly improves its procedures. In early 2022, the Fund signed the San Francisco Declaration on Research Assessment (DORA)

18. Due to budgetary constraints, the FRS-FNRS is unable to fund all the applications received and rated A+ (exceptional), A (excellent) or A– (very good).

and, more recently, in June 2023, the agreement on the reform of the research assessment system, thereby pledging not to pay undue attention to the names and impact of the journals in which candidates have published, and to make measured use of bibliometric indicators. On the contrary, the Fund encourages a more qualitative approach to assessing publication files.[19] One of the outcomes of signing DORA is that applicants for certain funding instruments—fellowship instruments for which CVs are particularly important for assessment purposes—are now required to provide evaluators with a full copy of five publications of their choice, to enable a more qualitative analysis of their application files. The problems associated with bibliometric indicators and impact factors should not be underestimated when it comes to gender equality in research issues, and measured use of these indicators can contribute to women and men being treated more equally. Indeed, several studies have shown that women can be put at a disadvantage when it comes to productivity or scientific impact indicators (see, for example, Larivière *et al.*, 2013; Kwiek and Roszka, 2022), particularly in times of crisis, as observed most recently in the context of the Covid-19 pandemic (King and Frederickson, 2021).

Meanwhile, the Fund is under no illusion that the above efforts are not enough to eliminate possible gender bias in its recruitment procedures. It has been closely monitoring the gender issue statistically for over ten years now. A series of quantitative studies are carried out throughout the year to analyse the various current processes. The results are generally presented to the Fund's board of directors and, more recently, some of them have been published as reports and made available to FRS-FNRS researchers and academics at WBF universities via its website[20] and its newsletter. The idea is also to identify possible biases within evaluation processes, including gender bias, so that procedures and regulations can be revised where necessary. In addition, at the request of the WBF government, the FRS-FNRS publishes an annual 'Gender Equality Status Report', which is publicly available on the FRS-FNRS website. This report provides an update of the gender issue within the FRS-FNRS and presents a series of indicators broken down by gender—of the applicant, the sponsor (as the thesis director is known in French-speaking Belgium) and the evaluator. It also discusses how these indicators have evolved over the last few years. We will come back to some of these indicators later in this chapter.

⏩ The feminization of grant holders over recent decades

If we look at the trend in the proportion of women[21] awarded grants and fellowships by the Fund, it is striking the extent to which the profession has become feminized over the decades. As mentioned above, the FRS-FNRS was created in 1928,[22] the year in which the first four-year doctoral grants were awarded.[23] At the time, eleven women and fifteen men

19. https://www.frs-fnrs.be/en/news/fnrs-has-endorsed-dora-declaration
20. https://www.frs-fnrs.be/fr/le-fnrs/analyses-etudes
21. It is important to note that while we use the term 'gender' throughout this chapter, the data analysed from the FRS-FNRS application database does not allow us to distinguish between '*sexe*' (the term used for the French version of the platform) and 'gender' (the term used for the English version). Furthermore, users invited to provide their sex or gender data only have two options: male or female.
22. Even though before 1992 and the progressive federalisation of the country the FNRS was national, not community-based, the data presented only takes account of data relating to French-speaking applications.
23. Doctoral support lasts four years (two years renewable once).

were designated by the Fund to carry out their doctoral research. The proportion of women doctoral students in 1928 was surprisingly high for the time. Unfortunately, this was only the case during the first few years of the Fund's existence. In the following decade, women accounted for only 9% of scientists receiving this doctoral funding (Figure 2.1). Since then, however, the proportion of women has risen steadily, exceeding 50% a few decades later. Unsurprisingly, the trends are very similar at post-doctoral level. In the 1940s,[24] there were no women on postdoctoral fellowships,[25] which researchers could apply for following a PhD. By contrast, in the 2010s women accounted for 43% of this fellowship category and 34% of all research associates[26] (entry-level permanent research position).

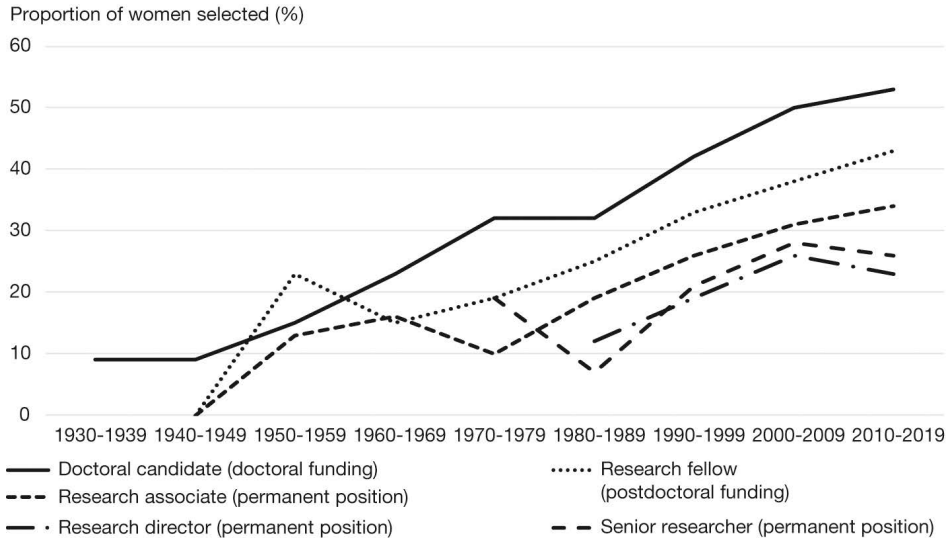

Figure 2.1. Breakdown by gender of successful applicants at different levels in recent decades.
Doctoral candidate: four-year doctoral funding in all scientific fields.
Research fellow: three-year postdoctoral funding.
Research associate: entry-level researcher with an open-ended contract and carrying out independent
Senior researcher: promotion awarded to research associates.
Research director: promotion awarded to senior researchers.

The trends appear similar for all three levels, despite the starting points being spread across the decades—the curves progress in the same way for all the levels, which would indicate that the speed at which the proportion of women is increasing is identical. This is promising for the years ahead, and could suggest that a balance will be reached over the next few decades. However, the Fund will still need to keep a close eye on any signs of slowdown or stagnation.

24. The first junior research fellowships (three-year postdoctoral fellowships) were awarded in 1940. The first research associate positions (entry-level permanent research positions) were awarded in 1942.
25. The junior research fellowship is a three-year postdoctoral fellowship.
26. Research associate is the entry-level for permanent research positions at the FRS-FNRS. Two other levels are subsequently open to them: senior researcher, which is accessible as of the eighth academic year following appointment as a research associate, and research director, accessible as of the fourth year following appointment as a senior researcher. Researchers on a open-ended FRS-FNRS contract can also resign from their position to join an academic team at a university.

Generally speaking, the feminization of FRS-FNRS grants and fellowships reflects a gradual feminization of academia in Belgium as well as the rest of Europe. In 1955, women accounted for just 12% of authors of scientific publications (data from a study covering 83 countries and 13 disciplines), but this proportion has since risen steadily, reaching 35.4% in 2005 (Huang *et al.*, 2020). The low number of women on FRS-FNRS fellowships in the 1930s is therefore not surprising given the historical context. In Europe, apart from a few exceptions prior to the eighteenth century, the first time that a doctoral thesis was defended and obtained by a woman, Nadejda Souslova, was in Switzerland at the end of the nineteenth century. In Belgium, it was not until 1880 that a woman, Emma Leclercq, was allowed to enrol at a university, along with two other women, Marie Destrée and Louise Popelin (Henneau, 2017). At the beginning of the twentieth century, there were still very few women in academia, including within the student community. Statistical analysis of historical FRS-FNRS data provides remarkable insight into this gradual feminization of the academic profession and, more generally, of how the profession has changed over recent decades.

Although administrative data from the FRS-FNRS on the gradual feminization of grants and fellowships is encouraging, the proportion of female postdoctoral researchers remains systematically lower than that of female doctoral students, as does the proportion of female research associates compared with female postdoctoral researchers, and so on. (Figure 2.1). In other words, when we look at all levels (from doctoral to research director) at a given point in time, the proportion of women decreases drastically the higher the research position level (Figure 2.2). This is commonly referred to as the 'leaky pipeline' phenomenon (or scissor-shaped curve), showing an increasingly marked under-representation of women, the further one goes up the academic career ladder (Alper, 1993; FRS-FNRS, 2021c). This gradual decline is all the more striking given that women represented 56.8% of the student community at WBF universities in the 2019 to 2020 academic year (CRef, 2020).

Breaking down the results by main scientific field[27] confirms this decrease in the proportion of women as career levels progress for each of the FRS-FNRS's three main scientific fields (Figure 2.3). It is equally important to underline the difference in the proportion of women between the scientific branches: the Humanities and Social Sciences (HSS) and Health and Life Sciences (HLS) are far more feminized, particularly at doctoral and post-doctoral levels, where almost half the scientists recruited in the 2010s were women (an over-representation of women can also be observed at Master's level). Within the final permanent researcher tier, only 10% of research directors were women in the Natural and Physical Sciences (NPS), compared with 40% in the HSS and almost 30% in the HLS (Figure 2.3). When it comes to observing research fellowship data broken down by gender, it is very important for a funding agency to look at the data by major scientific branch as well, especially when it comes to changes in the proportion of women over the course of academic careers. What may be interpreted as a gender effect could in fact be a scientific branch effect (Walton and Walton, 2016). In our case, presenting the 'scissor-shaped curve' by scientific branch highlights two elements: firstly, that the proportion of women decreases the higher the level in all major scientific fields, thereby

27. The FRS-FNRS has defined three main scientific branches: Natural and Physical Sciences (NPS), Humanities and Social Sciences (HSS) and Health and Life Sciences (HLS).

ruling out the scientific branch hypothesis, and secondly, that the proportion of women varies widely from one field to another.

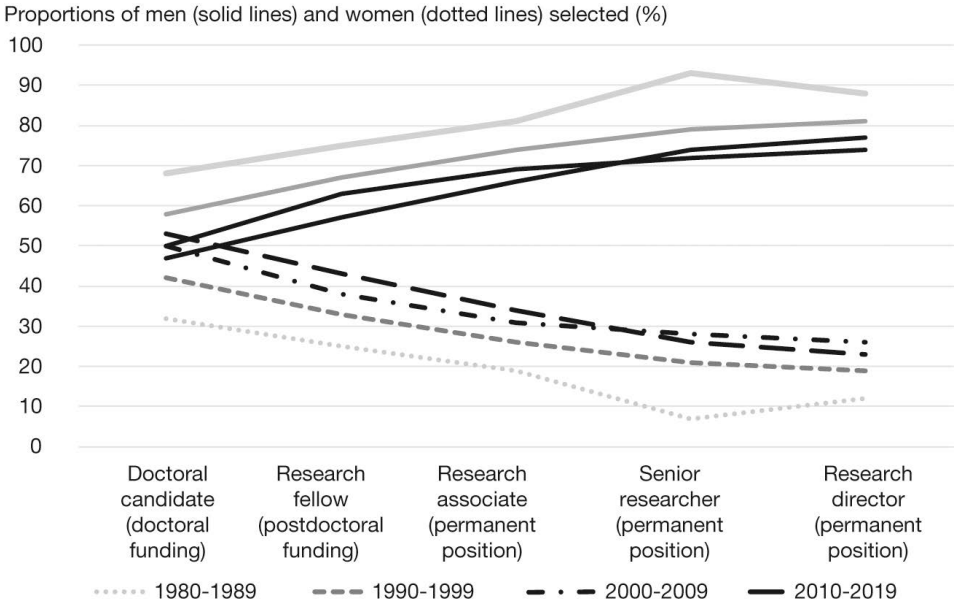

Figure 2.2. Proportion of women and men selected across the different levels—from doctoral and postdoctoral fellowships to the three permanent research levels—over the last few decades.

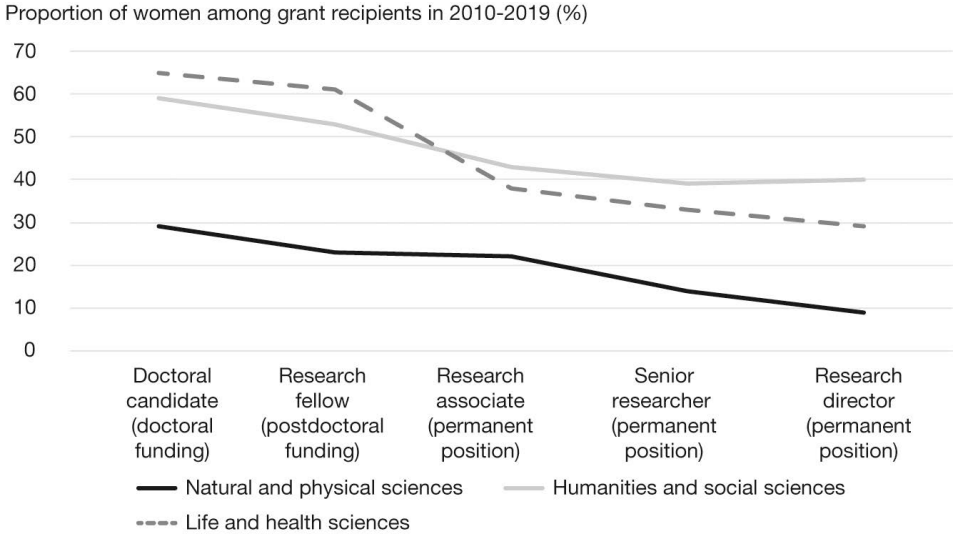

Figure 2.3. Proportion of women having been awarded a PhD grant (doctoral funding), a research fellowship (postdoctoral funding), or recruited to permanent positions of research associate, senior researcher or research director between 2010 and 2019, by main scientific field.

Success rates and gender

Research funding agencies need to pay specific attention to examining the success rates of candidates having applied for the various funding instruments on offer, especially when it comes to gender bias issues. The Fund has been monitoring the success rates of applicants after each call for proposals and publishing them in various reports for several years now. More specifically, these rates are presented in detail in the FRS-FNRS's 'Gender Equality Report', annually published with open access. Otherwise, a study was published on this subject in 2017, in a peer-reviewed journal (Beck and Halloin, 2017). The data presented in the study were collected by analysing 6,393 applications submitted between 2011 and 2015 for four distinct types of FRS-FNRS funding (doctoral and postdoctoral grants and credit or project funding). Overall, the study showed that the applicant gender variable is not correlated to the probability of success, with the exception of one funding instrument, research credits. However, since the publication of this article, no further significant correlation has been observed for this instrument, suggesting that the discrepancy observed is not necessarily repeated from one year to the next (see, for example, FRS-FNRS, 2021c).

To add a historical perspective, we also analysed application data for the three instruments—'doctoral', 'postdoctoral' and 'research associate'—over the last thirty years. To perform a statistical analysis that takes account of the evolution of success rates over recent years, applications were grouped by decade: 1990 to 1999, 2000 to 2009 and 2010 to 2019 (Figure 2.4). The following analysis is purely illustrative and does not take on board the considerable changes that society and the FRS-FNRS have undergone over the last few decades. Before continuing, it is important to note that, while the names of the funding instruments have remained the same since the creation of the FRS-FNRS, the contexts have changed, especially since the major reform of evaluation procedures initiated in 2010, which we will discuss further below.

The first thing to consider is the wide variation in success rates over recent years, explained by a strong fluctuation in the number of applications submitted to the Fund (+180% for 'doctoral fellowship' applications between 1990 and 2020, +717% for 'postdoctoral fellowship' applications and +92% for 'research associate' applications) and, to a lesser extent, by the Fund's budgetary constraints. Secondly, we can see that although there are differences year on year, the success rates for men and women have remained similar overall in recent years.

Logistic regression analyses were carried out to determine whether an applicant's gender had a significant impact on the probability of being awarded a fellowship. Initially, the analysis was carried out with data from the last thirty years and the statistical model included the variables 'fellowship' (3 levels), 'gender' (2 levels) and 'decade' (3 levels), along with the interaction between the variables 'gender' and 'decade' (Table 2.1). The analysis included 17,298 applications: 44.3% from women candidates, 48.1% from doctoral candidates, 35.0% from postdoctoral candidates and 16.9% from research associate candidates.

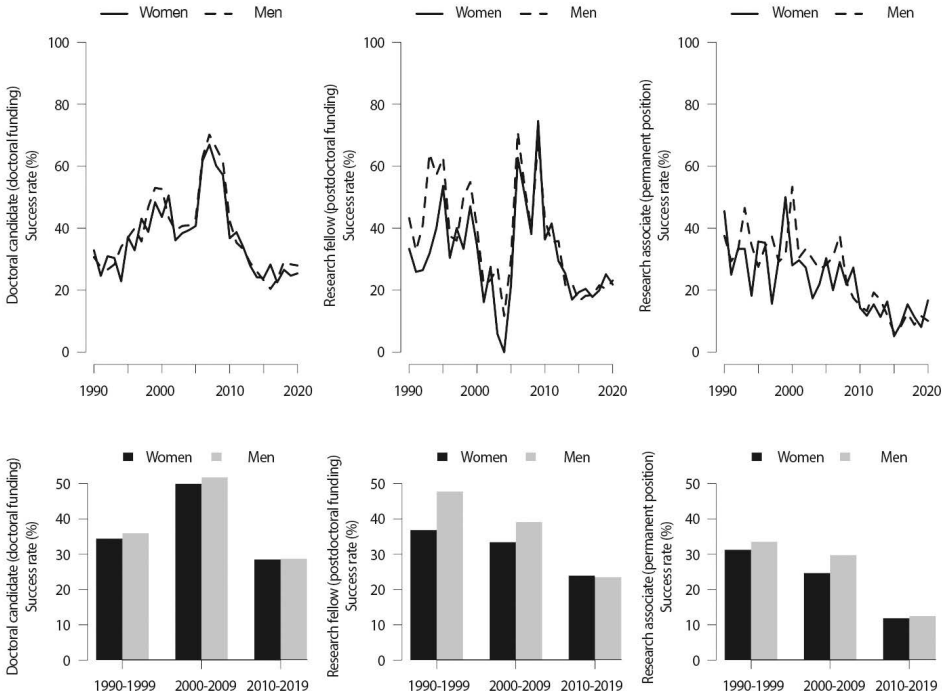

Figure 2.4. Funding rates for the 'doctoral' (four-year funding), 'postdoctoral' (three-year funding) and 'research associate' (entry-level for researchers with an open-ended contract who pursue their research independently) instruments over the last thirty years, by gender.

Table 2.1. Results of the logistic regression analysis on the probability of being granted a fellowship over the last thirty years (1990 to 2019).

Predictors	Odds ratio	Confidence interval	p-value
(Intercept)	0.62	0.55 - 0.70	< 0.001
Funding instrument [1= CR, 0= ASP]	0.8	0.74 - 0.86	< 0.001
Funding instrument [1= CQ, 0= ASP]	0.47	0.42 - 0.51	< 0.001
Gender [1= male, 0= female]	1.27	1.10 - 1.47	0.001
Decade [1= 2000, 0= 1990]	1.36	1.17 - 1.57	< 0.001
Decade [1= 2010, 0= 1990]	0.63	0.55 - 0.72	< 0.001
Gender [1= male, 0= female]× decade [1= 2000, 0= 1990]	0.88	0.73 - 1.07	0.195
Gender [1= male, 0= female]× decade [1= 2010, 0= 1990]	0.77	0.65 - 0.92	0.004
Comments	17,298		
R2 Tjur	0.042		

This analysis shows that, over the last thirty years, the probability of being granted a mandate is, all other variables being equal, significantly dependent on the gender of the candidate (OR= 1.27 [1.10-1.47]; p= 0.001). The interaction between the 'gender' and 'decade' variables was also significant for the decade 2010-2019 *vs.* 1990-1999 (OR= 0.77 [0.65-0.92]; p= 0.004), suggesting that the effect of the 'gender' variable varied according to the decades and was, at the very least, less significant in the 2010s.

Additional models were run separately for the three decades studied (Table 2.2). This was justified by the previous statistical model in particular (significant interaction between 'decade' and 'gender'), as well as by the fact that the 2010-2019 decade was marked by a major reform of evaluation procedures at the FRS-FNRS (discussed further below). The analysis shows that, as suggested by the first result, the 1990s and 2000s were marked by a significant gender effect (being a man significantly increased the probability of being awarded a fellowship), which is no longer present in the 2010s (no significant gender effect for this decade). The absence of a significant effect in the last decade is further corroborated by the study mentioned above, which had not identified a significant gender effect over recent years (Beck and Halloin, 2017).

Table 2.2. Results of logistic regression analyses on the probability of being granted a fellowship over the last thirty years (1990 to 2019), by decade.

	Model 1 (1990-1999)			**Model 2 (2000-2009)**			**Model 3 (2010-2019)**		
Predictors	OR	CI	p-value	OR	CI	p-value	OR	CI	p-value
(Intercept)	0.49	0.43 - 0.56	< 0.001	0.96	0.87 - 1.07	0	0.4	0.37 - 0.43	< 0.001
Funding instrument [1= CR, 0= ASP]	1.4	1.19 - 1.66	< 0.001	0.55	0.48 - 0.64	< 0.001	0.78	0.70 - 0.86	< 0.001
Funding instrument [1= CQ, 0= ASP]	0.88	0.73 - 1.05	0.157	0.37	0.31 - 0.43	< 0.001	0.35	0.29 - 0.42	< 0.001
Gender [1= male, 0= female]	1.19	1.03 - 1.38	0.017	1.17	1.03 - 1.32	0.015	1	0.91 - 1.10	0.989
Comments	3 386			4 440			9472		
R2 Tjur	0.01			0.04			0.02		

ASP: doctoral; CR: postdoctoral; CQ: research associate; OR: odds ratio; CI: confidence interval.

The fact that for at least two decades women's success rates were significantly lower than men's is worth noting. Unfortunately, it is not possible to differentiate these fellowship applications by scientific branch for the years prior to 2010 (due to lack of available data). In the scientific literature, there is no consensus on whether differences in success rates or scores between women and men exist, with some authors reporting them in the evaluation of funding applications in different national contexts and scientific fields (Bornmann *et al.*, 2007; Severin *et al.*, 2020), while others, including ourselves (for the

analysis limited to the years 2011 to 2015), not. It should be noted here that our statistical models do not include covariates linked to scientific productivity or other data such as international mobility, and that the inclusion of such covariates has been proposed by some authors as a possible explanation for the differences observed between studies (Sato *et al.*, 2021).

The absence of significant differences in success rates between men and women at the FRS-FNRS in the 2010s (Table 2.2) is equally thought-provoking. It could be explained by a number of factors. It has already been shown that actions such as modifying forms can attenuate or, on the contrary, accentuate gender biases among evaluators (Severin *et al.*, 2020). As already mentioned, a major reform of evaluation procedures was initiated in 2010, with the development of a database of international scientific experts willing to carry out assessment tasks for the FRS-FNRS, the creation of thirteen new scientific commissions, the launch of a centralized IT platform, evaluation criteria known to candidates, evaluation reports communicated to candidates, and so on. The reform was also marked by the gradual increase in international applications[28] and a general move to open up internationally. The fact that the statistical models used in the analysis above include applications assessed in such different contexts limits their scope. It is fair to suppose that a gradual change in attitudes and stereotypes has also taken place in the academic world, linked in part to the gradual increase in the proportion of women among applicants and evaluators.

This development once again underlines the value of collecting consistent data over several decades, as well as the importance of annually checking for biases, particularly when changes are made to procedures. In a context where gender in science policy is a much debated topic and funding agencies are invited by the European Commission to have a 'Gender Equity Plan' (European Commission, 2021a), putting the various studies into their historical context is key, because what was published ten years ago may no longer be valid today. An FNRS Gender Equality Plan (2022-2025) was drafted and approved by the Fund's board of directors in 2022, and is currently being implemented.

⏩ Women under-represented at the top of the academic ladder

As discussed in the previous section, FRS-FNRS success rates were generally higher for men for at least two decades (1990s and 2000s). However, the differences in success rates between women and men were relatively limited and are not enough to explain the lower proportion of women at different stages of their careers. Gender bias is in fact most keenly observed at the funding application level: fewer women than men submit applications to the FRS-FNRS, especially at the more advanced stages of their careers.

As with fellowships (Figure 2.1), the proportion of women applying for funding has increased in recent years, but continues to fall at the higher fellowship levels when observed at a given point in time (Figure 2.5).

28. In 2020, 57% of 'postdoctoral' applications and 45% of 'research associate' applications were submitted by candidates whose doctoral degree was obtained in a country other than Belgium (FRS-FNRS, 2021a).

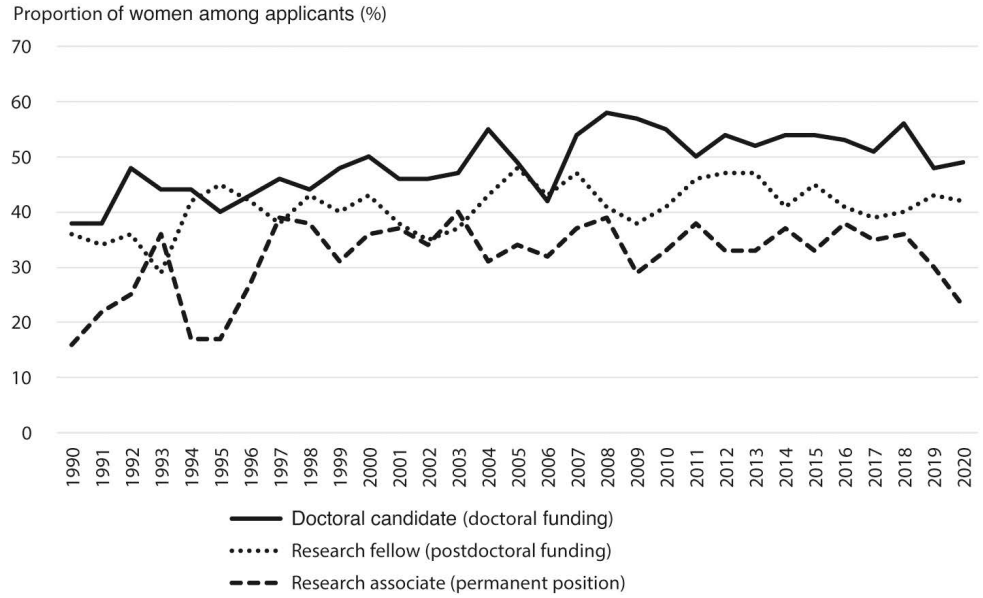

Figure 2.5. Distribution of candidates by gender for three FRS-FNRS funding instruments.

Doctoral fellowship: four-year doctoral funding in all scientific fields.
Postdoctoral fellowship: three-year postdoctoral funding.
Research associate fellowship: entry-level researchers with an open-ended contract and carrying out research independently.

Fewer women than men pursue academic careers. This is also documented in other countries. For example, a survey of Swiss universities showed that fewer women than men intended to pursue an academic career (Dubach, 2014). The study indicated that the reasons most frequently given for not pursuing an academic career were 'career planning uncertainties', 'tough competition for chairs', 'difficulty in reconciling academic career and family' and 'problematic demands in terms of mobility'. In terms of differences between men and women, the study also revealed that more men gave 'insufficient earning potential during the qualification phase' as a reason for not choosing an academic career, while more women cited problems with reconciling private and professional life. Finally, very few respondents cited a lack of passion, motivation or interest in an academic career as a reason.

The difficulties of reconciling family and professional life for young researchers are widely discussed in scholarly literature, especially the fact it is harder for mothers than for fathers, and harder for researchers with children than for those without. A Belgian survey of FRS-FNRS postdoctoral researchers working in 2010-2011 showed that postdoctoral researchers who were mothers spent more time on domestic tasks than those who were fathers (Fusulier and del Río Carral, 2012). Family life can therefore encroach more on professional life for mothers than for fathers, even when they are at the same stage in their careers (in this case, FRS-FNRS postdoctoral researchers). Partner employment is also a key consideration. In the above-mentioned survey, only one in five researchers who were mothers reported that their partner had reduced his or her working hours to devote himself or herself to family responsibilities, whereas one in two researchers

who were fathers had a partner who did this. Young female FRS-FNRS researchers are no exception to gender inequalities when it comes to the division of labour, whether domestic or professional. Although the gendered division of domestic tasks is mentioned here, it is not solely responsible for the lower representation of women at more advanced academic career levels. In countries where the division of domestic tasks between women and men is more equal, there is not necessarily a higher proportion of female researchers (Löwy, 2004). The aforementioned 'problematic demands in terms of mobility' are another factor among others that lead women to view their research careers differently from men, especially if they are parents.

This echoes a study carried out by the Observatory for Research and Scientific Careers-FNRS. The observatory is a WBF-funded structure, created in 2018 and integrated into the FRS-FNRS. Its mission includes monitoring the careers of researchers. It launched a survey between December 2018 and January 2019, as part of a study entitled 'The future of PhD graduates'. A total of 2,065 people who graduated with a PhD between January 2012 and May 2018 responded to this survey (estimated response rate of 42.0%). The survey covered a range of topics, including professional integration, the doctoral process, employability, the added value of the PhD and mobility. A first report showed that the majority (55.8%) of PhD graduates not pursuing an academic career at the time of responding to the survey would have wished to do so had the opportunity arisen (Bebiroglu *et al.*, 2019). The choice not to pursue an academic career is therefore a 'plan B' for a small majority of them. Furthermore, the reason most frequently cited by these PhD holders who graduated in WBF was the lack of job offers at the university (the reason selected by 54% of participants), followed by the desire to do more applied and practical work (36%).

Returning to the Swiss survey mentioned above, one of the reasons frequently cited as an obstacle to pursuing an academic career was the demands of international mobility. A yet to be published study by the FRS-FNRS and the Observatory for Research and Scientific Careers-FNRS, based on data from a survey of PhD graduates in French-speaking Belgium, showed that the probability of international mobility during the post-doctoral period significantly correlated with having had one or more children while studying for a PhD—but only women were concerned.[29] Yet international mobility is valued by funding agencies and academia, and is beneficial to the careers of both male and female researchers (see, for example, Dubois *et al.*, 2014; Equeter and Hellemans, 2016). It would therefore seem that having a child while studying for a PhD has an impact on the international mobility of mothers with young children during the postdoctoral period. This could lead to them being disadvantaged in their future careers, or even drive them away from academic careers, as implied by the results of the aforementioned Swiss study.

These findings struck a chord at the FRS-FNRS, leading the Fund's board of directors to make a regulatory change which came into effect in early 2021. Whereas the FRS-FNRS previously granted an additional year to apply for its various research fellowships in the event of childbirth or adoption occurring after obtaining a required degree, it now grants an additional year for any childbirth or adoption, regardless of whether it occurs before

29. This has since been confirmed by another study carried out by the FRS-FNRS, based on survey data concerning PhD holders who graduated with a thesis between 2018 and 2021, from a survey also carried out by the Observatory (FRS-FNRS, 2023).

or after obtaining the degree that gives access to the funding instrument. However, we do not yet have the necessary hindsight to assess the impact this may have on applications from women, given that this change only took effect from the beginning of 2021. It is worth pointing out that the study behind this regulatory change was not at all geared towards this end, but had a completely different objective, which was to study the impact of international mobility on the likelihood of obtaining a permanent position. This is just one illustration of the importance of monitoring, studies and research, whether in terms of scientific careers, such as the studies carried out by the observatory, or research evaluation (Fortunato *et al.*, 2018; Severin and Egger, 2021). Lastly, it is important to remember that, since 2017, candidates have been able to provide reasons for a lack (or even absence) of international mobility in their application file. In addition, inter-institutional mobility between the WBF's own academic institutions is encouraged at the FRS-FNRS. This recent measure aims to encourage women candidates and researchers, especially those who, as mothers, may face difficulties linked to the demands of geographical and international mobility (FRS-FNRS, 2023).

The under-representation of women in academia is well documented in the literature, but reviewing the current situation is not the goal of this article. However, it seems important for funding agencies to be able to identify levers for action. For example, the FRS-FNRS Communications Department is careful to ensure that women are represented among the scientists featured in its various media. Recently, it has started keeping a gender count of the scientists appearing in FRS-FNRS communication materials and actions to monitor this, as well as ensure that the proportion of women among those featured is representative of those in office (FRS-FNRS, 2021c).

⏩ Under-representation of women in assessment processes

Aside from the candidates, the other key players in research assessment processes are the evaluators. At the FRS-FNRS, there are two main categories of evaluators: remote experts, involved in the first stage of evaluating funding applications (from institutions outside the WBF), and scientific committee members, involved in the second stage (until 2023, 60% of these were from outside the WBF and 40% from within).

In 2020, 3,355 experts carried out at least one remote evaluation for the Fund—27.7% of them were women (FRS-FNRS, 2021c). This figure seems relatively low, but it simply reflects the low proportion of women working as full researchers and university professors in Europe (European Commission, 2021b) and elsewhere.[30] The proportion of women among FRS-FNRS experts is highly dependent on the scientific branch (15.1% in NPS, 39.3% in HSS and 28.7% in HLS), which comes as no surprise. It has also been observed at the FRS-FNRS that women show a slightly lower acceptance rate than men when invited to serve as evaluators, although the difference remains small (for example, 62.6% of female experts and 65.7% of male experts invited to assess a funding application in 2020 accepted the task). Experts having taken part in the FRS-FNRS evaluation processes are listed in a database which is updated with new entries as and when (and

30. According to the latest 'She figures' report, 26.2% of 'grade A' (professor-equivalent) male and female researchers were women.

contained over 16,000 experts in early 2022). In fact, with each new call for proposals, around 30% of the experts approached for remote evaluations are first-time evaluators for the Fund. Special attention is paid to gender in the selection of evaluators, to ensure a balanced representation of men and women wherever possible.

As far as scientific committee members are concerned, the Fund's board has been actively seeking to recruit more female members to its scientific committees for some years now. This follows the alarming finding in 2015 that only 16.2% of committee members were women at the time. Since then, there has been a very positive change in the situation, thanks to the efforts made over the last few years, with almost half (45.9%) of the members in 2022 being women, and more than half (8 out of 14) of the scientific committees chaired by women (Figure 2.6). As is the case with remote experts, acceptance rates tend to be slightly lower among women. Indeed, of the 127 male and female researchers (70% of whom were women) invited to take part in FRS-FNRS scientific committees between November 2021 and January 2022, 34% of women accepted compared with 37% of men.

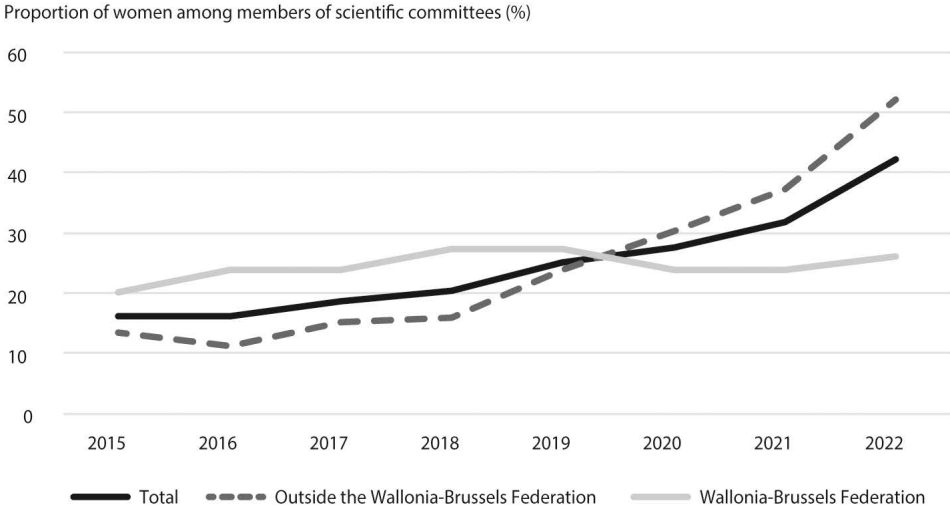

Figure 2.6. Proportion of women among members of FRS-FNRS scientific committees in recent years.

The Fund is fully aware of the situation and is committed to recruiting more women as funding application evaluators, without opting for a quota-based approach—mainly because of the low number of women working as university academics (especially in certain fields). This drive is motivated by the Fund's concern that women and men be represented fairly and equally among candidates and experts, while it is also aware that the proportion of women on juries and scientific committees probably has no impact on the success rates of female candidates (Vernos, 2013). At the same time, care must be taken not to make too many demands on permanent women researchers, who are less numerous than their male colleagues (European Commission, 2021b). Placing too many demands on women experts could ultimately have deleterious effects. For example, female researchers may have less time to devote to research and professional development, which could have negative knock-on effects on their careers (Vernos, 2013). The under-representation of women among committee members cannot be explained solely

by the slightly lower acceptance rates for women than men, as may have been the case in the past. Initiatives designed to highlight the profiles of female researchers, such as the international AcademiaNet database, to which the FRS-FNRS contributes (financially and by proposing female researchers) are of definite interest in this respect.

Evaluation tasks are time-consuming for remote experts. A survey was recently carried out among all remote experts who evaluated at least one funding application for the Fund during 2020 (41.3% response rate, 1,389 responses collected). Regardless of the scientific branch, experts reported spending an average of 6.0 +/– 3.9 hours on each assessment (FRS-FNRS, 2021b); 54.4% of them also said they felt concerned by peer-review fatigue,[31] albeit in similar proportions for men and women in this study. This is a major challenge that funding agencies will need to tackle in the future, and one where gender will probably have to be taken into account so as not to accentuate the existing under-representation of women among experts. In the Fund's survey, 45.7% of female respondents said they had less time than usual to assess funding applications because of the Covid-19 pandemic, compared with 34.0% of male respondents.

⏩ Conclusion

As we can see, gender is a very important issue for funding agencies, whose goal is to fund the best possible research with the limited budgets at their disposal. Indeed, it is now clearly established that taking diversity into account, including gender, is key in achieving higher quality research (Campbell *et al.*, 2013; Nielsen *et al.*, 2017; Gewin, 2018). The challenge is to ensure a gender balance in research teams, while also guaranteeing equal opportunities for everyone starting and pursuing a career in research, and fighting against the leaky pipeline phenomenon.

There are several concrete steps that research funding agencies can take to achieve a better gender balance. Firstly, in terms of regulations. Measures can be taken through regulatory adjustments to make it easier for female researchers to start an academic career, such as extending the eligibility periods for applying for a fellowship in the event of maternity, or other changes that make academic careers more attractive to women and ensure a better balance between personal and professional life. In terms of communication, it is important to ensure a balance between men and women appearing in the content diffused on various communication media: videos, articles, reviews, publications on social networks. Taking a proactive approach to increasing the proportion of women among experts involved in assessment processes is also a good idea. When it comes to assessment, time needs to be spent on making evaluators aware of the existence of gender biases, which affect both women and men. These biases are mostly unconscious (Régner *et al.*, 2019), which is why being aware of their existence rapidly helps to limit them. In terms of science policy, it is important to reflect on current research culture and the values that underpin it, as well as the changes that can be made to move towards

31. Reviewer fatigue occurs when experts in a field are repeatedly called upon to evaluate research, both in their own country and internationally. This adds to the list of duties required of researchers, which also includes peer reviewing publications, editorial tasks and supervision (Science Europe Position Statement and Recommendations on Research Assessment Processes, https://www.scienceeurope.org/our-resources/position-statement-research-assessment-processes/).

a sustainable European research ecosystem that guarantees equal opportunities for researchers of all genders to pursue an academic career, along with favourable working conditions conducive to scientific excellence. In this respect, the Fund's participation in various gender-related initiatives is important, whether at regional, national, European or international level. Lastly, to implement effective policies, issues need to be properly quantified and studied before proposing solutions. That is why the regular production and publication of statistical analyses is so important. It helps identify possible levers for improving processes and sheds light on existing problems and imbalances.

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Chapter 3

Assessing gender bias in the allocation of research funds

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'I hadn't been aware that any doors were closed to me until I started knocking on them.'
Gertrude B. Elion (McGayne, 2001)

Gertrude Belle Elion was an American biochemist and pharmacologist who won the Nobel Prize in Physiology or Medicine in 1988 along with two other scientists. Although she had achieved outstanding results during her studies, she was denied financial aid to pursue graduate studies fifteen times and was unable to formally obtain a doctoral degree before receiving the Nobel Prize (McGayne, 2001). She is best known for describing the barriers and closed doors preventing women from pursuing a career in science. Today, thanks to those who have paved the way, more and more women are participating in science (European Commission, 2021), which suggests that doors are opening. However, many inequalities remain and weigh heavily on women and their activities in academia.

Gender-related inequalities can be reflected in the access women have to permanent positions (Larivière *et al.*, 2013), the number of times they are published or cited (Fox *et al.*, 2017; van den Besselaar and Sandström, 2016) and even in their salaries, which in current-day Europe is generally explained by differences in academic positions and areas of expertise (European Commission, 2021). The study of these differences remains tricky because the various elements are interconnected. For example, being published opens the door to a permanent position, which determines salary and, most probably, resources for research activities, which in turn influence the probability of being published.

Gender differences in academia have been studied through productivity (Huang *et al.*, 2020) in some of the literature, which is likely to explain differences in the promotion of women and men (Long *et al.*, 1993; Mairesse *et al.*, 2020). The argument is that women possibly publish less than men, which would explain differences in academic position. However, doubts have been expressed as to whether productivity is a 'gender-neutral' measure. The need to determine whether this measure could be biased against women led to an in-depth study of the peer review system. Indeed, in the scientific community, to assess the quality of an applicant's research, funding agencies often rely on other researchers to filter out unsuitable work and assess applicants' abilities to produce scientific output relevant to the field of the funding call. Peer review is now recognized as a key part of the resource allocation and scientific quality control processes,

regardless of criticism concerning its predictive validity in promoting the 'best science' (Resnik and Elmore, 2016). It is used in many research evaluation processes, such as for publishing articles in journals, during the hiring process, or for awarding grants. However, decisions made in the peer review process can sometimes be based on perceptions influenced by stereotypes rather than on the researcher's qualifications.

Research grants are essential resources that can have an impact on researchers' scientific productivity and therefore their career path. That is why gender differences need to be studied in the context of grant allocation, to analyse whether there is any gender bias at work. That said, grant allocation mechanisms are not all the same and differences in selection procedures can lead to the prevalence of one form of bias or another. Furthermore, the findings in the literature on this subject are disputed and not enough studies address the evaluation process as a whole (Bianchini *et al.*, 2022) (Table 3.1).

Table 3.1. Previous empirical studies on gender bias during peer review of grant applications (source: Bianchini *et al.*, 2022).

Reference	Country	Research funding agency	Period	Discipline	Dependent variable	Gender effect
Banal-Estañol *et al.* (2019)	United Kingdom	EPSRC	1991-2007	Physical and engineering sciences	Allocated or not	No
Bautista-Puig *et al.* (2019)	European Union	ERC	2007-2016	All disciplines	Allocated or not	Yes
Bedi *et al.* (2012)	United Kingdom	Wellcome Trust	2000-2008	Biomedical sciences	Allocated or not	Yes
Bol *et al.* (2022)	Netherlands	NWO	2005-2016	All disciplines	Scores + evaluation stages	Yes
Burns *et al.* (2019)	Canada	CIHR	2000-2014	Biomedical sciences	Allocated or not	Yes
Cañibano *et al.* (2009)	Spain	Ramón y Cajal Programme	2005-2006	Physics, molecular biology, philosophy and philology	Allocated or not	Yes
Ginther *et al.* (2011)	United States	NIH	2000-2006	Biomedical sciences	Allocated or not	Yes
Ginther *et al.* (2016)	United States	NIH	2000-2006	Biomedical sciences	Allocated or not	Yes
Head *et al.* (2013)	United Kingdom	Miscellaneous	1997-2010	Biomedical sciences	Allocated or not	Yes
Jagsi *et al.* (2009)	United States	NIH	1993-2007	Biomedical sciences	Allocated or not	Yes
Lerchenmueller and Sorenson (2018)	United States	NIH	1985-2015	Biomedical sciences	Allocated or not	Yes
Magua *et al.* (2017)	United States	NIH	2010-2014	Biomedical sciences	Scores + sentiment analysis	Yes

Reference	Country	Research funding agency	Period	Discipline	Dependent variable	Gender effect
Mutz *et al.* (2014)	Austria	ASF	1999-2009	All disciplines	Scores+ awarded or not	Low
Pohlhaus *et al.* (2011)	United States	NIH	1999-2004	Biomedical sciences	Allocated or not	Moderate
Sandström and Hällsten (2008)	Sweden	VR	2004	Biomedical sciences	Scores	No
Severin *et al* (2020)	Switzerland	SNSF	2009-2016	All disciplines	Scores	Yes
Tamblyn *et al.* (2018)	Canada	CIHR	2001-2005	Biomedical sciences	Allocated or not	Yes
van der Lee and Ellemers (2015)	Netherlands	NWO	2010-2012	All disciplines	Scores + sentiment analysis + evaluation stages	Yes
Witteman *et al.* (2019)	Canada	CIHR	2011-2016	Biomedical sciences	Allocated or not	Yes
Yip *et al.* (2020)	Hong Kong	University of Hong Kong	2015-2020	Social Sciences	Allocated or not	No

Gender bias in research funding has been studied in different fields, countries and disciplines for over three decades. This table presents studies published after 2008. Bornmann *et al* (2007) and Marsh *et al* (2009) offer a systematic review and meta-analysis based on literature prior to 2008.

The GIGA (Gender Bias in Grant Application) project is an attempt to fill this gap. It provides an in-depth understanding of gender bias in grant allocation by studying data shared by the European Science Foundation (ESF). We studied the EUROCORES (European Collaborative Research Scheme) programmes, providing a framework for analysis and examining each stage of the evaluation process. The aim is to highlight where, when and which biases might occur and have an impact on selection.

⏩ Research grants

Research grants are essential to the process of creating new knowledge, providing researchers with the funding they need to investigate new topics and extend our knowledge in a given field. As well as enhancing academic research, grants also encourage team work and networking (Hicks and Katz, 1996). Studies such as Bloch *et al.* (2014) show that receiving grants significantly increases the likelihood of being promoted and achieving full professorship. Hechtman *et al.* (2018) point out that women who obtain funding tend to remain in academia with similar funding longevity to men. The central role of grants in science policy leads research funding bodies to adopt strategies aimed at reducing bias in evaluation processes, in order to provide funding for the highest quality research.[32]

32. https://erc.europa.eu/about-erc/erc-glance

Indeed, a bias against women in the awarding of grants has profound consequences for their careers in all these respects.

Grants are mainly issued by national and international research funding bodies. Although these bodies may have different criteria and procedures, most rely on external peer review and panels of experts. The grant peer review process comprises at least two stages: review by an assessment panel or committee, sometimes involving several phases, and evaluation by external experts. In general, the applicant's project proposals are checked for admissibility and eligibility, and then external reviewers are invited to evaluate these proposals. The characteristics of the panels and external reviewers depend on the specifics of the grant call, such as the objectives and the funding amount.

Every stage in the funding process is conditioned by a human decision—this where bias can occur. However, there is no consensus in the literature on the existence of gender bias in the awarding of grants. Some studies have shown that gender has an influence, especially on the review of grant applications by peers (Viner *et al.*, 2004; Wennerås and Wold, 1997). Indeed, women tend to have less success in obtaining funding. Yet authors like Teresa Rees (2011) explain that from one discipline or nation to another, data and interpretation sometimes appear different, even contradictory. Other studies highlight the lack of evidence of mechanisms that would be considered as gender biases in the allocation process (Bazeley, 1998; Ley and Hamilton, 2008).

There are several reasons for these conflicting views. Although a significant amount of data is generated by research funding agencies during grant calls, this data is rarely accessible to researchers, leading to a lack of multilayered data, and therefore questionable results (Albers, 2015; Volker and Steenbeek, 2015). Consequently, to highlight the comparative disadvantage, most previous publications in this field focus on one stage of the evaluation process at a time (van der Lee and Ellemers, 2015; Witteman *et al.*, 2019). Furthermore, these studies focus on either a given discipline or institution and do not necessarily provide a conceptual basis for analysing the different forms of bias that could arise in the evaluation process. The advantage of our approach is that it exploits a relatively comprehensive data set from each stage of the evaluation process, using different methods of analysis.

⏩ Gender bias in the allocation process

To prove or disprove the existence of gender bias in grant allocation, we first need to define what a gender bias is. The literature provides several definitions for the term 'bias', and many types of bias have been identified in human decision-making. Several authors describe bias as suboptimal decision-making based on systematic simplifications or deviations from the principles of rationality (Cosmides and Tooby, 1994; Haselton *et al.*, 2016; Korteling *et al.*, 2018). Gender bias therefore refers to biases based on gender stereotypes, or their consequences.

The literature on the origins of gender stereotypes highlights two main approaches used to explain why they exist and persist in our societies (Jalabert, 2021). The first is historical and cultural, with the prevalence of unequal gender norms throughout history. Among the reasons leading to this inequality, literature in anthropology and development

economics has shown that when nations began to develop, their activity, which relied heavily on physical strength, led to a gender-based division of labour (Alesina *et al.*, 2013; Leyaro *et al.*, 2017). The ratio of women to men in the population had a strong impact on how gender norms evolved (Grosjean and Khattar, 2014; Guttentag and Paul, 1984), with unequal norms reinforcing this ratio through parents investing less in their female children (Coale, 1991; Gupta, 1987; Sen, 1989). These gender norms are maintained through culture (Bisin and Verdier, 2001; Grosjean and Khattar, 2014), institutions and laws (Alesina *et al.*, 2013; Burnette, 2019).

The second approach is a more behavioural one. It looks at stereotypes, which are generalizations made about a group that are then transposed onto the individuals within that group by virtue of their membership (Heilman, 2012). They are often based on erroneous inferences about the relationship between a characteristic and the occurrence of a specific event, for example, an overestimation of a specific behaviour adopted by members of a particular group (Hamilton and Gifford, 1976). Gender stereotypes are therefore generalized opinions about the attributes of men and women (Bordalo *et al.*, 2019). They are one of the strongest social constructs on which we judge others (Wood and Eagly, 2010) and are beliefs that have remained relatively unchanged over the last few decades (Haines *et al.*, 2016). This could be explained by the fact that without knowing or controlling it, one of the first ways we categorize people in a social situation is by gender, and subsequent categorizations are built on this initial basis (Brewer and Lui, 1989; Liberman *et al.*, 2017). Consequently, an unequal gender norm in a society can fuel the stereotyping process.

The prevalence of these stereotypes means women are generally less associated with competence than men (Carli *et al.*, 2016) and deprived of specific characteristics associated with masculinity, such as leadership (Fitzgerald, 2013; Madera *et al.*, 2009). Studies have shown that women are more often profiled as less capable and skilled in science, even when they perform equally to men (Chubb and Derrick, 2020; Foschi *et al.*, 1994; Moss-Racusin *et al.*, 2012). This reinforces the idea that science is generally associated with masculinity (Schiebinger, 1999). The existence of these stereotypes can translate into gender bias, suboptimal gender-based choices, and lead to discrimination phenomena.

Statistical discrimination is a theory that explains these types of behaviour through the difficulties that can be encountered during the decision-making process. This process is often complex and information or time may be lacking (Arrow, 1973; Phelps, 1972), leading individuals to rely on their beliefs about a specific characteristic. This is an attempt to cope with uncertainty, but stereotypes do not necessarily represent observed reality. Two types of bias can be identified: explicit and implicit.

Explicit biases are prejudices or beliefs consciously held by individuals. An example is taste-based discrimination (Becker, 1971), which is the idea that individuals prefer not to interact with a specific group of people or with individuals because of a specific characteristic, such as gender or ethnic origin. For instance, a reviewer who deliberately and explicitly does not treat two individuals who have a similar level of productivity equally because they are not of the same gender.

As for implicit biases, they express themselves through the unintentional actions of individuals shaped by their stereotype-based perceptions. These individuals are unaware of their discriminatory behaviour and sometimes explicitly reject it (Bertrand *et al.*, 2005;

Frankish, 2016). This means that in an evaluation situation, for proposals of the same quality, men would be given the same score, whereas women would unintentionally be given a lower score.

Research into implicit biases is growing despite different interpretations of what makes them 'implicit' (Corneille and Hütter, 2020). Many studies rely on text mining algorithms to uncover implicit patterns in reviewer reports (Magua *et al.*, 2017; van der Lee and Ellemers, 2015). Implicit biases can also directly affect individuals experiencing prejudice, leading to self-selection issues (Bordalo *et al.*, 2019). Unlike explicit and statistical biases, which can be measured and estimated relatively well, the task is trickier for implicit biases. One of the contributions of our research is to offer a way of assessing implicit biases in the context of grant evaluation.

To examine how these gender biases may influence the awarding of grants in more detail, and to identify their nature, studying an evaluation process from start to finish full seems essential. In this study, we have chosen to analyse EUROCORES research programmes from the moment applicants send in their outline proposals, through to the moment when grants are awarded.

⏩ EUROCORES programmes

EUROCORES was created by the European Science Foundation (ESF) in 2001. Its goal was to boost high-level, bottom-up, pan-European research projects in and across all scientific fields. The scheme provided a framework for bringing together national research funding organizations, opening up new horizons for science. It was launched in 2003 with the European Union's 6th Research Framework Programme, the main instrument for funding research in Europe, proposed by the European Commission. For the first five and a half years, the cost of coordinating and networking EUROCORES was covered by a contract with the European Commission. After 2009, it continued with direct financial support from ESF member organizations. The scheme came to an end in December 2015.

EUROCORES was most active between 2003 and 2014, with a total of 47 major programmes in different research fields (for a total budget of around 150 million euros) such as the humanities and social sciences (19), life, earth and environmental sciences (12), physical and engineering sciences (11) and biomedical sciences (5).

The research programme topics were selected by an annual call for themes and each programme brought together several collaborative research projects (CRPs). Each CRP comprised at least three individual projects (IPs), each led by a principal investigator (PI) affiliated to a European university. A project leader (PL), also the PI of an IP, was responsible for coordinating the CRP made up of different IPs.

A total of 10,533 applicants (PLs, PIs and associated partners (AP)) submitted 1,642 outline proposals (OP); 756 of these were rejected, resulting in 886 final proposals (FP), 223 of which were accepted.

The EUROCORES programmes were large and complex in nature, and the project selection process was unique in that it represented a wide range of evaluation methods (Figure 3.1). The evaluation of CRP proposals in a EUROCORES programme was a

multi-stage process, including the creation of a panel of international and independent experts. The evaluation process involved 2,246 external reviewers and 829 expert panels.

The study of EUROCORES programmes offered several advantages. It enabled us to fill a certain gap in the literature by studying a complete, multi-stage procedure for awarding grants. In addition, these programmes involved several fields of research and applicants from several countries. Although we could not exclude the possibility of self-selection bias in applications, we were still able to focus on the other ways gender bias could influence the evaluation process.

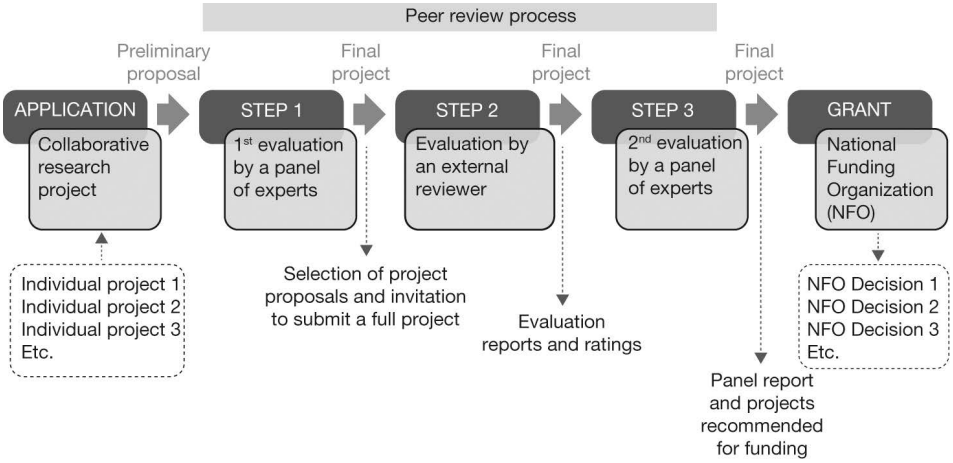

Figure 3.1. The peer review process (source: Bianchini *et al.*, 2022).

Phase 1. Initial assessment by a panel of experts

The process. The first selection phase took place immediately after application submission. It was based on the outline proposals submitted to the panels of experts for evaluation. Each outline proposal was around three pages long and submitted by a team of applicants (at least three PI teams from three different countries). The panels of experts were made up of twelve members on average and each member was a spokesperson for three proposals. Decisions were made through peer-to-peer discussions within the scientific panel until a consensus was reached.

In summary, the overall evaluation was the result of a collective decision-making process subject to tight time constraints. In addition, since submissions only included an outline proposal, the information was incomplete and limited, particularly as regards the scientific merits of the candidates.

Data. For each CRP application, the data included information on the name, year of birth, gender and institutional affiliation of each PI and reviewer. We also had details of application dates, the amount of funding requested, review reports and reviewer scores. However, before carrying out any analysis, the original data required some pre-processing. Indeed, around 20% of observations were incomplete, with values missing for certain variables, such as the applicant's gender, age or affiliation. Where possible, these characteristics, were retrieved from each researcher's personal or institutional web page. We also limited the analysis to proposals containing complete information

for all consecutive stages and covered the period from 2003 to 2010. Table 3.2 shows all the variables used in this study, the dependent variables and the available variables that could influence them.

We began the analysis with 1,347 CRPs, 9,158 candidates, and 467 individual panel members. Women were represented (i.e. at least one woman was present) in over 64% of consortia. However, on average, they only led 19.8% of them. This low leadership rate at the start of the process may be explained by the presence of biases at team formation (Pezzoni and Visentin, 2024). As for the other characteristics, consortia had an average of seven members (6.8) with an average age of around 47, and 4.4 different participating countries; 57.4% of teams had a member affiliated to a university in the top 100 of the Shanghai ranking; 6.5% included a star scientist and 3.9% a private partnership. Lastly, the average diversity ratio was 43.7%, and 2.5% of consortia were concerned by network proximity and 37.6% by panel cognitive proximity.

If we look at disciplines, life sciences and biomedicine represented the largest field of study in our sample (48.9%), followed by physics and engineering (26.6%) and the humanities and social sciences (24.5%). Certain characteristics were more prevalent in specific fields. For example, research diversity was higher in the humanities and social sciences, but less than 2% of consortia in this field included private partnerships. A significant proportion of consortia in physics and engineering included at least one member who had already applied for and received a EUROCORES grant in the past (17.3%).

The panels were made up of around 12 people, 20% of whom were women, on average, and the average age was 53. In the panel with the highest ratio of women to men, 50% were women, and in the panel with the lowest ratio, there were no women at all. Panels evaluated an average of six projects.

Table 3.2. Variables (source: GIGA, 2021).

Label	Description
Dependent variables	
First stage passed	Variable equal to 1 if the project has passed the first stage of the selection process, i.e. from outline to final proposal.
Reviewer's score	Average reviewer score for Q1 (i.e. project merit) and Q3 (i.e. team merit) (Z scores)
Reviewer's sentiment score	Average score for the reviewer's feeling about Q1 (i.e. merit of the project) and Q3 (i.e. merit of the team)
Accepted	Variable equal to 1 if the project has passed the third stage of the selection process, i.e. if it has been recommended to national funding bodies for the award of a grant.
Candidate characteristics	
Ratio of women in the team	Proportion of women in the team
Parity	Variable equal to 1 if the proportion of female team members is between 0.40 and 0.60
Team productivity	Average number of publications for team members (in logs)

Label	Description
Star scientist	Variable equal to 1 if the team includes at least one of the most cited candidates according to the distribution of citations by discipline/year (top 1%).
Cognitive proximity of the team	Proportion of WoS (Web of Science) subject categories that overlap between team members and panel members/reviewers (256 WoS subject categories sorted into 21 groups)
Team's network proximity	Variable equal to 1 if team and panel members have at least one common co-author
Diversity of team research	Average Blau index of team members $(1- \sum (s_i)^2$, where s_i is the share of publications in WoS subject category i)
Team size	Number of researchers in a team: project leader + principal researchers + associated partners (in logs)
Team age	Average age of team members (in logs)
Shanghai team ranking	Variable equal to 1 if the team includes at least one member affiliated with a university in the top 100 of the Shanghai ranking (base year 2005).
Private partnership	Variable equal to 1 if the team includes at least one member from the private sector
Requested budget	Total budget amount requested for the project, normalized by team size (euros, in logs)
Team with EUROCORES grant in the past	Variable equal to 1 if the team includes at least one member with a project funded by EUROCORES in previous years
Number of countries	Number of countries participating in a team (in logs)
Panel member characteristics	
Ratio of women in the panel	Proportion of female panel members
Panel productivity	Average number of publications for panel members (in logs)
Panel size	Number of panel members (in logs)
Panel age	Average age of panel members (in logs)
Panel workload	Number of projects evaluated normalized by panel size (in logs)
Shanghai ranking for panel	Variable equal to 1 if the panel includes at least one member affiliated with a university in the top 100 of the Shanghai ranking (base year 2005).
Characteristics of external reviewers	
Gender of reviewer	Variable equal to 1 if the external reviewer is a woman
Reviewer productivity	Number of publications for external reviewer (in logs)
Age of reviewer	Age of external reviewer (in logs)
Reviewer's Shanghai ranking	Dummy variable equal to 1 if the external reviewer is affiliated with a university in the top 100 of the Shanghai ranking (base year 2005).

Method. The decision of the panel of experts was a binary choice; in other words, either the preliminary proposal was selected or not. For this reason, we used a probit model to study the first stage of the selection process. The probit model enabled us to assess the correlation between our variables and the probability of being selected for the second phase. We estimated the effect of the ratio of women in the research team on the probability of advancing to the next stage of the evaluation process.

Results. Teams with a higher proportion of female scientists were evaluated less favourably at the first selection stage by the expert panel. The full model specification suggests that a 1% increase in the share of women scientists significantly reduces the probability of moving on to the second stage by around 0.2% (Column 1, Table 3.4, or Figure 3.2). If we look at the scientific fields, life sciences and biomedicine is the only field in which this negative relationship did not appear significant at this first stage. In addition to the gender composition of the research teams, other factors seem to have played an important role in the selection process: for applicants, affiliation with a university in the Shanghai Top 100 ranking and previous success in EUROCORES applications had a positive influence and a highly significant effect on success at the first selection stage. Cognitive proximity between applicants and the panel, the number of participating countries, team size and having a star scientist also appeared to have a significant positive influence on moving on to the next selection stage. Interestingly, team productivity had no significant effect at this stage. In contrast, research diversity (diversity of research backgrounds) and network proximity regarding the panel, in other words, the presence of a common co-author, both had a significant negative influence on selection. Again, if we look at the scientific fields, cognitive proximity and team size were only significant for physics and engineering, and budget requested had a positive effect in life sciences and biomedical disciplines. The overall marginal effect of each significant variable can be found in Figure 3.2.

Panel characteristics also seem to have influenced the probability of success at the first selection stage. Panel size and workload (i.e. the number of projects per panel member) are associated with a lower probability of success. Apart from these elements, other panel characteristics have no significant effect.

Our results tend to indicate that the 'gender effect' in panel decisions may be due to statistical discrimination. At this stage, we cannot assess whether the bias is implicit with the data at our disposal. The evaluation conditions for panel members, characterized by a limited amount of time and information available, may have led them to develop a decision-making strategy based on group characteristics. Stereotyped beliefs about gender may have introduced noise around leadership abilities or, more generally, the ability to perform scientific tasks. According to statistical discrimination theory, to 'maximize quality', individuals tend to avoid the noisiest signal, which in this instance would be a consortium with a high proportion of women. It appears that scientific merit is not judged based on productivity in this case, but on gender.

Selection. The success rate for this first phase was 38% overall, which represents 511 projects and 3,579 candidates. At the start of the process, the ratio of women in a team averaged at 19.8% for all disciplines, falling to 17.5% after the first selection phase. If we look at these results by discipline group, the humanities and social sciences had the highest percentage of women—around 27%. After the first selection phase, this percentage fell to 22.4%. We noted a slight increase in the proportion of women among

applicants in the life sciences and biomedicine, which ranged from 19.9% to 20.6%. Lastly, among physics and engineering candidates, the proportion of women fell by 3%, from 12.9% to 9.9%. The number of women in teams (at least one woman per team) fell in all three fields after this first stage.

Phase 2. Evaluation by external reviewers

Process. For the second stage of evaluation, applicants submitted final proposals which were sent to at least three anonymous external reviewers, including reviewers from outside Europe. These reviewers were asked to complete a standardized evaluation form comprising eight to ten sections, each measuring a different criterion. The reviewers assessed proposals from their own area of expertise and assigned a score on a 5-point Likert scale. They also provided short written reports to justify these scores, in support of the assessment.

The decision-making process in the second stage was very different from the first one. During the second stage, decisions were made on an individual basis over a longer period of four to six weeks. Reviewers had access to far more information on the research proposal and candidate profiles during the decision-making process.

Data. From this selection stage onwards, women were present in 60% of consortia. The average team age was still around 47, and the team size was seven individuals. Compared with the previous stage, there were more teams with a star scientist (8%) or at least one member affiliated to a university in the top 100 of the Shanghai ranking (68%). One interesting change we can highlight was the significant increase in team productivity. The average number of team member publications rose from 11,085 to 13,418. This possibly illustrates that the first stage succeeded in eliminating what, at first glance, appeared to be the 'weakest candidates', even though team productivity seemed not to weigh in the balance.

The distribution of consortia by discipline changed after the first selection phase. Life sciences and biomedicine accounted for almost 40% of consortia in the second stage, with physics and engineering accounting for about a third and the humanities and social sciences 28%.

In terms of reviewer characteristics, reviewers were 48.6 years old on average, 17% of them were women and 26.7% of them were affiliated with a university in the top 100 of the Shanghai ranking. On average, they had a more than six works published (which was considered a measure of their productivity).

Method. We used the reviewers' answers to Question 1, the overall quality of the project, and the scientific merit of the applicants in Question 3, as an indicator of scientific merit. We justify this approach by the fact that the format of the two questions relating to the scientific quality of the proposal and the qualifications of the PIs remained unchanged throughout the period, while the format of the other questions underwent some minor changes, making them unsuitable for statistical analysis. Reviewer evaluations, based on a 4 or 5-point Likert scale, were converted to standardized numerical scores. Given that the dependent variable was a numerical average of the reviewers' scores, we used ordinary least squares (OLS) regression.

One concern regarding this analysis was the possibility of selection bias, because the statistical analysis was only carried out on the sample that passed the first selection stage. To address the issue, we corrected this potential bias by following Heckman's two-stage estimation procedure (Heckman, 1979; Puhani, 2000) using the inverse Mills

ratio (IMR[33]). The IMR generated by the first probit estimation (the first selection step) is included in the OLS estimation as an additional explanatory variable. Regressions are estimated with heteroskedasticity-robust standard errors, clustered at programme level, and include year, scientific field and programme fixed effects.

As an alternative measure, we modelled the sentiments associated with external reviewers' written evaluation reports. To do this, we performed a sentiment analysis using the VADER algorithm (Valence Aware Dictionary with the Sentiment Reasoner; Hutto and Gilbert, 2014). This tool enabled us to capture the emotional polarity (positive or negative) and intensity of criticism, while also taking into account polarity shifters (i.e. negators), amplifiers, downtoners and adversative conjunctions. We developed a list of evaluative terms for projects and candidates using the Word2vec model (Mikolov *et al.*, 2013). For the analysis, we removed all reviewer reports with fewer than fifteen words, as well as any words appearing fewer than five times. Further technical details are given in Bianchini *et al.* (2022).

The aim of this combined approach is first to assess whether a gender bias can be observed in the text or the scores. However, it also allows us to determine whether reviewers' perceptions and scores are concordant and influenced by the same variables.

Results. Our OLS regressions showed a negative relationship between the proportion of women in a consortium and the scores of its reviewers. Column 2 in Table 3.4 shows that a 1% increase in the proportion of female PIs in a consortium leads to a 0.356% drop in the scores received.

In contrast, no gender differences were found in the reviewers' written reports. Although results varied according to the different algorithms and dictionaries used, the valence scores of the evaluation corpus were not affected by the gender composition of the consortia (or positively affected when the team was gender-balanced—only when using Syuzhet). We could interpret these results as showing that, in written comments, reviewers did not perceive female applicants as less competent and did not use a more negative vocabulary to evaluate their applications.

We can therefore observe a discrepancy between the scores awarded (quantitative evaluation) and the comments and associated feelings (qualitative evaluation). For proposals with the same qualitative assessment result, a consortium with a higher proportion of women would have a lower score. This discrepancy supports the idea that an implicit gender bias may be at play. Although theories differ on implicit bias (Corneille and Hütter, 2020), in this study, we chose to assume that individuals are implicitly biased when they are unconscious of stereotypes or reject them (hence the absence of a more negative vocabulary towards women in reports), yet their behaviour shows that stereotypes are there somewhere under the surface (women receive a lower score) (Frankish, 2016; Mandelbaum, 2015).

Among other significant results, candidate productivity finally came into play and was positively associated with a better (quantitative) score. This can be explained by reviewers having more time and information for evaluating proposals. Cognitive proximity was negatively associated with scores, showing that reviewers penalized applications closer to their area of expertise, which is in line with previous research (Boudreau *et al.*, 2016). In physics and engineering, having a star scientist had a negative influence. Lastly, the productivity of reviewers had a negative impact on both quantitative and qualitative evaluation.

33. The inverse Mills ratio (IMR) is the ratio of a distribution's probability density function to its cumulative distribution function.

Selection. No selection took place at this stage. The aim of having anonymous reviewers was to guide the next selection phase by means of the scores and reports provided for each proposal.

Phase 3. Second assessment by a panel of experts

Process. The reviewers' written reports for each applicant and the scores awarded were examined by the same panels of experts as during the first phase, with scientific quality as the main selection criterion. Once the panels had reached a decision, they submitted recommendations for CRP funding, in order of priority, to the various national research councils, such as the EUROCORES funding organizations.

This was a collective decision taken after open discussion between expert panel members, with additional information available from the reviewers. The reports submitted by the reviewers were to be used as the main basis for this evaluation phase according to EUROCORES guidelines.

Data. As there was no selection in the second phase, the population characteristics remained the same as for the previous phase. In addition to these characteristics, we now had the reviewers' scores and reports.

Method. As with the first selection phase, the third phase could also be seen as a binary decision for the panels of experts. Consortia would either pass or fail the third stage of the selection process. We therefore used probit models to estimate the effect of the proportion of women among a consortium's candidates on its probability of passing this stage.

Results. We found no evidence that parity or the ratio of women in the consortia influenced the probability of passing the third selection stage. Nevertheless, the expert panels' decisions were strongly correlated with the reviewers' scores, which fell in line with EUROCORES guidelines. However, given that the reviewers' scores appeared biased against consortia with a high ratio of women, the expert panel's decisions may also have been indirectly biased.

Looking at the disciplines, we found some interesting results for life sciences and biomedicine. Although the reviewers' scores were biased against women and had a significant impact on the probability of passing this final stage, this did not mean there was a lower proportion of women in the discipline. The explanation for this surprising result could lie in the fact that this is the only scientific field in which having a gender-balanced team is significantly positive. The close attention paid to an equal balance could have therefore offset the previous bias. Nevertheless, further analysis would be needed to be able to draw conclusions about this particularity.

The data also revealed other significant variables. Network proximity seems to have had a positive and substantial influence, coinciding with the old boy network pattern (Rose, 1989; Travis and Collins, 1991) already identified in previous literature (Sandström and Hällsten, 2008; Wennerås and Wold, 1997). These studies highlight the existence of a 'double penalty': some women also suffer from a negative effect linked to their professional network and need to be more productive to compensate for this. In physics and engineering, having a star scientist in the team had a significant positive effect. Surprisingly, team productivity and belonging to a Shanghai-ranked university had a significant negative

impact. In addition, having a private partnership seems to have had a negative effect in general, yet a positive effect for the humanities and social sciences.

Otherwise, panel size and workload were associated with a lower probability of being selected, which coincides with the first stage of the selection process. However, panel age also seems to have a negative impact in this respect.

Selection. Around 60% of the projects and candidates that reached this stage were successful, which represented 306 projects and 2,200 candidates. At the end of the whole evaluation process, age and team size remained unchanged, and most of the other characteristics of the population had not changed significantly after the first evaluation stage.

However, a more detailed analysis by discipline reveals different trends between fields. For example, the average team size seems to decrease slightly with each new stage for life sciences and biomedicine, while it increases slightly for physics and engineering and, even more noticeably, for the humanities and social sciences (Table 3.3).

Table 3.3. Some characteristics of the consortium across the evaluation stages (source: GIGA, 2021).

Variable by stage (1, 2, 3)	Physics and engineering	Life sciences and biomedicine	Humanities and social sciences
Individuals	1,913	5,036	2,189
	1,035	1,491	1,053
	638	902	660
Outline proposals	358	659	330
Final proposals	170	200	141
Accepted proposals	99	127	80
Teams with female members (%)	45.3	70.3	72.4
	40.6	68.5	71.6
	35.4	66.1	75.0
Ratio of women in teams (%)	12.9	19.9	27.0
	9.9	20.6	22.4
	7.2	19.8	23.5
Team productivity (average)	12.469	11.241	9.273
	15.537	13.979	10.066
	17.676	13.158	10.437
Team size (average)	5.344	7.672	6.633
	6.088	7.455	7.468
	6.444	7.102	8.250
Number of countries involved (average)	3.816	4.426	4.894
	4.276	4.540	5.333
	4.495	4.480	5.700

Statistics are calculated based on the outline proposals submitted, the final proposals reviewed and the projects accepted for funding. Individuals may appear several times in more than one project and/or over time.

In terms of gender, the proportion of women fell again, from 17.5% to 16.7%. Physics and engineering saw a decrease of over 2.5% after this selection stage to 7.2%, the lowest proportion of women since the start of the evaluation procedure, and only 35.4% of their consortia included at least one woman. The humanities and social sciences were the only fields where the proportion of women actually increased slightly (1%), and 75% of consortia in this field included at least one woman. The life sciences came in between the other two fields, with 66% of consortia including at least one woman, and the proportion of women stood at 19.8%.

Interesting points can be made when comparing the marginal effects of the main variables (Figure 3.2). The impact of the ratio of women within a consortium varies between the different stages and disappears in the last stage. This observation underlines the importance of including all evaluation process stages in an analysis when investigating gender bias, rather than focusing solely on one of them. The comparison also reveals that the variables with a positive influence on success are different at each stage. For example, the variables with the most effect during the first stage were having obtained EUROCORES funding in the past and having cognitive proximity to the panel, whereas, during the second stage, scientific productivity had the most effect. Lastly, the comparison between the two phases of the second stage enables us to reveal the possible existence of an implicit bias.

⏩ Conclusion

Discussion

In this study, we analysed the evaluation system of the EUROCORES grant programme to explore the different factors influencing evaluation at each stage of the peer review process. Our results provide key insights into the interaction between peer review outcome and applicant gender. We provide relevant evidence that having more women members in consortia has a strong negative impact on evaluation results. After controlling for a large set of variables, the gender difference in results can be found in the peer review phase during the first stage and in the external review: we consider this to be gender bias.

We can observe that, on the whole, the proportion of female candidates declines throughout the selection process. However, if we look at each discipline individually, we find that this is especially true for physics and engineering, at all three stages. The proportion practically halves after the three selection stages. In the field of life sciences and biomedicine, the proportion of female candidates seems relatively stable throughout the three consecutive evaluation stages. In the humanities and social sciences, the proportion of female candidates falls during the first selection stage mainly. However, it is not easy to further investigate how gender bias varies according to scientific discipline given that most projects were interdisciplinary.

We submit that statistical discrimination may dominate when decisions are taken collectively and when the deadline is short. This is especially the case during the first selection stage. These evaluation conditions could also explain why the productivity factor is not significant at this stage. However, an implicit bias could arise when decisions are made by one person, who is given more time and detailed information.

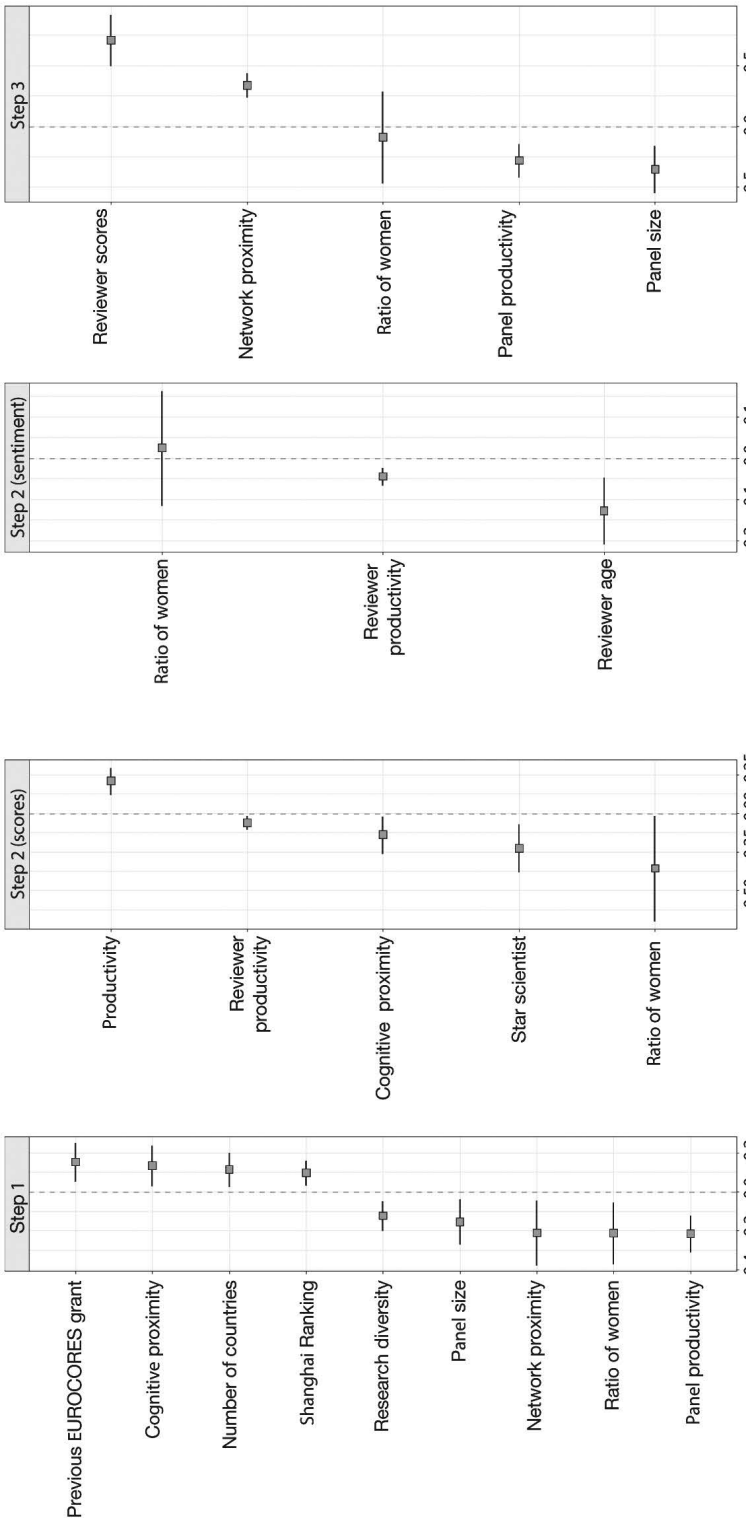

Figure 3.2. Marginal effects.

Marginal effects (squares) and 95% confidence intervals (horizontal bars) for selected variables. Marginal effects were calculated by setting all covariates to their mean values. The 'ratio of women' is shown in all models, while other variables are shown only when significant, with a p-value < 0.05. Coefficients have been arranged in the graph, from largest to smallest effect. No factor had a significant influence on the evaluation vocabulary in the reviewers' reports; consequently, the results are omitted from the figure.

Table 3.4. Estimation of coefficients. Full specifications.

	Stage 1	Stage 2
		Reviewer's notes
Female ratio	– 0.213***	– 0.356**
	(0.081)	(0.175)
Parity	0.013	0.084
	(0.061)	(0.084)
Reviewer's average score		
Variance in reviewer's scores		
Productivity	0.022	0.211***
	(0.028)	(0.045)
Star scientist	0.094*	– 0.226***
	(0.053)	(0.079)
Cognitive proximity	0.135**	– 0.138**
	(0.054)	(0.062)
Research diversity	– 0.123***	– 0.046
	(0.039)	(0.089)
Network proximity	– 0.211**	
	(0.084)	
Team size	0.079*	– 0.025
	(0.047)	(0.082)
Age	– 0.208	0.193
	(0.172)	(0.229)
Shanghai ranking	0.097***	0.089
	(0.032)	(0.061)
Private partnership	– 0.090	– 0.076
	(0.071)	(0.123)
Previous Eurocores grant	0.154***	0.094
	(0.050)	(0.079)
Requested budget	0.027	– 0.014
	(0.021)	(0.038)
Number of countries	0.115**	0.135
	(0.045)	(0.105)
Ratio of female panel members/reviewers	0.023	– 0.039
	(0.198)	(0.055)
Panel/reviewer productivity	0.056	– 0.059**
	(0.056)	(0.023)
Panel size	– 0.154***	
	(0.059)	
Age of panel/reviewers	0.339	0.64
	(0.389)	(0.098)
Panel workload	– 0.216***	
	(0.049)	
Shanghai ranking of panel/ reviewers	– 0.030	– 0.0005
	(0.186)	(0.045)

Stage 2 (evaluation and reviewer's feelings)				Stage 3
SentimentR	(Syuzhet)	(VADER)	(Evaluation periods)	
– 0.035	0.456	0.024	0.042	– 0.089
(0.039)	(1.338)	(0.071)	(0.091)	(0.191)
– 0.002	1.333*	– 0.018	– 0.022	0.077
(0.016)	(0.754)	(0.034)	(0.048)	(0.093)
				0.708***
				(0.106)
				0.039
				(0.043)
0.028**	0.134	0.008	0.013	– 0.046
(0.011)	(0.425)	(0.017)	(0.026)	(0.040)
– 0.012	– 1.211*	– 0.058	0.056	0.151*
(0.018)	(0.730)	(0.036)	(0.047)	(0.087)
– 0.005	0.064	0.004	0.021	– 0.025
(0.012)	(0.575)	(0.024)	(0.036)	(0.112)
– 0.043**	– 0.614	0.038	– 0.013	0.208
(0.019)	(0.742)	(0.038)	(0.048)	(0.151)
				0.338***
				(0.051)
0.053***	1.170*	0.020	0.007	– 0.088
(0.020)	(0.659)	(0.033)	(0.046)	(0.083)
0.072	1.416	0.043	0.055	– 0.262
(0.058)	(1.893)	(0.087)	(0.128)	(0.377)
0.021	0.544	0.027	0.058*	– 0.023
(0.014)	(0.516)	(0.026)	(0.035)	(0.097)
– 0.0035	– 0.267	0.004	0.030	– 0.185
(0.036)	(1.102)	(0.051)	(0.080)	(0.195)
0.028	0.763	0.002	0.009	0.049
(0.017)	(0.778)	(0.034)	(0.046)	(0.069)
– 0.005	0.418	0.007	– 0.001	0.078*
(0.009)	(0.328)	(0.015)	(0.021)	(0.041)
– 0.011	– 1.112	– 0.004	– 0.036	0.056
(0.021)	(0.987)	(0.046)	(0.060)	(0.113)
– 0.013	0.848*	0.001	0.022	– 0.298
(0.011)	(0.488)	(0.023)	(0.031)	(0.294)
– 0.009*	– 0.663***	– 0.044***	0.0003	0.005
(0.005)	(0.202)	(0.011)	(0.013)	(0.081)
				– 0.353***
				(0.100)
0.033	– 2.696***	– 0.127***	– 0.038	– 1.094**
(0.020)	(0.872)	(0.041)	(0.056)	(0.555)
				– 0.281***
				(0.071)
– 0.026***	-0.473	-0.031	0.023	0.114
(0.010)	(0.372)	(0.020)	(0.026)	(0.113)

Table 3.4. (to be continued)

	Stage 1	Stage 2
		Reviewer's notes
Inverse of Mill's ratio		– 0.028
		(0.248)
Programme fixed effects		×
Dummy variable: year	×	×
Dummy variable: domain	×	×
Comments	1,347	1,862
Akaike information criterion	1,511.633	
Bayesian information criterion	1,673.008	
Maximum likelihood	– 724.817	
Deviance	1,449.633	
R^2		0.148
Adjusted R^2		0.122
Studentized residual		0.834
F-statistic		5.700^{***}

Steps 1 and 3 represent the expert panel evaluations and present the marginal probability effects of probit estimates, while holding all explanatory variables at their mean values. The dependent variable is 'Stage 1' for column 2 and 'Stage 3' for column 8. Stage 2 first displays the 'Reviewer's score' and then the 'Reviewer's feelings'. Column 3 presents the coefficients of the OLS estimation with 'Reviewer's score' as the dependent variable. Columns 4-6 show the coefficients of the OLS estimation, and

We assume that this type of bias applies mainly to evaluations carried out by an external reviewer, although the data did not allow us to test this hypothesis.

Our analysis still has several shortcomings that need to be investigated in more depth. Firstly, we had no information on candidates' work-life balance and family composition (e.g. household chores and childcare), or on the time allocated to different activities (such as research, administrative tasks and teaching). In addition, certain confounders that were not controlled could have guided or influenced the selection process, such as the textual characteristics of preliminary proposals. The quality and style of writing may depend on the gender composition of the team (Kolev *et al.*, 2020).

Nevertheless, the study highlights some interesting findings. It shows that gender biases not only impact individuals, but also groups of individuals. Another interesting finding is that the framework of the evaluation process itself, the goal of which is to select the best proposals, could allow gender bias at one stage to influence subsequent stages. This reinforces the idea that all the stages of evaluation processes should be studied together.

Implications

It would seem that peer review system for awarding grants needs to be adapted if we want to ensure more equality in science. Social or cognitive conflicts of interest and other forms of proximity should be avoided and candidate profiles could be made anonymous to stop prejudices from interfering with the process. Going a step further, informing

Stage 2 (evaluation and reviewer's feelings)				Stage 3
SentimentR	**(Syuzhet)**	**(VADER)**	**(Evaluation periods)**	
0.067	– 1.780	– 0.007	0.030	
(0.058)	(2.028)	(0.101)	(0.133)	
×	×	×	×	
×	×	×	×	×
×	×	×	×	×
1,862	1,862	1,862	1,862	511
				518.656
				658.392
				– 226.328
				452.656
0.081	0.119	0.136	0.062	
0.053	0.092	0.109	0.033	
0.183	7.305	0.357	0.478	
2.896***	4.4141***	5.157***	2.167***	

column 7, the probit estimation of different dependent variables corresponding to several 'Sentiment scores' obtained by different algorithms, whose names appear in the column heading. All other explanatory variables are defined in Table 3.2. Robust standard deviations are shown in brackets, grouped at programme level: ***, **and *denote significance levels of 1%, 5% and 10%, respectively.

panel members and reviewers of any biases observed in their behaviour could improve their awareness of this issue.

Our study does not allow us to conclude whether more gender balance is needed in panels. What we have observed is that a higher proportion of women in them is negatively associated with the probability of passing the first stage in the humanities and social sciences.

In this study, the specific case of life sciences and biomedicine suggests that careful attention to gender balance within teams could compensate for the presence of bias. Although our results do not allow us to confirm this possibility, it would be interesting to test the hypothesis by studying situations where parity is officially valued in the evaluation and selection process.

Lastly, given that funding agencies do not all have the same evaluation procedures, it is difficult to generalize about results. We therefore need to open up the possibility of investigating biases for all of them. To do this, the collection, cleaning and sharing of data from funding agencies would need to be standardized to provide greater transparency and facilitate research. Indeed, the topic of gender differences is relevant across the board, yet there are strong specificities and heterogeneities depending on the time, place or, as we observed here, scientific field. That is why it is necessary to encourage and make it easier for researchers to study gender differences in a variety of circumstances, to identify where and when doors are closed for 'gender reasons' and help unlock them to truly make for 'better science'.

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Part II

Gender bias in knowledge production

How can we and why should we get scientists to include the sex and/or gender dimension in the research they conduct and take on the concept of gender as a 'useful category' (Marry, 2011)? What are the potential impacts if they don't? Christine Verschuur addresses these questions in Chapter 4, drawing on the experience of gender studies in the field of development to demonstrate why we need to transform the power relations intrinsic to the system of knowledge production and circulation.

Nowadays, public institutions at both national and European levels are committed to tackling gender inequalities. Some institutional Gender Equality Plans have been drawn up within the framework and with the support of European projects, such as the GenderSmart project, which brings together research organizations and funding agencies. However, getting funding agencies to take on the role of helping scientific communities understand they need to include the sex and/or gender dimension in research projects by making it an evaluation criterion is still a challenge. With this in mind, the French National Research Agency (ANR) has decided to gradually introduce this new criterion by first setting up an experimental phase in which applicants were asked to describe how they included the sex and/or gender dimension in their research projects over two consecutive editions of the ANR's generic call for proposals. This information, which was not submitted for evaluation or shared with assessment committee members, was analysed both quantitatively and qualitatively. While the results presented in Chapter 5 show that there is still confusion between the notions of gender, sex and parity, they also underline the fact that there may be resistance to taking the sex and/or gender dimension into account.

This resistance is found in all areas of social life, and more research is required to identify and describe it in depth so that it can be overcome. In Chapter 6, the URGEN project reveals the inner workings of resistance to social change by analysing gender stereotypes, the ideology of intensive mothering and neoliberal ideology and how they maintain gender inequalities.

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Chapter 4

Gender bias in the production and circulation of knowledge in a development context

Christine Verschuur

The purpose of gender research, as well as the methods used and feminist researchers themselves, have long been—and still are—considered 'illegitimate'. Gender research has always had to break with what might be described as 'normal(e)' social sciences (Chabaud-Rychter *et al.*, 2010), which think in terms of the masculine without realizing it. For some, women's studies is unscientific, represents a specific point of view on society, or is tainted by 'emotion'. But the truth is that women's studies criticizes generalist studies, which ignore gender and thereby produce truncated, incomplete or pseudo-general knowledge.

Gender analysis enables us to understand how symbolic values become part of institutions, social processes, perceptions and social organization (Scott, 2000). Gender is therefore not only a useful category of analysis, but also a necessary one.

Addressing gender bias in knowledge production should help answer the following question: what difference does it make to be interested in women (Tilly, 1990)? More broadly, we argue that gender as a category of analysis has a heuristic scope and paves the way to renewing theories and knowledge in development studies (Verschuur *et al.*, 2015), as well as in other fields of research.

I will address three aspects here: the invisibilization of women and gender, gender bias in research, and the marginalization of feminist and gender studies. Drawing on the experience of gender studies in the field of development, I will conclude by demonstrating why we need to transform the power relations intrinsic to the current system of knowledge production and circulation.

⏩ Invisibilization of women as research subjects

Historically, in medieval Europe, village witches took on the role of midwife, physician, seer or enchantress. With the persecution of folk healers, women were dispossessed of a heritage of empirical knowledge about plants and remedies, which they had accumulated and passed down from generation to generation. Accusations of witchcraft were in fact often used to punish attacks on property, which had increased sharply with the

growing privatization of land and agriculture in the sixteenth and seventeenth centuries, and with the deteriorating living conditions of impoverished peasant families. They also reflected the fear of the knowledge women possessed, which could compete with that of (male) physicians (Federici, 2014).

It is now commonplace to say that women—especially the most marginalized—their experiences, knowledge and contributions have long been ignored, along with gender relations. How can we imagine today that research on labour was ever carried out without taking gender into account? That unemployment, employment and wages were studied without taking inequalities between men and women into account? That we sought to understand social reproduction without considering women's domestic work? That the reproduction of educational inequalities was analysed while ignoring the differences between girls and boys at school? Or that research on fertility or the reconciliation of work and family life was carried out without including men? Yet women, their experiences and their resistance have long been regarded as too insignificant or uninteresting to be studied: too 'specific' and not 'general' enough.

A 1997 history symposium in Rouen, entitled *Une histoire sans les femmes est-elle possible*? [Is history without women possible?] asked a provocative question that did not seem so incongruous at the time (Sohn and Thélamon, 1998). Women had long been excluded from history as it was studied at the time, always perceived as victims rather than as active subjects. Although not always successful, revolts and demands by women workers and peasants actually took place (Tilly, 1990). In her analyses of social movements in the twentieth century, Touraine focused solely on the work of male workers (but excluded reproductive labour), male workers' consciousness (but neglected female workers' consciousness) and male workers' movements (while the feminization of the wage-earning sector was invisibilized and protest movements led by women were ignored) (Touraine, 1984; 1996; 2006).

In the field of rural studies and North-South relations, women have also been invisibilized since colonial times, as Chantal Ndami reveals in her research on colonial history in rural Cameroon. Women's agricultural knowledge and practices, though subtle and rich, were spurned, ignored and discredited in favour of those of 'expert colonial agronomists'—even though they were often unsuitable and unsound—but not without resistance on the part of peasant women (Ndami, 2018).

The invisibility of women from the 'Third World' in development discourse has been hard to dislodge. It only began to be denounced in development circles in the 1970s, largely thanks to pressure from feminist organizations in the South, which were also the main driving force behind the organization of the United Nations Conference on Women and for peace in 1975 (Boserup, 1970; Pronk, 1975; Bisilliat and Verschuur, 2000). It became necessary to dismantle the 'myth' (Cornwall *et al.*, 1997) of the 'Third World Woman', represented not as the subject of her own history, but as an object constructed by Western feminists (Mohanty, 2000). It was not until 2011 that the Food and Agriculture Organization of the United Nations finally devoted its annual report to women in agriculture (FAO, 2011). The report confirmed the central role of women in production systems, their substantial contribution to subsistence farming, and their specific and very rich knowledge and practices, such as in the field of agroecology or farmers' seed systems, to give just two examples. And yet, for a long time, public policies in support of peasant women have totally ignored them, and even disadvantaged them. Similarly, at

the International Labour Organization (ILO), the predominant and specific role played by women in the informal sector, in domestic work and as agricultural workers was only brought to light and recognized belatedly. It took contributions from feminist researchers—notably from within the ILO (Benería, 1981)—in research centres and universities combined with pressure from feminist movements to deconstruct the concept of work and reveal the amount of 'invisible' and 'free' work performed by women, especially for social reproduction purposes (Verschuur *et al.*, 2021), and obtain recognition of their rights as workers. Yet the importance of women's agricultural work in contributing to the world's food supply is on par with that of all their work in contributing the reproduction of life more generally (Verschuur *et al.*, 2021).

The field of medicine is also a fine illustration of the aberrations to which this attitude can lead, and a perfect example of the radical transformation of a branch of knowledge by the feminist movement (Löwy, 2005). Numerous studies have demonstrated the problematic absence of women as subjects of medical research. Although women live longer, use more health services, undergo more health tests and make more use of doctors than men, there is a drastic lack of information about their health. Medical research has long been carried out mainly, if not exclusively, on male subjects (and white males at that). Even laboratory research was mainly carried out on male rats (Keville, 1994)! Research on women has focused on certain parts of the female body, associated with what corresponds to perpetuating dominant norms about female roles and functions. This lack of data on women's health does nothing but reduce our understanding of their health needs. Examples from medical research in the United States speak for themselves—a major study in the 1980s on whether taking aspirin could prevent heart attacks involved 22,701 subjects, all of them male! Another study, on the correlation between caffeine intake and heart disease involved 45,589 men and no women. And that is without counting the inequalities in the allocation of research funds, such as in 1989, when only $16 million out of a total budget of $7.7 billion for medical research was earmarked for breast cancer research. Some examples border on the absurd, such as research on the effects of obesity on breast or uterine cancer carried out only on men because the focus was on the effects of certain nutrients on oestrogen metabolism (Keville, 1994)! We could also highlight the fact that contraceptive research on birth control methods focuses almost exclusively on women, which is linked to women being viewed as mothers and sexual objects. For Donna Haraway (1978), knowledge surrounding the natural sciences has been used to dominate rather than liberate women, despite all the birth control claims made by 'propagandists'. Underlying all of this is the implicit view that male is the norm, female is the unimportant rest, only of interest where certain specific functions are concerned. This inevitably results in insufficient and imprecise or erroneous information about women, and expresses itself in the different treatment women receive. For example, according to a U.S. study (Keville, 1994), women between the ages of 46 and 60 were 50% less likely to be offered a heart transplant. They were also more likely to have their symptoms attributed to psychiatric or non-cardiac causes. Yet heart disease has become the leading cause of death for American women.

The absence of women—and especially of subaltern women—as subjects of research from all fields of study over such a long time is problematic, not only ethically but also because it limits, alters or invalidates understanding in all areas of knowledge.

Gender bias in research and higher education

The American science historian Margaret Rossiter (Cornell University) coined the term 'the Matilda effect'[34] (Rossiter, 1993) to describe the erasure of women's contributions to science for the benefit of men. She was parodying what a sociologist (Merton, 1968) had dubbed 'the Matthew effect'—in reference to the gospel which says only the rich get loans—and who had shown that big-name scientists tend to overshadow lesser-known contributors. Margaret Rossiter claimed that this is particularly true of women. She cited Trotula, an eleventh-century physician from Salerno, whose name was masculinized because her medical treatise seemed too important to be attributed to a woman; Lise Meitner, whose work on nuclear fission with Otto Hahn did not earn her a share of the Nobel Prize in 1944; and Rosalind Franklin, whose contribution to the discovery of the structure of DNA has been downplayed. The awarding of Nobel Prizes serves to highlight the erasure of women's contributions: in 2019, there were 863 male prize-winners compared with 52 women.

Beyond the Matilda effect, gender bias in the organization and dissemination of research—in terms of teams, methods, legitimacy and sharing of the knowledge produced—leads to wasted effort and distorted views. The conditions under which knowledge is produced and circulates in the developing world are riddled with inequalities of gender, class, race, institutional affiliation and geographical origin.

Women—especially marginalized women, as ever—are in the minority in the world of research. In France, in 2014, in public administrations (public bodies, higher education and research establishments and not-for-profit institutions), 42% of people working in research (146,000 in total) were women. However, the proportion of women among research support staff was 53% compared with 36% among researchers, whereas these proportions were 27% and 20% respectively in companies (Ministry of Higher Education and Research, 2017). This disparity between women and men varies, however, depending on the field of research. Thus, in 2014, there was almost the same number of women and men among the researchers at INSERM (French Institute of Health and Medical Research), Institut Pasteur (health) or INRA (French Institute for Agricultural Research). In contrast, women accounted for just 34% of researchers at the CNRS (French National Centre for Scientific Research), and less than 20% at the ONERA (French Aerospace Lab) and the INRIA (French Institute for Research in Computer Science and Automation). At the CIRAD (French Agricultural Research Centre for International Development), women accounted for 37.7% of researchers and 58% of research support staff.

Women are also in the minority among university professors. They represented just 8.6% of professors and 29.5% of lecturers in France in 1985. By 2016 these figures had only risen to 24% and 44% respectively (Prost and Cytermann, 2010; Ministry of Higher Education and Research, 2019),[35] and the rise was thanks to the number of female professors in

34. Named after the American suffragette Matilda Joslyn Gage (1826-1898), author of a small book on the contribution of women to the history of technology.

35. In Switzerland, in 2010, women accounted for 17% of professors and 25.5% of other teachers. They were also significantly more numerous in some scientific fields than in others: in the humanities and social sciences, they made up 28.1% of all professors (73.7% of students), compared with only 9.5% in the technical sciences (Fassa, 2013). However, this feminization is a recent phenomenon. In universities in the United States, although women are in the majority among those earning doctorates, they are still under-represented in full professorships, have lower salaries and less senior positions in faculties or senior administration, and especially so in certain fields such as physical and engineering sciences or technology (Cundiff *et al.*, 2018).

the arts and humanities. There may indeed be a trend towards feminization, but it is a very slow one. Of course, France is not the only country to have this glass ceiling, but it cannot be said that it is one of the highest performers...

In the USA, a 1994 study at the Massachusetts Institute of Technology (MIT; Hopkins, 1999) showed that, although there were just as many female as male students in the sciences, career prospects were fundamentally different. Despite twenty-five years of initiatives, there were still only 15 women full professors, compared to the 194 male ones, in the MIT's six science departments. In his conclusion, Hopkins stands amazed in front of this (albeit small) group of women full professors, given the unbelievable number of obstacles they had to overcome to get there…

Various studies have highlighted the importance of managerial culture in the academic world, with its performance and quality control indicators. Excellence is measured in terms of productivity, peer-reviewing, citation indexes and being part of editorial boards (Dubois-Shaik *et al.*, 2019). The low number of women working as professors or researchers is notably attributed to their lower scientific productivity and performance, which are measured by indicators that are far from neutral.

Studies have shown that female researchers are less productive (van den Besselaar and Sandström, 2017). Yet the most cited authors are also those who publish the most. There are many reasons for lower productivity. Employment conditions are often more advantageous for men than for women (Fassa, 2013), which subsequently makes it easier for men to prepare scientific dossiers and publications that enable career advancement. Female teacher-researchers are often in lower academic positions, benefit from less mentoring than men, have more part-time positions, or are in positions that are more service-oriented, administrative or supervisory (corresponding to gendered norms). The speed with which people are expected to publish and the number of publications they are supposed to produce contribute to excluding all candidates, especially women, who are not working full-time (Benschop and Brouns, 2003, cited by Pigeyre and Valette, 2004) or who are experiencing career interruptions (often due to maternity leave). Women have less time available for research and also obtain less funding, with prestigious funding characterized by a bias in favour of men (van den Besselaar and Sandström, 2017). Women often have a lower status in research teams and networks, which is also reflected in their position in the list of article authors. In addition, men benefit from networks linked to being members of committees (three times as many men as women benefit from this) (Pigeyre and Valette, 2004). Women are underrepresented in peer review processes, when it has been demonstrated that male and female reviewers show a marked preference for authors of the same sex (Helmer *et al.*, 2017). And furthermore, as shown by a study in Sweden on postdoctoral fellowships awarded in medical research, to obtain the same competence scores from reviewers, female candidates had to have been 2.5 times more productive than male candidates (Wennerås and Wold, 1997, cited by Cundiff *et al.*, 2018)!

Research has also shown that recruitment procedures are more favourable to men. This is due to a variety of 'visible and invisible' obstacles (Fassa, 2013) that are more likely to hold back women's careers than those of their male colleagues—self-censorship, lower competitiveness, internalization of gendered stereotypes by recruitment committees (such as women supposedly having fewer leadership qualities), etc. This also stems from the attitudes of recruitment committees, for whom evaluation based on merit, excellence

and the number and quality of publications appears fair, even though we know that these committees are also subject to gender, class, race and other biases.

The career progression of male and female researchers is also gendered. According to a rich database,[36] 'at the CNRS, the probability of holding a research director position is 44.8% for men and 17.9% for women' (Revillard, 2014). The criteria most valued in the evaluation of candidates (publications, team coordination) reflect a gendered division of labour within the academic world (research versus teaching and administrative tasks) or a work environment marked by attitudes that evoke gendered norms. For example, women are less likely to apply for the CNRS research director entry exams (45% less likely than men) for reasons such as lower confidence levels, less taste for competition and the anticipation of discrimination, which reflects the systemic nature of gender inequality.

As in other sectors, stereotypical expectations concerning women's abilities (value of work, skills, leadership qualities, etc.) lead to higher standards and requirements being applied when evaluating women. Extensive recent research has confirmed that these biases have not diminished over the years (Heilman, 2012, cited by Cundiff *et al.*, 2018). Such gender biases are further reinforced by racial biases, with female academics of colour particularly likely to experience double standards and the trivialization of their work. For example, they have a particularly heavy service workload, especially as the primary contact for minority female students. Yet these skills are devalued in the evaluations built into the academic meritocratic system (Martínez Alemán, 2014, cited by Cundiff *et al.*, 2018) when compared to certain qualities seen as masculine, such as assertiveness, self-promotion and leadership in research. Any women adopting these supposedly masculine behaviours risk being penalized or sidelined because they do not fit in with stereotypical gender expectations.

Other obstacles also come into play, such as, for people from certain non-English-speaking countries, the dominance of English—and the system of thought associated with it—which has imposed a grid of intelligibility on knowledge (de Lima Costa and Alvarez, 2019) and conditions access to the most prestigious gateways for disseminating knowledge (journals, publishing houses, institutions). There is also the way in which knowledge is attributed varying levels of prestige based on the institution to which researchers belong—English-speaking or not, central or peripheral, etc. This is a key factor in the creation of networks of academics and experts who call on each other to participate in research teams, evaluate research projects or publications, etc. It means that the legitimacy of individual researchers is based on their affiliation, which creates an additional obstacle to promoting knowledge produced elsewhere than in dominant English-speaking institutions, such as in the South (Verschuur, 2019; see also Hountondji, 2019). For example, the vast majority of gender 'experts' in the field of development come from a few renowned English-speaking universities (Thompson and Prügl, 2017). Knowledge from other academic institutions, particularly those in the South, does not enjoy the same legitimacy and therefore the same weight in theory-building or policy debates. Gender biases are reinforced by biases linked to unequal North-South relations, which means that we all too often continue to privilege concepts and theories developed in the North or in Northern institutions.

36. This database includes data from periods between 1991 and 2008 on all teacher-researchers listed in Section 5 of the CNU (French National Council of Universities) and researchers listed in Section 37 of the CNRS, as well as lists of candidates for and recipients of the *agrégation du supérieur en sciences économiques* (competitive public exam for recruiting economics teachers) and CNRS Section 37 research director positions.

Gender bias also intersects with racial discrimination, which also permeates the world of research. Surveys could serve to better document the situation, but a reluctance to remedy the issue persists.

There are striking contrasts in the type of discrimination affecting racialized women between English-speaking countries, such as the United States and Great Britain, but also between the Nordic countries, Switzerland and Canada, on the one hand, and France on the other—a country where certain issues, such as the Muslim veil, have sparked strong reactions from feminists.

It is clear that 'France discovered racial discrimination long after most Western countries and many Third World nations' (Fassin, 2002). For a long time, French society denied that foreigners or French people of foreign origin were treated differently. It was not until 1988, when the French prime minister received the report on discrimination from the High Council for Integration, that France finally acknowledged racial discrimination. Recording data on origin had been forbidden previously, which made it all the more difficult to document the fact that women from invisible minorities were discriminated against, especially in research organizations and when in positions of responsibility.

In France, the struggles of migrant and racialized women denouncing the persistence of a system of exclusion stemming from colonial power are increasingly visible. Meetings, publications and research bear witness to this. The emergence of these movements has been criticized by mainstream feminism, which has reproached them for their communitarianism and even their promotion of anti-white racism.

The development of migrant and racialized women's feminisms took place in parallel with debates on immigrant integration, secularism and discrimination during the 1990s. These debates highlighted the 'unsuspected affinities of mainstream feminism with French republican ideology' (Lépinard, 2005).

Indeed, in France, in the name of universal rights enshrined in 'grammars imposed by republican doctrine' (Lépinard, 2005), a mainstream feminist movement defended the idea that gender equality has progressed more among some women than others. It claims that in certain groups, whose background culture is considered particularly patriarchal, women are more oppressed and gender equality is flouted, in violation of France's republican values. It is amazing how easy it is for people to forget that French society in itself remains very patriarchal and still disregards many women's rights (wage inequalities, unequal access to positions of responsibility, unequal division of domestic work, sexism, violence, etc.).

Uma Narayan (2010), a researcher from India, recalls how the presuppositions of the superiority of 'Western culture' were used by colonizers to justify their goals. "'Western culture' could see itself as staunchly committed to values like liberty and equality, a commitment that was often held up as a mark of its 'superiority', even as Western powers engaged in slavery and colonization and resisted the granting of political and civil rights to large numbers of Western subject, including women' to many Western subjects, including women, disrupted this self-perception" (Narayan, 2010).

The debate on the Muslim veil in France has illustrated the overlapping of complicated debates on immigration, the colonial past and a feminist movement that proposes only one road to emancipation, remaining reluctant to question its privileges, include people from minorities and recognize feminist collectives with different founding visions.

The emergence of these racialized women's collectives has made it possible to denounce the specific types of discrimination arising from tensions between gender, race and ethnicity.

⏩ Marginalization of gender and women's studies

Gender studies do not focus on a specific aspect of a general case. And neither does it represent the work of a specific category of researchers, nor a specific category of work within a general, neutral body of work. It considers the oppression of subalternized women as an inherent social reality, that gender is an organizing and structuring principle, an expression of power relations embedded in all social processes, including concrete social perception and organization (Scott, 2000). Gender as a category of analysis enables us to understand how gender, class and race inequalities arise and are reproduced, including in research and higher education.

Despite this, gender consistently meets with resistance and reactions of 'boredom' (Verschuur, 2009). All too often, gender and women's studies continue to be considered unscientific, too 'specific' or tainted by 'emotions'. And yet they serve to criticise generalist studies, which forget to take gender relations into account and thereby produce truncated, partial or pseudo-general knowledge. Theories that are supposed to be neutral or objective are in fact blind not only to gender inequalities and the domination of women, but also to gender relations as a system that organizes the social space in which they occur.

Women's studies are still relatively marginalized in France and have limited means. However, this is changing, as the organization of this symposium on Gender in Research (ANR-CIRAD, December 2020) shows, along with the existence of the Gender Institute, a CNRS scientific interest group founded in 2012 as a coordinating, reference and scientific hub for French research on gender and sexualities. Gender and women's studies have always been (and still are) seen as minor, insignificant, 'illegitimate' fields of study, with little or no recognition of their theoretical contributions. This has resulted in inequalities regarding the citing of feminist works and references to female authors, the invisibilizing of collective works—which are often prioritized in women's studies—and even the appropriation of many of the achievements of feminist research. These practices reproduce and bolster the position of dominance: in symposium forums and seminars, on editorial boards, as chairmen of sessions or directors of collective works, for the benefit of their careers (power, economic advantages, etc.), to occupy the territory, for glory, etc. This social dominance is even expressed through the misappropriation of work produced by feminist researchers, 'their theorizations, their concepts, the construction of their research subjects; a misappropriation that goes hand in hand with the distortion of their thinking' (Devreux, 1995).

The practice of invisibilization is even present in contributions on gender issues. Devreux (1995) hence denounces the "process of appropriating and misrepresenting ideas. For example, the idea that the oppression of women also takes on symbolic forms becomes 'the domination of women is first and foremost symbolic', which then becomes 'Bourdieu says that the domination of women is first and foremost symbolic—it has to be true since Bourdieu said it.' This leads some of our colleagues, who claim to be feminist researchers, to agree wholeheartedly with Bourdieu when he says that domination of women is symbolic" (Devreux, 1995).

"The institutionalized expression of (the dominant's) consciousness and his view of the situation is the only one to be published, disseminated and commented. This then is referred to as 'theory', by right." In contrast, "thought that emerges from a position of submission, silence, inferiority, diffuse threat [...], the thought that emerges here is never referred to as theory." Moreover, "the first theoretical texts produced by minority groups are always disqualified from a theoretical perspective and presented as 'political' products, which, of course, they are" (Guillaumin, 1981, quoted by Devreux, 1995).

Yet, is it not the goal to analyse how subjects—women and men—shape social life through their activities and interactions? To observe the everyday situatedness of practices and the meaning subjects give to their practices, their points of view and the diversity of their experiences? Feminist sociology or anthropology is not limited to a specific field, that of 'women'; it studies society as a whole. Research on how the oppression of marginalized women manifests itself sheds light on the workings of society in general. Whereas positivist social sciences develop explanatory theories that invalidate the viewpoints of actors in the name of neutral objectivity, women's studies draw on stand-point theories, questioning the neutrality of social sciences and the production of knowledge. Feminist epistemology shows how different experiences and configurations of power inform the diversity of feminist points of view (black feminism, decolonial feminisms, subaltern feminisms, etc.). Feminist research reveals the symbolic and political violence of theories claiming universally valid points of view, and how everyone is affected, but especially women. The gender and race relations that run through social practices and the power relations between nations have also been overlooked.

'Gender' as a category of analysis first appeared fifty years ago. It was developed by American feminist social science academics (Oakley, 1972). It was only introduced into the development repertoire in the 1980s and was sometimes regarded by feminist movements in the South as a 'fuzzword', "an acceptable euphemism that softened the harsh discourse on rights and power" (Cornwall, 2007). Feminist movements and theories in the South have often considered that this buzzword obscured and depoliticized their fundamentally critical analyses and proposals. In France, for the feminist school of thought that had conceptualized the 'social relations of sex' (Delphy, 1970; Devreux, 1985; Mathieu, 1985; Daune-Richard and Devreux, 1992), placing the emphasis on the concept of gender sometimes felt like a step backwards in terms of theory. However, it is now widely used (see, for example, the title of the book by Chabaud-Rychter *et al.*, 2010, *Sous les sciences sociales, le genre*), with emphasis placed on its heuristic value, which stems from its original meaning as a category of analysis expressing power relations (Scott, 2000). The concept still regularly comes under attack from those opposing so-called 'gender' theory, who generally come from conservative circles in various countries around the world. These violent attacks generally demonstrate a total lack of understanding—or rather, a malicious distortion—of what the term actually covers. Gender is, in fact, nothing other than an analytical tool enabling us to transform the way we look at and analyse reality.

Incorporating a gender perspective therefore means not only taking women into account as study subjects, but also adopting a feminist approach to epistemology, with tools, methods, teams and knowledge from multiple standpoints. Feminist economics, feminist sociology, feminist medical research (Löwy, 2005), feminist diplomacy—this approach should cut across all disciplines.

⏩ Transforming power relations in the production and circulation of feminist knowledge

The field of 'gender and development' contributes significantly to thought on the dynamics behind the production and circulation of knowledge on gender. As mentioned above, feminist sociology or anthropology is not limited to a specific field, that of 'women'; it studies society as a whole. The same goes for all disciplines, including the field of development.

Development studies have been affected not only by the gender biases outlined above—the long-standing invisibilization of women, gender biases in research, the marginalization of gender and development studies—but also by the 'coloniality of power and knowledge' (Castro-Gómez and Grosfoguel, 2019).

The notion of decoloniality, emerging as early as the 1970s in Latin America and linked to critical analysis of the world-system theory, seeks to show how gender, race and class relations intersect with and reinforce inequalities (Verschuur and Destremeau, 2012). Unfortunately, this theoretical corpus is all too often ignored by critics of decolonial approaches. Debates concerning decolonial feminisms have often been caricatured.

Decolonial feminisms demand that knowledge, struggles and marginalized feminist perspectives—indigenous, Afro-descendant, migrant, racialized—in both North and South be recognized and heard. They are part of an approach that seeks to critically analyse the coloniality of power and the system that perpetuates inequalities.

The decolonial standpoint considers that culture is intertwined with political and economic processes, and that we cannot understand globalized neoliberal capitalism without taking account of the discourses of race and gender that organize the world population in an international division of labour (Castro-Gómez and Grosfoguel, 2019). It defends the need to engage with spaces and temporalities in which the world order is contested by 'others', in the South or North, whatever their trajectories (colonial or not), nourished by awareness of relations of domination and the emergence of new social movements, which also contributes to the process of decolonizing thought.

Critical analyses of development have long ignored the contributions made by feminist movements, especially the theoretical contributions of feminists from the South and those resulting from their struggles on the ground. Gender experts, who implement gender programmes and policies in international cooperation, have long echoed the dominant—Eurocentric—way of thinking about gender.

Yet feminist and women's movements have been present in most countries of the world, from the very beginnings of feminism in the nineteenth century (Verschuur, 2010; see also the recent work by Ripa and Thébaud, 2024). Let us not forget that the first feminist congress in Latin America was held in Buenos Aires in 1910! Moreover, it was pressure from feminist organizations from the South that pushed the United Nations to organize the first conference on women in Mexico in 1975, which gave considerable impetus to this issue (Bisilliat, 2000) and drew strong participation from Southern feminists. Despite this and the fact that they have contributed to the construction of knowledge in development studies, feminist researchers from the South have rarely received the recognition they deserve.

Numerous female researchers from the South have made fundamental theoretical contributions, some of them based in English-speaking universities, like Gayatri Spivak (1988),

Deniz Kandiyoti (1988) or Saba Mahmood (2001), others in institutions in the South, such as Heleieth Saffioti in Brazil (1969, cited by Connell, 2019a), who discussed intersections of gender and class, or Sueli Carneiro (2003), who discussed intersections of gender and race, and many others in other countries in Latin America (Lagarde, 2006; Viveros, 2002; Millán, 2012), Africa (Imam *et al.*, 1997), India (Chaudhuri, 1993) and elsewhere. In reaction to what has sometimes been presented by nationalists or conservatives in countries of the South as an imposition of Western thought, Uma Narayan (2010) demands the right to be able to criticize the inequalities of gender relations in her country without her ideas being branded as 'Westernized' or "one more incarnation of a colonized consciousness, the views of 'privileged native women in whiteface' seeking to attack their 'culture' on the basis of 'Western' values" (Narayan, 2010).

The difficulties in recognizing the contributions of feminists in the South are therefore due to a number of factors—several of which are shared with marginalized researchers in the North and have been mentioned above—which are sometimes amplified in the South (such as the greater precariousness of researcher positions). Feminist researchers in the South value the construction of knowledge from their own perspectives. They have contributed to a broader revisiting of development studies, around issues such as work, the economy, social reproduction, agricultural development, violence and many more.

⏩ Conclusion

Valuing the contributions of feminists, and especially taking the contributions of the global South into consideration, in no way means producing a unified theory of gender (Connell, 2019b), relying solely on the perspectives and contributions of the global South. On the contrary, it means seeking another economy of knowledge production and circulation, unbiased by gender, class, race, institutional affiliation or geography, through a process of decolonizing thought. It is an approach based on dialogue, that draws from the many places where knowledge is developed—in the South and in the North—and that recognizes the contributions of the global South without denying the contributions of the North or idealizing the knowledge of 'others'. Encouraging exchanges between academics, but also with feminist organizations, experts, communities, women and men from different backgrounds, would make it possible to include mutual theoretical—and not just empirical—contributions, fuel debates and enrich global intellectual production. This implies rethinking research methods and objectives, giving priority to collaborative, transformative feminist epistemologies that break with the coloniality of knowledge. In the field of development, it means rethinking research priorities, especially in light of those set out in the South, without cutting ourselves off—as advocates of the Latin American decolonial turn would have it—from the concrete social, economic and political struggles of the most marginalized groups in these regions (Verschuur and Destremau, 2012). This requires a profound transformation of the power relations intrinsic to the current system of knowledge production and circulation.

More generally, a critical analysis of knowledge production in the field of feminist and gender studies applied to development suggests avenues to be explored to free the world of research from the shackles of gender biases.

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Chapter 5

The sex and/or gender dimension in research projects. Analysis of a test phase at the ANR

Angela Zeller, Laurence Guyard, Emmanuelle Simon

Numerous studies conducted over the last thirty years have shown that stereotypes and gender-blind scientific approaches (Hamberg, 2008) introduce real bias into the production of knowledge (Mathevon and Viennot, 2017), even though recommendations to incorporate gender and/or sex dimensions[37] into research have multiplied since the 1960s. In addition, tools have been developed to better understand the issues at stake and support their practical application.

One such initiative is Gendered Innovations, a collaborative project launched in 2009 at Stanford University, which developed practical methods for integrating sex and gender into research and published concrete examples of such studies on its website.[38] That same year, Yellow Window started supporting scientific communities internationally with numerous practical examples from multiple disciplines on why and how to integrate the sex and/or gender dimension into research.[39] More recently, in 2020, the French National Authority for Health published a report entitled 'Sexe, genre et santé' (Sex, Gender and Health), which explains how sex and gender are major determinants of individual health and healthcare, and why taking them into account helps reduce health inequalities (HAS, 2020).

Funding agencies such as the Canadian Institute of Health Research (CHIR) and the Irish Research Council (IRC) now make the funding of research projects conditional on the quality of how the sex and/or gender dimension is addressed in project proposals. The French National Research Agency (ANR), which has formally committed to equality through a defined policy and a 2020-2023 Gender Equality Plan, has chosen to provide support and gradually raise awareness within scientific communities before making the consideration of sex and/or gender in research a formal evaluation criterion.

As part of this approach, a test phase was launched during Stage 2 of the ANR's 2020 Generic Call for Proposals (AAPG), and then repeated for the 2021 edition. These two test phases also provided an opportunity to assess the scientific communities' understanding of the issues related to this dimension in research and to identify potential resistance.

37. On the theoretical issues between biological sex and social sex, and the critique of sex-based bicategorisation, see the article by Michal Raz (2016).
38. Gendered Innovations: http://genderedinnovations.stanford.edu/policy/timeline.html
39. Yellow Window Gender in EU-funded research Toolkit and training.

The results of the analysis conducted on the content of responses provided by the project coordinators are presented in this chapter.

Methodology

The test phase was implemented as part of the AAPG, in view of the wide range of scientific fields it covers. For the 2020 edition, the call included 49 scientific areas: 36 research topics grouped into 7 major scientific fields – environmental sciences, energy and materials sciences, life sciences, humanities and social sciences, digital sciences, mathematics and its interactions, and physics of matter, high energies, and earth and space. The remaining 13 areas of research addressed cross-disciplinary issues involving several scientific fields. For the 2021 call for proposals, one of the areas was divided into two, bringing the total to 50 scientific areas: 37 in major fields and 13 in cross-disciplinary areas. Each of these areas corresponds to an evaluation committee (EC).

For each of the two test phases, the coordinators were invited to complete a dedicated section on the project submission platform addressing how the sex and/or gender dimension was considered in their project. More specifically, they were asked to indicate how this dimension was considered in their research, or, if it was not, to provide an explanation. During these experimental phases, completing this section was not mandatory, and the information provided was not shared with evaluators (committee members and experts); only the ANR staff in charge of this study had access to this information.

For the first year (AAPG 2020), the analysis was carried out on the 3,106 projects submitted during the second stage of the selection process, and then on the 3,165 projects submitted for the 2021 edition, using a quantitative and qualitative cross-sectional approach[40] (Figures 5.1A and B). The responses were considered in relation to the project summaries, and even their detailed scientific description, to provide a better understanding of the proposed research and the methodologies envisaged.

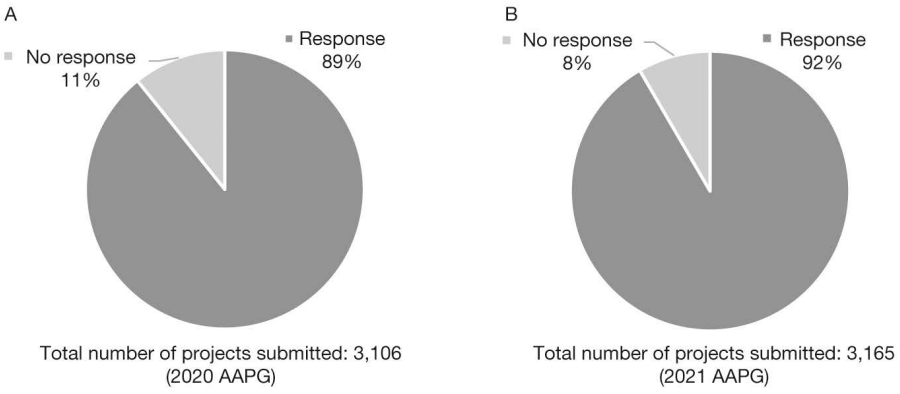

Figure 5.1. Response rates for (**A**) 2020 AAPG and (**B**) 2021 AAPG.

40. The analysis was carried out by the Equality, Scientific Integrity and Ethics Officer (PhD in Sociology), the Gender Studies Officer (Master's in Sociology) and the Head of the ANR's Health and Biotechnology programmes (PhD in Biochemistry), who together formed the GenderSmart project team and were in charge of implementing the ANR's Gender Equality Plan.

It quickly became apparent that the responses addressed two main themes: 1) human resources within the project consortium, and 2) consideration of the sex and/or gender dimension in the proposed research. For the 2020 edition, these two broad categories were further developed through a more detailed analysis of the responses, which helped identify sub-themes that were then integrated into the analytical framework for the 2021 edition and quantified. For example, the *human resources* theme was broken down into eight thematic sub-groups. The theme of *taking (or not taking) into account the sex and/or gender dimension in research*, referred to as the *research* analysis category, was divided into two thematic sub-groups: one for projects that addressed the dimension, and another for those that did not. These were further divided into three and four sub-categories, respectively. This categorisation enabled a faster and more detailed analysis of the responses that were then classified to identify quantitative trends, which are presented in this chapter.

⏩ A very high response rate

Although the dedicated section on the submission platform was not mandatory, the vast majority of project coordinators completed it. Between the first and second editions, the response rate increased by three percentage points, suggesting that scientific communities are increasingly receptive to this criterion in a context of growing international attention. While the Gender Equality Plan is now an eligibility criterion for Horizon Europe—the European Commission research funding programme—, it has also become mandatory in France for research institutions and organisations under the 2019 French Civil Service Transformation Act and its implementing decree of March 2020[41]. In contrast, inclusion of the sex and/or gender dimension in research content and teaching is not a formal European requirement but is a strongly recommended criterion.[42]

⏩ Highly contrasting responses

Confusion between the notions of gender, sex and parity

An analysis of the content of the responses revealed a significant gap between what was expected and what was described by the project coordinators, although some changes were observed between the two editions. In the 2020 edition, the vast majority of comments (53%)[43] focused exclusively on human resources (HR) considerations related to the composition of research teams. Only 19% of the responses addressed how the sex and/or gender dimension was taken into account in the research itself, and only in combination with HR aspects. A small proportion of comments (0.7%) were off-topic.

In the 2021 edition, there was a slight change: 49% of the responses still focused solely on HR considerations, but 15% addressed only the integration of the sex and/or gender dimension in the research, while 26% addressed both HR and research content. The proportion of off-topic responses remained low (1.6%) (Figures 5.2A and B).

41. Research bodies and higher education and research institutions were required to implement equality plans by the end of 2020 or face financial penalties.
42. European Commission, Research and Innovation: https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/democracy-and-rights/gender-equality-research-and-innovation_en
43. Percentages calculated on the total number of projects at stage 2.

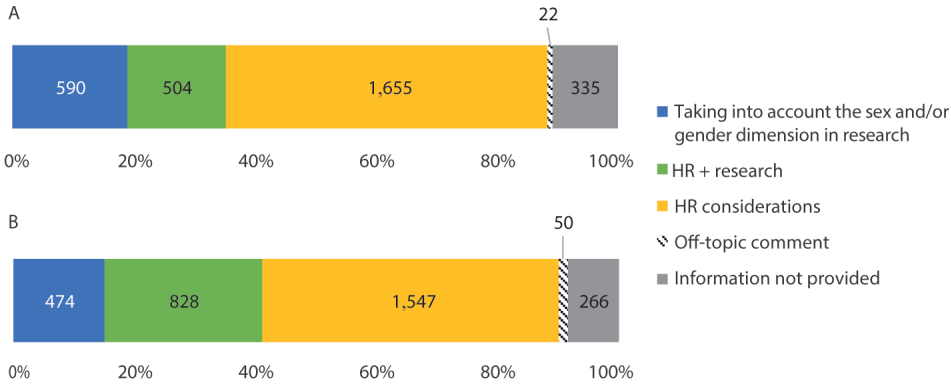

Figure 5.2. Types of responses for (**A**) 2020 AAPG and (**B**) 2021 AAPG.

This over-representation of HR considerations can be interpreted in two ways. First, it reflects both national and international policy contexts where gender equality in research, particularly professional equality between women and men, is a major focus. Second, it demonstrates a lack of understanding and/or confusion between the concepts of gender, sex and parity. Some project coordinators, for example, wrote: 'Gender is taken into account in this research because there are women in the consortium.'

While this type of response still appeared in analyses of the 2021 edition, it is worth noting a slight shift between the two editions, with the HR argument more often associated with a consideration of the sex and/or gender dimension. This combined category increased between the two editions from 16% to 26% (represented in green on the graphs). As a result, in 2021, 41% of coordinators mentioned the sex and/or gender dimension in their research, either alone or in conjunction with HR considerations, compared with 35% in 2020.

For the 2021 edition, the nature of the responses was disaggregated by gender. While there was no significant difference in the response rate (92% for women and 91% for men), the content of the responses varied considerably. The HR dimension accounted for 45% of the responses from female project coordinators, the research dimension represented 18% while 28% of the responses combined both dimensions.

The male project coordinators mentioned the HR dimension in 51% of the projects and the research dimension in 14%, while 25% mentioned both. As a result, 46% of the projects led by women addressed the sex and/or gender dimension in their research, compared with 39% of the projects led by men (with 7 projects in the 'Information not provided' category) (Figure 5.3).

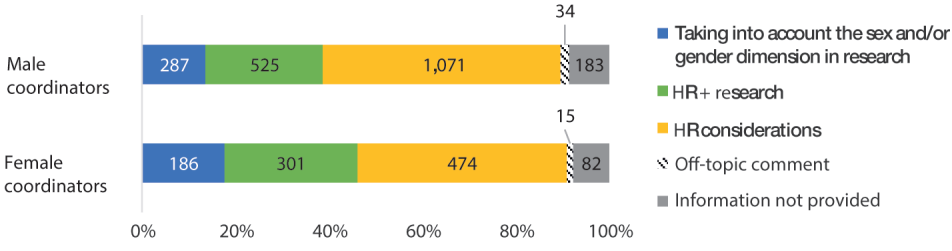

Figure 5.3. Types of responses to the AAPG 2021 by gender.

Variability of responses across scientific fields

Analysis by AAPG theme, or evaluation committee, reveals variability in responses according to the scientific field (Figures 5.4A and B), which is broadly consistent with the nature of the research topics.

In both editions, the highest proportions of comments addressing the sex and/or gender dimension in research, whether alone or accompanied by HR considerations, were found in two main fields: the humanities and social sciences, and the life sciences. Both fields also saw an increase in such responses between the two editions.

In 2020, 69% of projects in the humanities and social sciences, and 59% in the life sciences included a research dimension. In the 2021 edition, there is a clear increase in both areas, with 76% of projects in the humanities and social sciences and 63% in the life sciences addressing the sex and/or gender dimension in their research.

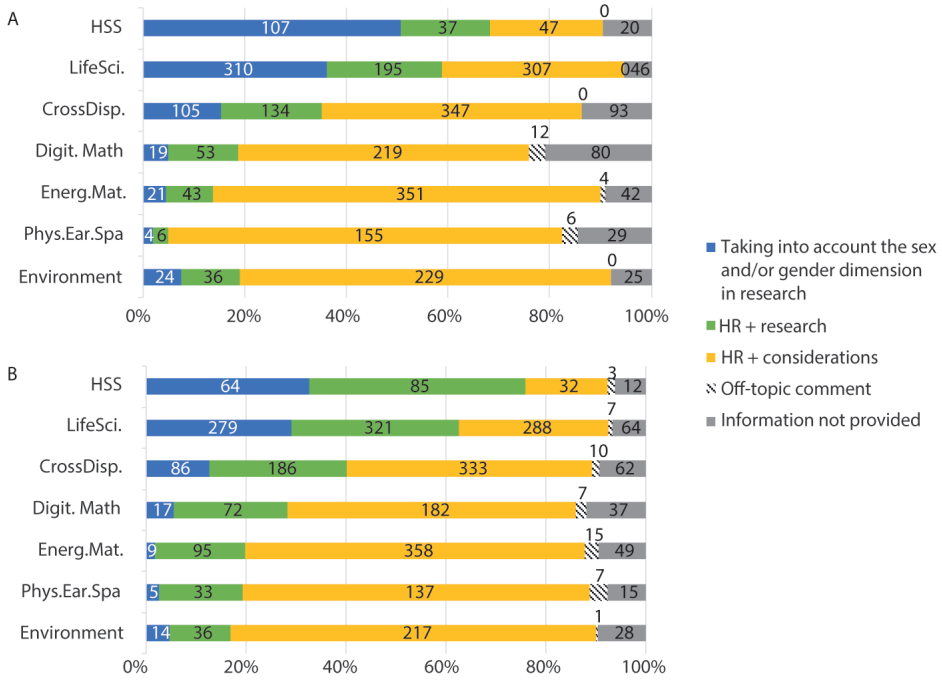

Figure 5.4. Nature of responses by scientific area for (**A**) 2020 AAPG and (**B**) 2021 AAPG.

Conversely, in 2020, the lowest proportions of comments addressing the inclusion of the sex and/or gender dimension in research were found in the fields of energy and materials sciences, and in physics-related disciplines (such as matter physics, high-energy physics and earth and space sciences) (14% and 5%, respectively). In the 2021 edition, this dimension was least often addressed in environmental sciences (17%) and, as in 2020, the physics-natural sciences field, although the latter showed a significant increase between the two editions. In 2021, this dimension was addressed in 19% of the comments, compared with 5% in 2020.

With the exception of the environmental sciences, which saw a slight decrease of two percentage points between 2020 and 2021, we can see a significant increase in references to the sex and/or gender dimension in research in all scientific fields.

The proportion of responses referring to the gender dimension increased from 19% in 2020 to 28% in 2021 for digital sciences and mathematics, and from 35% to 40% for cross-disciplinary fields. However, there are variations between thematic areas within the same scientific field and across the two editions.

There are also year-to-year differences within the same thematic area, as in the case of the 'Interaction, Robotics' area (CE33, Digital and mathematical field),[44] where 72% of the comments included the sex and/or gender dimension in 2020, compared to 'only' 51% in 2021.

Variations between thematic areas are particularly noticeable in the life sciences, cross-disciplinary fields, digital sciences and mathematics. There is a high degree of heterogeneity between scientific fields and within thematic areas, which seems to be linked to the specific nature of the research topics covered (Figures 5.5A, B and C).

Despite these thematic variations, the overall increase in the percentage of arguments mentioning the sex and/or gender dimension in research seems to confirm a growing awareness of the need and the feasibility of integrating this dimension into scientific research, or at least of recognising it as a relevant and responsible methodological approach.

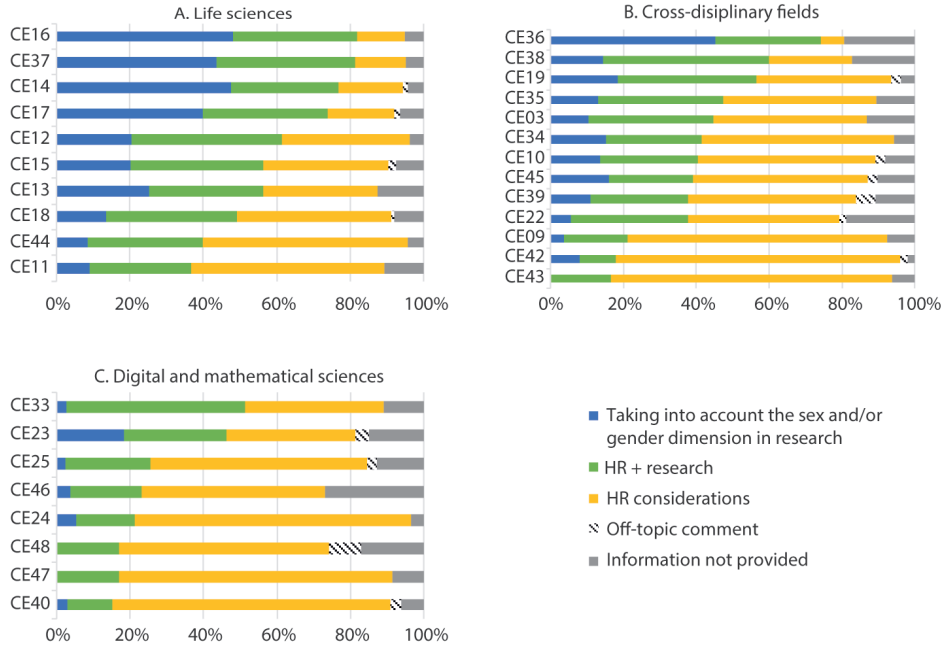

Figure 5.5. Nature of the responses by thematic area to the 2021 AAPG: (**A**) life sciences, (**B**) cross-disciplinary and (**C**) digital sciences and mathematics areas.

44. The projects submitted in this research area concern, on the one hand, all aspects of human-machine interaction, including natural dialogue and the creation of multimedia content, and, on the other hand, all aspects of autonomous and interactive robotics (service robotics, medical robotics, industrial robotics, multi-robot cooperative systems).

Human resources considerations

As previously noted, in the 2020 edition, it quickly became apparent from the first review of the responses that the question was largely interpreted through the lens of human resource considerations. In the first edition analysed, 70% of the comments focused on the HR dimension,[45] rising to 75% in 2021. For both editions, the scientific fields with the highest percentage of responses based exclusively on HR considerations were environmental sciences, energy and materials sciences, and the physical sciences of matter, high energy and earth and space sciences (ranging from 68% to 77%).

As indicated previously, the HR sub-themes identified during the 2020 comments analysis were systematically quantified in the 2021 edition. This allowed for a more detailed numerical analysis of the trends observed in 2020. As a result, the statistics on themes addressed by project coordinators in the 2021 AAPG presented below are based on the recurrence of these themes in the 2020 edition.

For the 2021 AAPG, out of all the responses relating to HR, 73% of project leaders described the composition of their consortium (a trend that was already dominant in 2020) in factual terms, using percentages or absolute numbers of men and women involved in the project. Teams were described as 'mixed' or 'equal', with particular attention paid to the male/female ratio in projects. Obvious imbalances were generally justified by the low proportion of female researchers in the relevant scientific field.

> 'In terms of female researchers or equivalent, including experts, there were 4 out of a total of 16 participants, i.e. 25%. This figure unfortunately reflects an imbalance, but it corresponds roughly to the proportion of women researchers in geoscience at [the] national level.' (2020 AAPG)
> 'Gender inequalities are particularly visible in the lack of parity in the world of engineering science research, in which the project [...] is included. Within the project, this observation is marked by the fact that there are only 2 women in the team.' (2021 AAPG)

In 63% of the responses relating to HR considerations, scientists described what we have classified as 'recruitment methods'. As early as 2020, we observed numerous references to institutional recommendations on recruitment, such as the Gender Equality Plans of the CNRS [the French National Centre for Scientific Research], universities and the ANR, as well as national and international frameworks such as the European Human Resources Strategy for Researchers (HRS4R).[46] This may reflect an awareness of gender bias in recruitment processes and a good understanding of policies, recommendations and charters, especially since recruitment has been identified as one of the levers for reducing gender inequalities in higher education and research. In some cases, however, these responses consisted simply of partial copy-paste excerpts from these texts or vague references to paying particular attention to the recruitment process, without further detail, suggesting a lack of interest in the subject by providing a standardised response.

45. Alone or accompanied by the sex/gender dimension.
46. HRS4R is based on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers. It aims to improve the practices of research organisations and institutions in terms of the recruitment and working conditions of male and female researchers. It has been awarded the HR Excellence in Research label by the European Commission.

> 'The European Human Resources Strategy for Researchers (HRS4R), which aims to ensure compliance with the principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, will be respected. Recruitment will be objective and posts will be filled with the most competent staff.' (2020 AAPG)
> 'The CNRS has laid down clear rules concerning interviews and the selection process for post-docs, which we undertake to follow. Similarly, we would point out that French law on gender equality is unequivocal [e.g. Law no. 83-635 of 13 July 1983 amending the Labour Code and the Criminal Code with regard to professional equality between women and men, or the Roudy Law, and Law no. 2001-397 of 9 May 2001 on professional equality between women and men, or the Génisson Law].' (2021 AAPG)

However, on reading these arguments, while the coordinators seem to be aware of the national and international recommendations for gender-sensitive recruitment in higher education and research,[47] it is clear that 'scientific excellence', 'scientific expertise', 'skills' and 'merit' remain the primary criteria for recruitment, regardless of gender.

> 'The participants will be members of staff already present in the various laboratories involved, and their involvement in the project will depend on their scientific and technical skills, regardless of their sex/gender. In particular, students or post-docs will be recruited on the basis of their scientific skills, regardless of their gender.' (2020 AAPG)
> 'The various contributors invited to take part in the project are all men. This imbalance is, of course, the result of a structural bias linked to the proportion of men in the fields of tribology and geomechanics, and is in no way the result of a deliberate choice. The speakers were chosen for their skills, and for no other reason. The person recruited for the post doctorate will also be the most competent of those who applied.' (2021 AAPG)

This awareness of gender bias in the recruitment process is, in several responses, accompanied by vigilance against all forms of discrimination, including those based on ethnic origin, race, age or disability.

In the 2020 edition, we observed the recurrence of recruiting women on fixed-term research contracts, non-permanent doctoral posts or post-doctorates as a solution for rebalancing a predominantly male consortium. In 2021, this approach was mentioned in 9% of the responses related to the HR dimension, and more frequently by men (11%) than by women (6%).

> 'To balance this ratio among staff, we can recruit women as non-permanent staff, bearing in mind that this obviously cannot be the only criterion for selecting our candidates for PhDs or postdocs in non-permanent positions.' (2020 AAPG)
> 'From the point of view of the composition of the consortium, there are currently 4 men and 3 women as permanent researchers/engineers or researchers/engineers. The fixed-term contract recruitments planned as part of the project will be made in such a way as to maintain a balance, and even to favour (at an equal level of skills) the recruitment of women (who are under-represented in the world of research).' (2021 AAPG)

However, while recruitment to doctoral and post-doctoral positions represents the entry point to a career in research, the practice of appointing women to successive non-permanent positions to compensate for the absence or under-representation of women

47. Agreement on professional equality between women and men in the civil service of 30 November 2018, and Law No. 2019-828 of 6 August 2019 on the transformation of the civil service, https://www.enseignementsup-recherche.gouv.fr/fr/bulletin-officiel

in consortia can be seen as a perverse effect, ultimately contributing to the increased insecurity of women in higher education and research professions[48].

In the first edition, we also identified a number of responses relating to the use of inclusive language[49] in job advertisements, as recommended by the High Council for Equality[50]. Some of these rules, however, such as the abbreviated forms used to indicate duplication in writing (e.g. 'chercheur·euse·s' in French), are still the subject of much criticism and controversy in France (Loison-Leruste *et al.*, 2020). In 2021, the use of inclusive writing was mentioned in only 2% of HR-related responses.

Parity on recruitment panels, presented as a guarantee of quality and a condition for objective recruitment without gender bias, was mentioned in 3% of HR-related responses in 2021. The transparent and open dissemination of job offers, through multiple distribution networks, and identified as a factor supporting gender diversity, is mentioned in 1% of HR responses. A written refusal to use positive discrimination in recruitment was mentioned in 1% of HR comments.

Work-life balance is a major lever for reducing gender inequalities in higher education, research, and the workplace more broadly, as it reflects significant differences between men and women. Private life has a greater impact on women's professional lives, because of the still highly unequal gender division of domestic responsibilities (Puech, 2005). The issue of balance between work and private life was raised in the comments, and is addressed through flexible working hours and advance planning of project tasks and scientific events. Project leaders see such arrangements as levers that can help women to better reconcile their professional and private lives, thereby encouraging or attracting female candidates to apply for project-related positions. This is in line with the 2018 agreement on professional equality, a key European level issue[51]. In 2021, work-life balance was mentioned in 5% of HR-related responses (Figure 5.6).

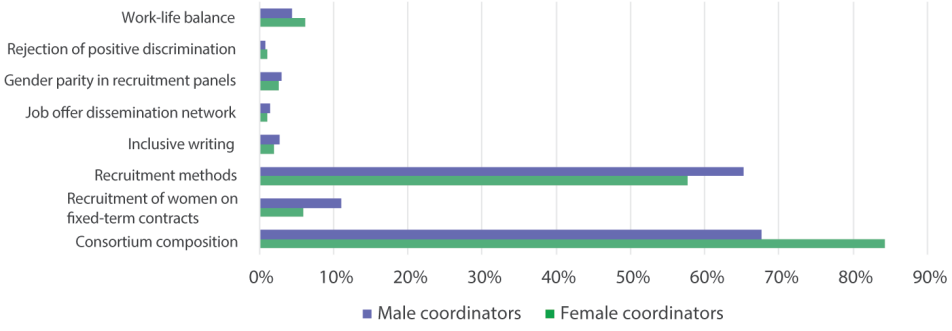

Figure 5.6. HR dimension: percentages of different topics relative to the total HR-related responses, AAPG 2021.

48. https://op.europa.eu/en/publication-detail/-/publication/9540ffa1-4478-11e9-a8ed-01aa75ed71a1/language-en

49. Inclusive writing is a set of linguistic procedures and techniques designed to ensure that men and women are equally represented in language and texts, and to adopt language non-discriminatory towards women.

50. *Guide pour une communication publique sans stéréotypes de sexe*, Haut Conseil pour l'égalité [*Guide to public communication without gender stereotypes*, High Council for Equality]: https://www.haut-conseil-egalite.gouv.fr/guide-pour-une-communication-publique-sans-stereotypes-de-sexe-1

51. The European GenderSmart project, in which the ANR is a partner, includes a workstream dedicated to work-life balance.

The sex and/or gender dimension of research

As previously noted, the second major theme addressed in the responses to the 2020 survey concerned sex and/or gender. As with the HR theme, the comments box in our analysis table enabled us, for the 2021 edition, to establish a more detailed grid to effectively quantify the responses.

In 2020, the sex and/or gender dimension of the proposed research was most frequently addressed in the humanities and social sciences (69%), life sciences (59%) and cross-disciplinary fields (35%). In the four other major scientific fields, the proportion varied between 5% and 19%. For 2021, based on these initial observations and a preliminary reading of the scientific proposals, the sex and/or gender dimension was divided into two sub-themes: the dimension 'taken into account' and 'not taken into account'. The first sub-theme was further divided into three sub-categories (research topic, methodology and impact), and the second into four: limited time/cost, biological constraints, regulatory context, and irrelevance of the dimension. A comments box was added to our analysis table for both sub-themes.

Most of the reasons for not taking the sex and/or gender dimension into account

While in some cases non-inclusion of the sex and/or gender dimension was not explained, in the majority of cases it was justified for a variety of reasons. In 2020, one of the responses, used in particular by the project leaders, was based on the regulatory context, especially relating to the 3Rs rule[52] (Replace, Reduce, Refine), to justify using only male animals in experiments to limit the number of animals used for scientific protocols. The European Data Protection Regulation (GDPR) was also cited as a justification for not including the sex and/or gender dimension in the proposed research, as sex-disaggregated data could be considered sensitive. In 2021, the regulatory context was addressed in only 1% of the responses related to the research dimension, specifically in the life sciences, cross-disciplinary fields and environmental sciences.

> 'At this preliminary stage, the study of the sex factor is not considered because this is a feasibility study/technical and methodological proof-of-concept on a small number of subjects. Using males and females would double the number of animals required (which runs counter to the reduction rule advocated in the 3Rs ethical code for animal experiments). However, the sex factor could be taken into account in subsequent studies whose objective goes beyond proof of concept.' (2020 AAPG)
> 'We therefore chose to include only males in our study in order to limit this variability in results, otherwise we would have had to increase the number of animals included in the study, which is not possible due to the workload associated with each manipulation and would not have enabled us to comply with the 3R rule.' (2021 AAPG)

52. Definition of the 3Rs principle according to the French FC-3R centre: 'The 3Rs principle defines the guidelines for an ethical approach to the use of animals for scientific purposes. It is based on three simple and fundamental rules, taken into account in the regulations and constantly adjusted to the technological and societal realities of the moment.' (https://www.fc3r.com/principe-des-3R.php)

Biological constraints were also cited as justification for not taking this dimension into account, particularly in relation to hormonal variations in females. These variations were seen as requiring significantly longer experimentation times, which researchers considered incompatible with the limited timeframe of an ANR project. Additionally, mixed animal facilities were described as demanding more resources and additional costs. The timeframe of project-based research was also cited as a reason for using pre-existing models based solely on male animals. However, the validity of these arguments can be questioned, as other projects, within the same committees or with similar scientific problems, do take this dimension into account despite facing the same constraints.

> 'During the oestrous cycle of females, there are significant hormonal changes. Including females in our study would mean testing them during all phases of their cycle and would therefore increase the number of animals used in order to include the cycle phase as a variable in our statistical tests. In order to 1) reduce the number of animals used (3Rs ethical rule), 2) respect the time allotted for this ANR project and 3) reduce the variability of our olfactory task, we have chosen to use only male rats.' (2020 AAPG)

In 2021, biological constraints were cited in only 6% of the responses related to the research dimension and, quite logically, almost exclusively in the life sciences (13%), often involving hormonal variations in female animals and pre-existing models developed solely on male animals. The choice to use only animals of the same sex can also be justified by the gender-specific nature of the diseases, conditions or cancers studied. The use of male animals, whether justified by biological constraints or by existing models validated by the scientific community, may in some cases be balanced by later studies involving female animals, patient cohorts including women[53] or as part of subsequent research projects.

> 'Venous thrombosis (VTE) is a common disease that affects women and men differently depending on their age group. Studies have shown that women are at risk during their fertile years, while men's risk increases with age (after 50). It therefore appears that men have a higher overall risk if the hormonal status of women is not considered. For this reason, only male mice will be used in this study. However, the convincing results will be reproduced on female mice in future studies. It is important to consider that in the project, the risk of venous thrombosis associated with complement regulation will be assessed in large cohorts including both females and males.' (2021 AAPG)
> 'Given the number of preclinical models (experimental conditions and transgenic models), we prefer to focus on male mice in this project, bearing in mind that organ damage, in particular the severity of cardiac remodelling, is also influenced by gender.' (2021 AAPG)

These justifications, however, call into question the validity and methodological relevance, particularly for projects that justify all-male cohorts for the sake of methodological continuity with previous studies or pre-existing models. The issues of time frame and additional costs were cited in only 1% of the research-related comments.

In the 2021 AAPG, the most frequently cited reason for not considering the sex and/or gender dimension, as identified in 30% of the responses,[54] was that it was irrelevant

53. These projects have been classified under the two sub-themes of 'taken into account' and 'not taken into account'.

54. Percentages are calculated based on the total number of projects pincluding a sex and/or gender dimension in their justification.

to the subject of the research. Project leaders provided varying levels of explanation as to why this dimension did not apply to their research.[55] This type of response was most common in the physical and earth and space sciences (97%[56]), followed by energy and materials sciences (85%) and digital sciences and mathematics (60%). In other fields, this justification ranged from 0% (environmental sciences) to 26% (cross-disciplinary fields) (Figure 5.7).

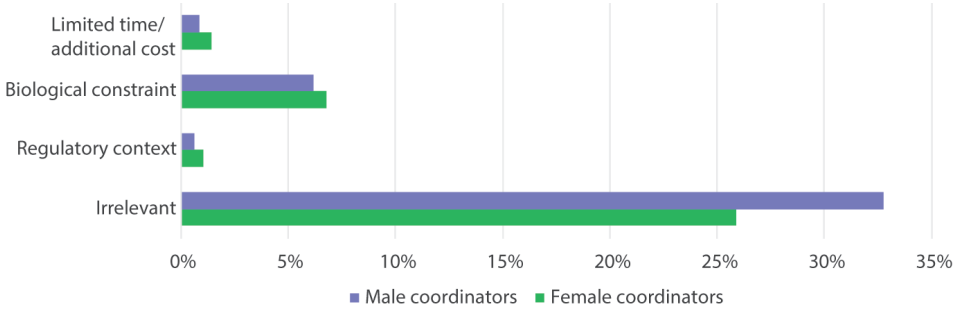

Figure 5.7. Reasons for not taking the gender/sex dimension into account in research, 2021 AAPG.

Taking the argumentative dimension into account

In the first year of analysis, when the sex and/or gender dimension was included in the projects, the research itself focused on these themes. The dimension was addressed methodologically, through the sampling of respondents, patients or animals, to ensure methodological robustness and good representativeness in the results, thereby avoiding gender bias in the analysis. The comments were generally well-substantiated, argued and supported by scientific references.

For the 2021 analysis, three main arguments were given. The sex and/or gender dimension was incorporated into the methodology in 51% of the responses.[57] This type of response was mainly found in the environmental sciences, with 66% of the comments indicating, for example, that male and female animals should be included in studies and the need for gender-specific analyses. In the life sciences, 59% of comments addressed methodological issues, particularly the use of animals of both sexes and patient cohorts to control and measure sex differences, avoid interpretation bias and thus promote unbiased experimental practices. The use of mixed-sex animal cohorts was mentioned by scientists as a quality criterion for certain funding agencies, such as the European Research Council (ERC) and the National Institutes of Health (NIH). In the humanities and social sciences, 57% of comments concerned methodology, stressing balanced panels of women and men in the studies to avoid interpretation bias, with gender considered an

55. There is, however, some margin for error: for certain projects, the justification sentence is brief and lacking in detail, which may suggest a misinterpretation of the application. In such cases, this is noted in the comments box.
56. Percentages are calculated by scientific field, based on the total number of projects that include the sex and/or gender dimension in the justification.
57. Always calculated as a percentage of the total number of responses addressing the research dimension.

'analysis variable'. In cross-disciplinary fields, 56% of responses also related to methodological issues, compared with 36% in digital sciences and mathematics, 11% in energy and materials and 5% in physics, earth and space (Figure 5.8).

> 'The project takes account [sic] of the sex/gender dimension in a number of ways, both in the scientific programme and in the coordination of the project. - In task 1, faeces from female and male volunteers will be collected, in order to study the impact of lipids and bacteria from dairy products on the human microbiota of women and men. - In task 2, female and male microbiota, modified or not by dairy components, will be inoculated into germ-free female and male mice, respectively, in order to identify the impact on the metabolism of this microbiota in both sexes. - This sex/gender dimension will be included and highlighted in our publications and communications, whether or not we observe differences in results between the two sexes.' (2021 AAPG)
> 'All experiments and treatments will involve the same number of individuals identifying as male or female and each group of participants will be gendered. This will ensure equal access to our paid experiments and allow project members to rigorously examine potential differences in the use of social information between people who identify as men and those who identify as women.' (2021 AAPG)

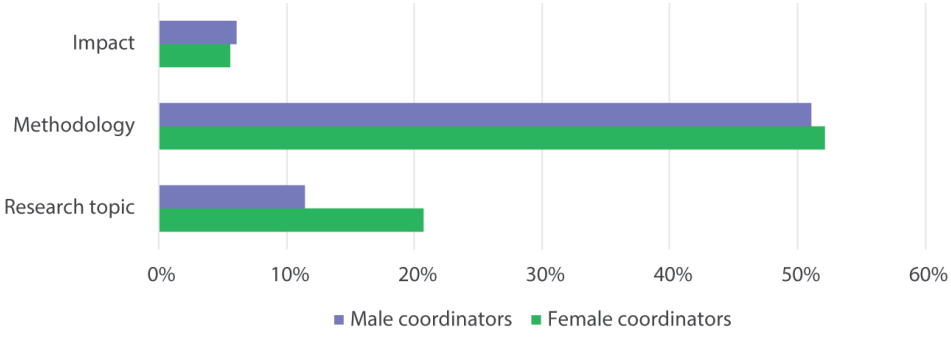

Figure 5.8. Topics for taking the gender/sex dimension into account in research, 2021 AAPG.

Gender or sex as a research theme or object was identified in 15% of the responses, slightly more often by female coordinators. Specifically, 21% of responses from female coordinators that addressed inclusion of this dimension concerned the research theme, compared with 11% for male coordinators. This type of response on gender as a research subject or theme appeared in 47% of submissions in the humanities and social sciences, 40% in environmental sciences, 16% in cross-disciplinary fields and 9% in the life sciences. In the other scientific fields, it ranged between 0% and 4%.

Finally, in the course of our analysis, we identified a last sub-theme, 'impact of research', which was present in 6% of the responses. Some scientists addressed the sex and/or gender dimension from the perspective of societal impact, including improvements in quality of care, innovations or technological advances that benefit both men and women. This type of response was most common in the life sciences (9% of submissions), followed by digital sciences and mathematics (more specifically in the thematic areas of 'artificial intelligence', 'interaction, robotics' and 'digital foundations') (6% of the responses), then energy and materials sciences (6% of submissions), and finally cross-disciplinary fields (4% of the responses).

> 'Although the gender dimension is not directly included in the applications of the proposal, this research could highlight possible gender biases in our sources (such as the press) and provide the scientific community with methods and resources for automatically recognising them.' (2021 AAPG)
> 'Concerning the impact of the research itself developed within the project [...], the potential spin-offs in terms of knowledge and applications, particularly in the field of health, will benefit everyone equally, regardless of gender.' (2021 AAPG)

Of all the comments classified under the broad analysis category of 'research', 38% justified not taking the sex and/or gender dimension into account in their projects, while 64% described how the dimension was considered in their research.

By 2020, we had identified around a hundred projects where inclusion of the sex and/or gender dimension would have been relevant to the issue, but the project leaders had either left the tab blank, focused exclusively on the HR dimension or cited the biological constraints mentioned earlier.

For the 2021 edition, we identified 163 projects where we believe integrating the sex and/or gender dimension would have been relevant in relation to other projects reviewed by the same committees and addressing similar research problems. The coordinators of these projects may have raised HR-related issues or considered sex and/or gender mainstreaming to be irrelevant. While this lack of consideration may be due to a misunderstanding of the request or a lack of specificity, it could also reflect scientific approaches that are blind to gender issues.

⏩ Conclusion

A comparative analysis of these two test phases of sex and/or gender mainstreaming in the research proposals submitted to the ANR's 2020 and 2021 AAPG editions shows that a real movement is underway. There is a growing awareness of the persistent inequalities between women and men in higher education and research, as well as a recognition of the need to implement corrective measures. The requirement for research institutions and organisations to implement Gender Equality Plan appears to be having an impact, as female and male researchers report being committed to actively applying the recommendations, both in building their research teams and in balancing their private and professional lives.

However, it is still essential to continue statistical analyses of the presence of women in research teams and the roles they occupy. Recruitment on the basis of merit and scientific excellence remains one of the main arguments put forward in the accounts. Yet, some of the measures adopted to achieve gender balance in teams, such as recruiting women to non-permanent positions, tend to reinforce the precarious position of women in higher education and research. Furthermore, standardised responses that exactly mirror the language of national and international recommendations raise questions about the practical application of measures aimed at reducing gender inequalities in the research sector.

We observed a clear discrepancy between the requirement to address the sex and/or gender dimension and the types of responses given by the coordinators. Although references to this dimension remained a minority in the project descriptions, there was a change

between the two editions. This development was particularly evident in the humanities and social sciences, where the sex/gender dimension can constitute a research subject in its own right, and in the life sciences, where the integration of sex- and gender-specific analysis variables is a determining factor in the interpretation of research results.

Following these two test phases, during which the comments were not submitted to the ANR's evaluation committees for assessment, the integration of the sex and/or gender dimension has been included as an evaluation criterion in the AAPG since the 2022 edition. We believe that this gradual evolution in how the dimension is addressed in the research funding process will enable it to be better integrated into research projects. Feedback is currently being provided to the evaluation committees.

Finally, these two test phases, designed as actions to gradually raise awareness of gender issues in knowledge production, align fully with the role a research funding agency can play in supporting the scientific community. This support must continue through other initiatives, including awareness-raising activities, provision of training and the publication of analyses such as the one presented here. However, this effort must be both collective and global, with training tailored to the needs of different scientific fields.

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Chapter 6

Understanding resistance to gender equality: the role of ideologies in justifying the system

Virginie Bonnot, Cristina Aelenei, Silvia Krauth-Gruber, Catherine Verniers

Despite significant strides, gender inequalities persist in France. Women continue to experience the glass ceiling at work, earn 18.6% less than men, and interrupt their careers to care for children (*Service des droits des femmes et de l'égalité entre les femmes et les hommes* [French Directorate for Women's Rights and Gender Equality], 2017). To better understand this persistence, it is important to understand not only what motivates social change, but also what prevents it.

The aim of the research programme presented here is precisely to explore the psychosocial legitimisation processes by which individuals, even when they belong to disadvantaged groups (i.e. women), resist or even oppose social change towards greater equality. To this end, we draw on the framework of system justification theory (SJT, Jost, 2019; Jost and Banaji, 1994; for an introduction in French, see Bonnot and Verniers, 2017). SJT proposes that individuals are motivated to view the system in which they live, and its functioning, as fair, legitimate, natural and desirable. Certain contexts are thought to amplify this motivation. For example, the status quo tends to be particularly defended if it is perceived to be under threat (e.g. by the arrival of women in positions of power or by feminist movements), or if it is perceived as being part of long-standing tradition (e.g. the traditional heteroparental family). Furthermore, SJT proposes that members of disadvantaged groups are just as likely as members of advantaged groups to support the system, even at the expense of their own interests or those of their group. Perceiving the system as fair implies that members of disadvantaged groups must see themselves as less deserving than others or believe that they possess characteristics that prevent them from achieving a higher social position. From this perspective, ideologies are seen as tools that help individuals perceive the system in ways that discourage questioning. This research programme focuses on three such ideologies, which will be discussed in turn.

One of the most widely studied ideologies related to the maintenance of gender arrangements concerns gender stereotypes. The attribution of complementary characteristics to men (e.g. assertiveness, mathematical skills, leadership abilities) and to women (e.g. benevolence, verbal skills, caregiving abilities) serves as a powerful tool for rationalising gender inequalities (Verniers *et al.*, 2016). In this chapter, we begin by examining these stereotypes and their consequences for women who do not conform to them in professional contexts. The next section explores the spread of the ideology of intensive mothering in

mothers' blogs in France and its role in maintaining an unequal division of domestic and parental labour. Finally, the third section considers how neoliberal ideology may reduce women's willingness to engage in collective mobilisation in support of gender equality.

⏩ Gender stereotypes and the maintenance of social hierarchies

Although the position of women in the labour market has changed in recent years, occupational inequalities between men and women persist (e.g. Schneider *et al.*, 2021; van Veelen and Derks, 2021). In this section, we will analyse the role of gender stereotypes in maintaining these inequalities. First, we examine how the characteristics conveyed by gender stereotypes help justify and sustain men's privileged position over women in the professional sphere. Second, we show that women who do not conform to gendered expectations are likely to face social and economic penalties. Finally, we explore ways to mitigate these negative consequences.

Content of gender stereotypes and links with social status

Gender stereotypes describe socially shared beliefs about the specific qualities typically associated with women and men in society (i.e. descriptive stereotypes). At the same time, they function as norms that specify what women and men should and should not be (i.e. prescriptive and proscriptive stereotypes). Through their content and associated injunctions, gender stereotypes reflect the position of men and women in the social hierarchy and simultaneously help to legitimise it.

Men, for example, are attributed so-called 'agentic' qualities (e.g. competence, ambition, assertiveness and competitiveness), which are perceived as aligning with traditional expectations for leadership and high status roles. Women, in contrast, are stereotypically attributed so-called 'communal' qualities (e.g. caring, warmth, emotionality), but are considered to lack agentic qualities. As a result, they are often judged to be less capable and less legitimate candidates for occupying high status positions (Prentice and Carranza, 2002).

To examine whether the content of gender stereotypes has changed over the last two decades, we conducted two studies with samples representative of the French population in terms of age, gender and region (Krauth-Gruber *et al.*, 2022). In Study 1, participants rated the extent to which 51 characteristics (traits and emotional expressions) are considered typical (descriptive stereotype) and desirable (prescriptive stereotype) in French society for a woman and for a man. In Study 2, participants made the same evaluations for individuals of high and low status. The aim of the second study was to determine whether traits and emotions deemed to be masculine were more strongly associated with high social status than characteristics stereotyped as feminine.

The results are consistent with previous research on the content of gender stereotypes and the social status associated with stereotyped traits, suggesting their persistence over time and their similarity across Western countries (Durik *et al.*, 2006; Prentice and Carranza, 2002; Rudman *et al.*, 2012). Agentic traits and emotions, which are associated

with high social status, were considered typical and prescribed for men. In contrast, communal qualities, associated with lower status, were considered typical and prescribed for women. In addition, dominant traits and emotions, considered typical of men and associated with high status, were proscribed for women, while vulnerability traits and emotions, viewed as typical of women and associated with low status, were proscribed for men (see Table 6.1)

Table 6.1. Gender stereotypes in France.

Prescriptions for men A man should be/express	Male proscription A man should *not* be/express
Agentic masculine traits: competitive, independent, ambitious, self-confident, determined, initiative, competent, demanding, intelligent, analytical, efficient, persuasive Emotion: pride	Vulnerable female traits: weak, emotional, naive, hesitant, indecisive Emotions: fear, sadness, shame, guilt, embarrassment, pity
Prescriptions for women **A woman should be/express**	**Proscription for women** **A woman should *not* be/express**
Communal feminine traits: sensitive to others, warm, helpful Emotions: compassion, joy	Masculine traits of dominance: dominant, ruthless, authoritarian, intimidating, arrogant, aggressive Emotion: anger

Defensive reactions to women who do not conform to gender stereotypes

As we have seen, women are perceived as being less agentic (i.e. less competent, ambitious, assertive, competitive) and therefore less suited to high-status roles. This stereotypical perception is a major obstacle to gender equality in the workplace. One might think that by displaying agentic behaviour, women would be seen as competent and capable of assuming leadership roles and responsibility. Research shows, however, that this is far from the case.

Displaying behaviour that contradicts the expectations conveyed by gender stereotypes has a backlash effect in the form of economic and social penalties (for a review of the issues, see Rudman *et al.*, 2012). For example, a woman who is assertive or self-promoting in a professional context is perceived as less likeable, and therefore less likely to be hired, than a man who displays the same behaviour (Rudman and Phelan, 2008). This backlash effect is studied within the framework of system justification theory (SJT), which provides an ideological analytical framework. According to SJT, individuals are motivated to view the social system in which they live as fair, legitimate and desirable. As a result, they are motivated to defend the status quo when it is perceived to be under threat. A woman who adopts stereotypically masculine traits and behaviours, which are associated with high social status, may be perceived as a threat to the gender hierarchy in society. Agentic women are therefore penalised not only because they violate stereotypical expectations of communality, but also, and more importantly, because they threaten male hegemony.

As most studies have been conducted in English-speaking Western countries, we recently examined the backlash against a woman who self-promotes in the French context (Aelenei *et al.*, 2022). Self-promotion refers to a set of behaviours aimed at highlighting one's abilities, pointing out one's strengths and talents, and attributing one's successes to internal rather than external factors (Rudman, 1998). Although self-promotion is essential in the workplace, women are evaluated less favourably than men when they express this behaviour, as it is stereotypically associated with men.

We also sought to clarify the role of perceived physical attractiveness in the evaluation of a woman who displays counter-stereotypical behaviour. Most research reports a positive effect of physical attractiveness on evaluations of women (for a recent review, see Paustian-Underdahl and Walker, 2016). This led us, in the context of backlash dynamics, to test the hypothesis that a woman perceived as less physically attractive, and who displays counter-stereotypical self-promoting behaviour in a professional context, would face the most severe sanctions (compared to a woman perceived as more attractive or a male target).

To explore this hypothesis, participants were asked to evaluate the application of a male or female candidate applying for a financial management position. This consisted of a presentation paragraph highlighting self-promotion and a photo of an attractive or moderately attractive woman or man. The results confirmed the existence of a backlash effect. A self-promoting woman was evaluated as being less competent, less likely to be hired and deserving of a lower salary than a man who displayed the same behaviour. The participants also believed that she should wait longer before applying for a promotion. In addition, regardless of gender, attractive candidates were evaluated more favourably than less attractive ones. The effects of gender and attractiveness combine additively, resulting in a double penalty for the moderately attractive, self-promoting female candidate, who was evaluated least favourably.

The backlash effect does not only occur when counter-stereotypical behaviours are displayed (i.e. agentic traits, self-promotion in women); it can also arise when counter-stereotypical emotions are expressed. As documented in our studies on the content of gender stereotypes, women are expected to express emotions that are oriented towards others and facilitate social relationships (e.g. compassion, joy) and not express dominant emotions (e.g. anger). Conversely, men are expected to express emotions of dominance, such as pride, but not emotions of vulnerability (e.g. fear, shame, guilt, embarrassment). Emotions do more than communicate how an individual feels—they also convey that person's position in the social hierarchy. For example, expressing anger in a professional context has been shown to be associated with a perception of competence and high status in men, whereas it leads to lower perceived status, competence and employability in women (Brescoll and Uhlmann, 2008). Expressing anger may not only hinder women's career progression, but it may also have negative consequences for women in leadership roles, who tend to be judged more harshly than men for expressing the same emotion (Raymondie and Steiner, 2021). Furthermore, anger is associated with the tendency to oppose injustice and encourages collective action (van Zomeren *et al.*, 2008; see also section on 'Neoliberal ideology and collective action'). Penalising women for expressing their anger can therefore prevent them from taking action against gender inequality, thereby contributing to maintenance of the status quo.

The research prospects that follow on from this work on the backlash effect should focus on identifying effective means of reducing it. The few studies conducted in this area converge on the conclusion that one way of protecting agentic women from backlash is to downplay their status by highlighting their communal qualities, e.g. by adopting an inclusive leadership style or emphasising a protective role (Amanatullah and Tinsley, 2013). From an impression management perspective—that is, focusing on how individuals shape others' perceptions of them—Brescoll and Uhlmann (2008) have shown that women can avoid backlash if they provide an external justification for expressing anger, e.g. having been misled by a colleague.

Both of these strategies, however, have significant limitations. While the first strategy may seem relatively effective at the individual level, it risks reinforcing gender stereotypes and thereby undermining the collective status of women. Moreover, in both cases, the burden falls on women (see the responsibility attributed to women; section on 'Neoliberal ideology and collective action'), who have to expend additional cognitive resources to avoid backlash (e.g. self-control, justification), which can interfere with their performance in professional tasks.

We are currently conducting research to test a new approach to reducing backlash based on the theory of positive social interdependence (Johnson and Johnson, 2012). We propose that encouraging people to see a woman's counter-stereotypical behaviour as contributing to shared goals, and thus as beneficial to society as a whole, should reduce punitive reactions to such behaviour. Reducing backlash would pave the way for greater gender equality. Being able to behave in an agentic manner without being penalised would enable women to be perceived as capable of assuming roles of leadership and responsibility, while being able to express anger without repercussion could facilitate collective action in favour of gender equality (van Zomeren *et al.*, 2008, see section on 'Neoliberal ideology and collective action').

In addition to the professional world, gender inequalities also manifest in the private sphere. The ideology of intensive mothering helps to explain the link between inequalities in the professional and domestic domains.

⏩ Ideology of intensive mothering

In recent decades, the employment rate of women has risen substantially across all OECD (Organisation for Economic Co-operation and Development) countries. However, in heteroparental families, the decline of the male breadwinner model, which implies a strict specialisation of women in domestic responsibilities, in favour of a dual-income model has paradoxically not led to a more balanced division of domestic tasks. This imbalance remains unfavourable to women and tends to become more pronounced after the birth of children (European Commission, 2018). The time women spend on domestic work is considered to limit their career opportunities (OECD, 2017), resulting in a direct loss of both human and economic capital (Gershuny, 2018).

Research into the factors that influence the division of domestic labour has so far focused mainly on explanations at the individual or couple level, as well as on national performance in terms of gender equality (Lachance-Grzela and Bouchard, 2010). As a result,

the analysis of dominant beliefs about parental roles and childrearing has been neglected, leaving the issue of inequality in the private sphere to be understood as a matter of personal choice or influenced by macroeconomic context.

In this context, we explore the ideology of intensive mothering (Hays, 1996) as a tool for legitimising and maintaining gender inequalities. In particular, we examine how intensive mothering is portrayed in the blogs of the most popular mother bloggers in France, integrating the perspectives of social psychology and information and communication sciences, at the intersection of cultural[58] and gender studies (Verniers *et al.*, 2022)

Intensive mothering in mother blogs

At the heart of intensive mothering is the expectation placed on individual mothers (i.e. the mother's practical responsibility) to give their full and constant attention to their child, to respond to the child's needs and rhythms (i.e. the child's centrality) and to invest time and money in finding the best products and services suited to each stage of the child's development (i.e. intensive methods). Moreover, mothers are expected to carry out these tasks with self-sacrifice (i.e. the mother's moral responsibility), as motherhood is considered the most important and fulfilling role a woman can assume. Initially associated with a cultural model of the 'good mother' then emerging in the American upper middle class of the 1990s, this ideology has since been reinforced and has crossed territorial boundaries, as recent research has shown (Ennis, 2014).

We sought to examine the explanatory power of the ideology of intensive mothering in the context of gender inequality in France. To do this, we analysed a corpus of French-language blogs written by women on the subject of parenthood. The blogs consist of a collection of posts presented in reverse chronological order. Written and published by people often identified with one or more social groups—in this case, women who identify as mothers—blogs are sometimes seen as a contemporary form of diary (Morrison, 2010).

Our interest in blogs is justified by the growing influence of social media on parenthood (Dworkin *et al.*, 2018). Mothers' blogs are particularly popular with mothers, who consult them for information and advice on raising children, as well as a means of validating their own practices (Jang *et al.*, 2015). These blogs thus provide normative models of parenthood.

Our analysis focused on 18 of the most widely read blogs in France, as identified by the Alexa traffic analysis tool. This enabled us to document the dominant discourses to which mothers are exposed on this digital platform.

A thematic content analysis of the posts in this corpus of blogs reveals a discourse aligned with the principles and prescriptions of intensive mothering as described by Hays (1996). The themes of the centrality of the child, intensive methods and the material and moral devotion of the mother are consistently present throughout the blogs. There are,

58. Cultural studies is a branch of research originating in the English-speaking world, situated at the crossroads of sociology, cultural anthropology, philosophy, ethnology, literature, mediology, the arts and more. With a transdisciplinary focus, it positions itself as an 'anti-discipline' with a strong critical dimension, particularly concerning the relationship between culture and power. By transcending traditional academic culture, cultural studies offer a cross-disciplinary approach to popular, minority and protest cultures.

however, some specific features of intensive mothering in the blogs analysed. Notably, intensive methods are updated to reflect contemporary environmental concerns. These are reflected in the 'homemade' approach to food, cosmetics and cleaning products, as well as in children's hygiene practices, such as switching to washable nappies and wipes ("I try to respect the environment while respecting my baby's skin."). However, this change does not rebalance the unequal division of parental labour.

More specifically, recent studies have documented the cognitive load associated with domestic work, including the anticipation of needs, identifying the actions required to meet them, making decisions and monitoring their effects (Daminger, 2019). The pro-environmental practices described in these blogs, assigned exclusively to mothers, are likely to represent an additional burden, reinforcing inequalities between parents. («I spend 10 minutes of my day loosening the stool, I lose 30 seconds on a nappy to place everything correctly compared to a disposable nappy [...], I do one extra wash a week, and folding nappies takes me around 15 minutes.»)

Another departure from the model of intensive mothering concerns the representation of the father. While in the intensive mothering initially described by Hays, the father is portrayed as incompetent, this depiction is absent from the most popular mothers' blogs in France. The father is rarely mentioned in the posts, but when he is, he is idealised for his involvement in parenting: «He showers them, feeds them, plays with them, rocks them [...]. The new generation of dads has changed [*sic*] and I think it rocks!" However, there is every indication that the burden of parenting still falls primarily on mothers. This is evidenced by the near systematic use of the pronoun 'I' when referring to domestic work or educational issues, as well as by explicit references to the father's more limited involvement: «I had to take this decision [...] to be freed from the weight crushing my shoulders. And I say MY [*sic*] shoulders, because although we had a lot of discussions with [father's nickname], I was the only one bending under the weight."

Along with highlighting a discourse largely aligned with intensive mothering in mothers' blogs, we took advantage of the format of this medium, whose posts are open to comments, to document a process of influence operating between bloggers and readers. In several posts, the bloggers confessed to their difficulties in 'being a good mum', in other words, in demonstrating complete and constant devotion to their child. The coexistence within the blogs of a discourse exalting intensive mothering and the admission of failure to meet these standards creates the conditions for vicarious dissonance (Cooper, 2019; Focella *et al.*, 2016). More specifically, when a member of a social group acts in a way that contradicts the group norm (i.e. a hypocritical act), this may provoke a state of dissonance among other group members. Vicarious dissonance predicts that members of the group, vicariously experiencing the hypocrisy, will be motivated to reaffirm their adherence to the norm, ultimately leading to its reinforcement.

An example of this process can be seen in a number of comments following a long post in which the blogger explains, with distress, why she has ultimately decided to give up home schooling, a practice highly valued in the context of intensive mothering on this blog, and to enrol her daughter in school. In one comment, a reader begins by reaffirming the value of home schooling, then supports the blogger's decision, before finally suggesting an alternative practice (i.e. school supervision) that still aligns with the principles of intensive mothering: «I share the same admiration for *unschooling* but it's not for me [...] so our eldest went to a traditional school [...]. I kept a close eye on

things, met the teacher several times when I was upset about something and joined the parents' association [*sic*] to keep one foot in the boat just in case."

Taken as a whole, the results of the thematic analysis of the most popular mothers' blogs in France demonstrate the role of this social media in propagating the ideology of intensive mothering. The analysis of the comments also illustrates the polarisation and consolidation of attitudes among readers of these blogs, confirming their role as an echo chamber (Gilbert *et al.*, 2009).

Support for intensive mothering and justification of the gender system

Having established the hegemonic nature of intensive mothering in this corpus of mothers' blogs, we looked more specifically at the relationship between this ideology and a set of beliefs conducive to the maintenance of gender hierarchies. Social psychology research has documented the link between certain ideologies and the belief in a fair gender system.

One such ideology, hostile sexism, can be defined as antipathy towards women who compete with men for power. Benevolent sexism, on the other hand, is the expression of male dominance under the guise of chivalry. Together, hostile and benevolent sexism form a system that rewards women who remain in subordinate positions and punishes those who threaten the gender hierarchy. This ambivalent sexism is associated with a belief in a fair, natural and desirable gender system (Verniers and Martinot, 2015), a belief which, in turn, reduces support for actions aimed at reducing inequalities (Becker and Wright, 2011).

In line with previous work, we further argue that the perpetuation of gender inequalities is promoted by norms that confine women to the private sphere, thereby limiting their career opportunities (e.g. Aisenbrey *et al.*, 2009) and potentially hindering their access to financial independence. Distancing women from the public sphere is encouraged by beliefs in gender-based role specialisation, support for reduced working hours for mothers (Verniers and Vala, 2018) and a backlash against childless women (Verniers, 2020). If intensive mothering operates as an ideology for justifying gender hierarchies, we would expect it to be positively associated with each of these beliefs.

To test this hypothesis, we conducted a questionnaire survey with a sample of women living in France who were mothers of at least one minor child (Verniers *et al.*, 2022). As expected, we found a positive correlation between their level of support for intensive mothering and their sexist attitudes. Specifically, the more the mothers in our sample adhered to the principles of intensive mothering, the more their perception of gender relations was marked by hostile sexism (e.g. «When women lose an honest competition against a man, they still complain about being discriminated against») and benevolent sexism (e.g. «Women should be protected and loved by men»).

Similarly, greater support for the principles of intensive mothering was associated with stronger beliefs in gendered role specialisation (e.g. «Certain types of work are simply not suitable for women»), increased opposition to maternal employment (e.g. «When she has a child under school age, a mother should work part-time or stay at home»), and greater endorsement of negative stereotypes about childless women (e.g. «A woman without children can hardly be fulfilled»).

Our work to date has shown that the most popular mothers' blogs in France convey a discourse consistent with intensive mothering and have the potential to encourage readers to embrace this ideology. We also found a link between intensive mothering and a set of beliefs associated with the justification and maintenance of gender inequalities. By glorifying the unique role of the mother, the ideology of intensive mothering essentializes parental roles. By exalting the value of resources such as money and time, it also reinforces class distinctions (Parsons, 2014). While we have highlighted the relevance of this ideology in understanding the processes by which gender inequalities are maintained in relation to domestic and parental work in France, future research will need to examine the role of intensive mothering in reinforcing class hierarchies, particularly through the stigmatisation of working-class mothers who deviate from the dominant cultural model.

The first two parts have illustrated how the ideology of intensive mothering and gender stereotypes promote rigid gender norms that must be adhered to under threat of social sanction, ultimately contributing to the persistence of inequality in both the professional and private spheres. The third part now turns to an ideology that targets the foundations of social change itself, by discouraging women's collective mobilisation to achieve equality.

⏩ Neoliberal ideology and collective action

The identity model of collective action (SIMCA; van Zomeren *et al.*, 2008) proposes that people's commitment to collective action on behalf of a disadvantaged group is predicted by three factors: their sense of indignation at injustice, their belief that collective mobilisation can bring about change, and their politicised identification with the disadvantaged group. Thus, to act in favour of gender equality, it is not enough to simply identify with women as a social group; it is necessary to identify with the feminist movement.

Collective action is understood here as behaviour undertaken, alone (e.g. signing a petition) or with others (e.g. taking part in a demonstration), with the aim of advancing the cause of a social group. There are many obstacles to women's identification with the feminist group, and therefore to their participation in collective action (for a discussion in French on women's resistance to feminism, see Bonnot *et al.*, 2022). We will focus here on the potential role of neoliberal ideology.

Definition and role of neoliberal ideology in maintaining inequalities

Neoliberal ideology, as both the foundation and product of a specific economic and political model, promotes a set of values and beliefs such as free choice, competition, autonomy, self-promotion, individual responsibility, personal merit, and the pursuit of individual happiness and perpetual self-improvement (e.g. Bettache and Chiu, 2019).

Thirty-two semi-structured interviews conducted with people aged between 20 and 50 years have shown that in France, despite a still strong attachment to public services and to the role of the state in reducing inequalities, these beliefs and values are nonetheless clearly perceptible in their discourse (Girerd *et al.*, 2021). Several dimensions of this ideology emerged from the analysis of these interviews.

The first dimension concerns the distribution of resources and the role of the state. A preference for a meritocratic distribution of resources, equal opportunities and state guarantees of these is central. The emphasis is placed on allowing free competition between individuals and not hindering the emergence of promising profiles likely to efficiently contribute to society. This dimension of competition, which is framed as natural, inevitable and a source of motivation and innovation, extends to all areas of life, including personal relationships, where the cost/benefit considerations can determine whether they are pursued or abandoned.

A form of detachment from socio-normative and structural contexts also emerges: contexts are not seen as having a significant influence on individuals; equality is often equated with uniformity (and therefore seen as relatively undesirable); and the promotion of individuality, independence and belief in free will and personal choice (i.e. unconstrained life choices free from conformism) are prevalent. Lastly, striving to become an 'entrepreneur of oneself' is central, a discourse grounded in individual responsibility, constant self-monitoring and self-regulation of emotions and behaviour (see the notion of 'neoliberal governmentality', Foucault, 2004). Personal development is seen as a means of increasing one's value on the market, and individual satisfaction (e.g. 'being happy' and satisfied with what one has, even if it's not much) is established as a fundamental objective.

Based on these results, we developed a scale, the Neoliberal Orientation Questionnaire (NOQ), which measures the extent to which individuals adhere to this ideology (Girerd *et al.*, 2023). The five validation studies conducted with this scale provide insight into the issues involved in justifying this ideology. The results show that the more individuals adhere to the neoliberal ideology, the more they justify socio-economic inequalities. They also tend to view social hierarchies as necessary and inevitable, and to oppose equality between groups. In addition, NOQ scores are positively correlated with adherence to other ideologies that justify inequality, such as social conservatism (e.g. opposition to non-traditional marriage or abortion), economic conservatism and intensive mothering (see section 'Ideology of intensive mothering'*).*

Some experimental research has also demonstrated the effects of this ideology on individuals, both in terms of attitudes and behaviour (see Pulfrey and Butera, 2013, in the educational context). A series of studies by Kim *et al.* (2018) illustrates its consequences for the maintenance of gender inequalities. This research shows that exposing individuals to messages emphasising assertiveness and internal barriers to women's advancement in the workplace (e.g. lack of confidence or ambition) leads them to view women as both responsible for the unequal situation and responsible for resolving it (i.e. by working on themselves). Notably, the fact that these messages also suggest the existence of external barriers (i.e. discrimination, gender bias) does not change this outcome. Moreover, individuals who read these statements express a preference for interventions that target individual change in women (e.g. assertiveness training) rather than structural changes within institutions (e.g. revising professional evaluation procedures to avoid gender bias). In other words, the focus shifts to correcting or changing the women rather than the system. Finally, when people are encouraged to interpret other people's behaviour as simply a matter of individual choice, they are less inclined to recognise gender discrimination, or, if they do recognise it, less likely to support action against it (Madan *et al.*, 2020).

Implications for collective action in favour of women

The general hypothesis central to this research is that neoliberal ideology fosters the belief that women's collective mobilisation (i.e. feminist action) as either useless or even dangerous, particularly if it is perceived as challenging the principles of free competition, individual responsibility or meritocracy. This ideology makes it possible to reconcile the promotion of equality with a rejection of forms of collective action, which are in fact essential for bringing about a fundamental change in unequal intergroup relations. The work of Zucker and colleagues (e.g. Fitz *et al.*, 2012) provides empirical support for this hypothesis. These authors have identified distinct profiles among women, based on whether they identify as feminists and whether they recognise gender-based discrimination.

In addition to non-feminists (i.e. women who neither identify as feminists nor recognise gender inequalities) and feminists, they distinguished two other groups: quasi-feminists and neoliberals. The women in these two groups recognise the existence of gender inequalities but do not identify as feminists. Quasi-feminists view equality as a matter of social justice. They tend not to identify as feminists due to the social stigma attached to the label, which can provoke negative reactions (i.e. hostile sexism, discrimination). Neoliberals, by contrast, see equality more as a matter of individual merit and have higher scores for sexism (whether hostile or benevolent, paternalistic; see section on 'Ideology of intensive mothering') than the quasi-feminists.

Corroborating these findings, more recent research (Bay-Cheng *et al.*, 2015) also shows that the more individuals adhere to neoliberal ideology, the more they endorse rape myths (i.e. beliefs that deny, minimise or justify men's sexual violence against women), the less they support feminist perspectives, and the less likely they are to report having engaged in collective action on behalf of women in the previous six months. Similarly, we have shown (Girerd and Bonnot, 2020) that the more women adhere to neoliberal ideology, the more they justify gender inequalities, the less likely they are to identify as feminists, and the less willing they are to take action, i.e. such as sending an email to their constituency MP to get him/her to combat sexist advertising. Our research is nonetheless unique in that it measures actual behaviour at the time of the study, rather than relying solely on intentions or retrospective accounts of past commitments. Moreover, these findings were obtained at a time when participants' attitudes were generally very favourable to gender equality.

All these studies are correlational, however, and therefore cannot determine whether adherence to neoliberal ideology leads to lower feminist identification and reduced commitment to collective action. The reverse may also be true: adopting a feminist identity and engaging in collective action could possibly reduce adherence to neoliberal ideology. Moreover, the aim of our research is to examine the contexts that either support or hinder the development of a feminist identity, and consequently, engagement in collective action in favour of women.

We conducted a second study (Girerd and Bonnot, 2020) to address this question using an experimental methodology. In this research, meritocratic beliefs (one of the pillars of neoliberal ideology) were made salient by presenting participants with a scale for measuring these beliefs prior to any other measures. The underlying idea is this: positioning oneself on the meritocratic statements of this scale, regardless of agreement or

disagreement, brings attention to these beliefs and brings them to the forefront of their thinking. This situation was compared to another in which the same scale was presented at the very end of the study (i.e. a condition in which meritocracy was not made salient). The results show that when meritocracy is made salient, participants identify less strongly as feminists, view collective action as less relevant and express less interest in receiving information about feminist initiatives, compared to the other situation. These effects were observed regardless of participants' attitudes toward meritocracy (i.e. even if their responses revealed relatively low support for meritocracy).

Finally, the results of our most recent studies encourage us to extend our thinking on the emergence of a genuine form of neoliberal 'feminism' (see Rottenberg, 2018), in which adherence to neoliberal ideology and feminist identification are no longer necessarily incompatible. This is suggested, for example, by the findings from our third validation study of the NOQ scale (Girerd *et al.*, 2023), conducted with a representative sample of French women. In this study, the absence of a correlation between NOQ scores and feminist identification scores is surprising, given our hypothesis and previous results. In fact, this absence conceals an interaction between political orientation and NOQ scores: for women who identify more with the political right, adherence to neoliberal ideology predicts stronger feminist identification (contrary to the hypothesis of a decrease in identification). Among women who are on the political left, by contrast, there is no such link.

It is possible that recent media coverage of certain forms of gender inequality, especially in the wake of the #MeToo movement (e.g. sexual harassment, feminicide), has made it easier to adopt the feminist label, while simultaneously somewhat distorting its meaning. Although this latter interpretation needs to be confirmed, it does raise questions about the increasing compatibility, enabled by neoliberal ideology, between the use of the feminist label and the preservation of the gender system. This issue of neoliberal 'feminism' is examined more closely through the lens of the #MeToo and #balancetonporc movements in the final part of our research programme (Redersdorff, 2022).

Taken together, this research suggests that neoliberal ideology may have harmful consequences for gender equality. Specifically, it can obscure structural factors that constrain women's lives and undermine their collective efforts to create a more egalitarian society.

⏩ Conclusion

The research programme presented here examines several ideological barriers to gender equality. Gender stereotypes, the ideology of intensive mothering and neoliberal ideology are all mechanisms for justifying gender inequalities across all spheres of life: public and private, professional and familial. Elsewhere, we have described other obstacles (e.g. the sexual objectification of women), as well as a number of factors studied in social psychology that could contribute to progress towards equality, including feminist models and inclusive language (Yzerbyt *et al.*, 2021). However, only strong political will and a challenge to these ideologies can bring about the kind of radical societal transformation required to achieve greater equality and social justice.

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Part III

Case studies

Why should scientific communities be encouraged to consider the sex and/or gender dimension in the research they carry out?

Because research projects that focus on gender, or that methodologically integrate the sex and/or gender dimension, contribute to scientific discoveries, as shown by the SexDiff project in chapter 7. By examining sex determination and disorders of sexual development, this research expands our understanding of the genetic networks involved in the formation and differentiation of mammalian ovaries, which in turn leads to better diagnostic tools for these conditions.

Because considering gender as a methodological tool can prove essential for understanding the phenomena under study. In Chapter 8, Emmanuelle Bouquet and Sandrine Dury discuss the importance of incorporating the gender dimension when analysing the links between agriculture and food in Burkina Faso, and the value of gender as an analytical lens in this context.

Finally, because integrating this dimension into research shows that scientific production without methodological bias has direct and beneficial impacts on society, as demonstrated in Chapter 9 by the RTBfoods project team. Dedicated to improving crops for better diets, this project focused in particular on cassava, yam, sweet potato and banana-based products in Benin, Cameroon, Ivory Coast, Nigeria and Uganda. The research team reports that it was only through the use of gender-sensitive, consumer-focused methods that it became possible to modify banana, tuber and root varieties and, beyond the varieties themselves, to improve the functioning of the commodity chain. This was achieved in particular by better meeting the needs of stakeholders who had not initially been included in the improvement programmes.

Chapter 7

Regulation of sex determination and ovarian differentiation: implications for variations in sexual development

Aitana Perea-Gomez, Marie-Christine Chaboissier

Sex determination is the biological process by which a sexually reproducing organism initiates female or male differentiation. The strategies used by different animal species to determine sex vary widely, both in terms of the type of control (environmental or genetic) and the cellular and molecular mechanisms involved. In most mammals, sex determination is genetically controlled by the presence of sex chromosomes, which dictate whether development proceeds along a female (XX) or male (XY) pathway.

One of the key stages in sexual development takes place during embryonic life with the formation and differentiation of the gonads. Before the sixth week of gestation in humans (corresponding to embryonic day 11 in mice), the undifferentiated gonads are identical in embryos of both sexes. Following gonadal sex determination, distinct genetic cascades lead to the formation of ovaries in XX female embryos and testes in XY male embryos. The function of the adult ovaries and testes is essential for species survival, as they produce the gametes (oocytes and spermatozoa), whose fusion at fertilisation generates a zygote capable of developing into a new individual. The gonads also produce hormones that control the development of anatomical sex, through the differentiation of internal and external genitalia.

Situations in which the chromosomal, gonadal or anatomical sex is atypical are referred to as disorders of sexual development (DSD) or differences in sex development (DSD). DSDs are heterogeneous in terms of their clinical presentation, incidence and cause. Identifying the genetic variants responsible for DSDs is important for predicting patient outcomes and adapting treatment. Currently, a molecular diagnosis can be made in fewer than 50% of DSD cases. To improve this rate and identify new causative variants of DSD, it is essential to study the genetic networks that control the various stages of sexual development, particularly the formation and differentiation of the gonads.

In 1990, the *SRY* gene, located on the Y chromosome, was identified as the initiating factor in testicular fate determination. Since then, numerous studies have focused on identifying the genetic networks upstream and downstream of *SRY* function, which are involved in morphogenesis, cell differentiation and hormone production in embryonic and adult testes. In contrast, the genetic networks involved in ovarian formation and differentiation have been comparatively less studied, and our knowledge of female sexual development remains incomplete. The ANR SexDiff project, presented at the Gender

in Research conference on 15 December 2020, is a collaborative research project aimed at expanding our knowledge of the genetic networks responsible for the formation and differentiation of mammalian ovaries, thereby contributing to improved diagnostic tools for DSDs.

⏩ Gonadal sex determination, a key stage in mammalian sexual development

Sex determination strategies

Sexual reproduction creates new individuals with unique genetic makeups by combining the genetic material of two individuals of different sexes. This mode of reproduction, which predominates in the living world, offers adaptive advantages. By generating genetic diversity with each generation, it allows for the emergence of new genetic combinations that may be crucial for adapting to new environments, while also eliminating deleterious mutations.

Sex determination strategies used by sexually reproducing species to create male and female individuals are highly diverse (Capel, 2017). In cases of environmental sex determination, external factors such as temperature influence male or female development. In many reptile species, for example, the sex of embryos depends on the incubation temperature of the eggs during a critical developmental period. In some cases, such as in the turtle *Trachemys scripta*, high temperatures favour female development, whereas in others, like the alligator *Alligator mississippiensis*, they result in male offspring. For species whose sex determination is highly temperature-dependent, global warming could pose a major threat to maintaining balanced sex ratios within populations (Lockley and Eizaguirre, 2021).

For the vast majority of mammals, the X and Y sex chromosomes transmitted to the zygote at fertilisation determine the individual's genetic sex: XX for females and XY for males. Other types of sex chromosomes exist, particularly in certain bird species, where females carry a Z chromosome and a W chromosome (heterogametic ZW females), while males carry two Z chromosomes (homogametic ZZ males). Furthermore, in some fish species, sex determination is genetically controlled, while distinct sex chromosomes have not been identified (Stöck *et al.*, 2021)

The importance of gonadal sex

Although chromosomal sex is determined at fertilisation by the presence of an X or Y chromosome, XX and XY embryos remain morphologically identical until the fifth week of gestation in humans (gestation week 5, GW5) or the tenth day of embryonic development in mice (embryonic day 10.5, E10.5). It is at this stage that the XX or XY chromosomal content begins to influence gonadal sex determination and the acquisition of either an ovarian or testicular identity. From GW6 in humans (E11.5 in mice), ovaries and testes differentiate according to two specific genetic programmes. Similarly, the outlines of the genital organs are identical in the early stages of embryonic development of both sexes, with the presence of Wolffian ducts (precursors of male structures) and Müllerian

ducts (precursors of female structures). It is only after gonadal sex determination and the formation of either ovaries or testes that the internal genital organs (the fallopian tubes, uterus and vagina in females, and the epididymis, vas deferens, prostate and seminal vesicles in males) and the external genitalia (clitoris and labia in females, penis and scrotum in males) begin to develop differently according to sex (Figure 7.1).

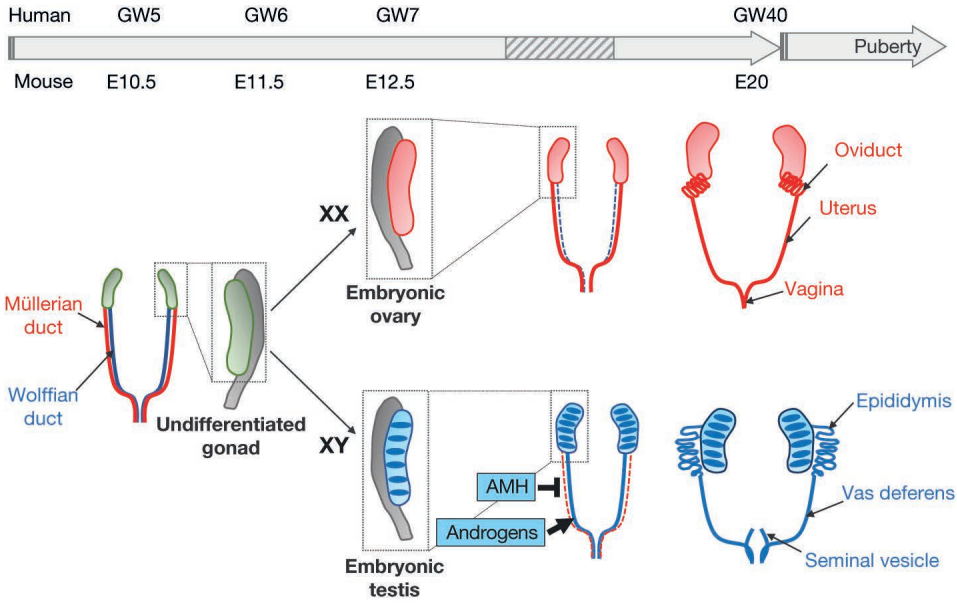

Figure 7.1. Differentiation of the male and female genital tract in response to the action of gonadal hormones.

The undifferentiated gonad, initially identical in embryos of both sexes, develops into either an ovary or a testis depending on the chromosomal sex (XX or XY). In XY embryos, testicular hormones act on the precursor tissues of the genital tract: androgens (including testosterone) are necessary to maintain the Wolffian duct (precursor of the internal male genitalia), and anti-Müllerian hormone (AMH) causes degeneration of the Müllerian duct (precursor of the female genitalia). In XX embryos, the absence of androgens leads to degeneration of the Wolffian duct, and the absence of AMH allows the Müllerian duct to develop into female reproductive structures.

The major role of gonadal sex in controlling sexual development was highlighted by the pioneering experiments of embryologist Alfred Jost in 1947 (Josso, 2008). By developing in utero microsurgical techniques, Jost performed gonadectomies (removal of the gonads) on male and female rabbit embryos at various stages of development. Removal of the ovaries had no effect on genital tract formation: the foetuses developed internal and external female genitalia. In contrast, early removal of the testes resulted in the absence of male derivatives and the development of a female genital tract. This research demonstrated that:
– the development of female genitalia does not require the presence of ovaries, whereas the formation of male genitalia is dependent on substances produced by the testes;
– testicular hormones are necessary to support the development of male structures and to eliminate the female structures initially present in embryos of both sexes.

Subsequent work identified the nature of the testicular hormones highlighted by Jost's experiments: testosterone, which is essential for the maintenance and development of

male structures derived from the Wolffian duct, and anti-Müllerian hormone (AMH), which controls the degeneration of female genitalia derived from the Müllerian duct (Josso, 2008; Zhao and Yao, 2019). In female embryos, the absence of these two hormones means that the male structures cannot be maintained due to the lack of testosterone, and the female genital tract develops unopposed by AMH.

Variations in sexual development

Defects in the formation or function of the gonads, or in the production of sex hormones, can result in impaired sexual development. In cases of testicular malformation or deficiencies in testicular hormone production, a child with XY sex chromosomes may have internal and/or external genitalia that are feminised or insufficiently masculinised. Conversely, a child with XX sex chromosomes may develop virilised genitalia due to the action of androgens produced in cases of congenital adrenal hyperplasia.

DSDs encompass a wide range of clinical and aetiological conditions, from cryptorchidism (a defect in testicular descent) to gonadal malformations, which may result in a discrepancy between the anatomy of the genital organs and the chromosomal sex (Lee *et al.*, 2006).

DSDs can be classified into three groups:
– DSDs affecting the sex chromosomes, such as the presence of a single X chromosome (as in Turner syndrome, 45,X) or two X chromosomes and one Y chromosome (as in Klinefelter syndrome, 47,XXY);
– 46,XY DSDs, affecting individuals with XY chromosomes, who may present, among other things, with defects in testes formation or in the production or action of androgens;
– 46,XX DSDs, affecting individuals with XX chromosomes, who may have, among other things, defects in gonad formation or excess androgen production.

The management of DSD patients requires multidisciplinary teams to assess the risk of tumour development (which would constitute an indication for gonadal ablation surgery), evaluate the impact on fertility, anticipate the risks of comorbidities and optimise the quality of life in both the patient and their family. Molecular diagnosis plays a key role in improving the early management of DSD. At least 75 genes are associated with the onset of DSD. However, despite advances in new high-throughput sequencing technologies, the genetic variants that cause DSD remain unidentified in more than half of all patients (Délot and Vilain, 2021). An in-depth study of the genetic networks involved in gonad formation, differentiation and function is essential to identify new candidate genes potentially implicated in DSDs.

⏩ A single embryonic organ, the undifferentiated gonad

Formation of testicular and ovarian cell precursors

In addition to its importance for improving molecular diagnostic tools for DSDs, the study of gonadal development is a fascinating area of developmental biology. In this unique process, a single primordial organ, the undifferentiated gonad, can give rise to two distinct organs, the ovary or the testis, depending on the genetic network activated (Nef *et al.*, 2019).

Despite their very different morphologies, adult ovaries and testes are composed of equivalent cell types that perform similar functions in both sexes. The gametes (oocytes and spermatozoa) produced in the ovaries and testes from puberty onwards are the only haploid cells in the body. They are generated through the process of meiosis and can subsequently fuse to give rise to a new organism. The production and survival of these gametes (oogenesis and spermatogenesis) require specific molecular signals and a specialised cellular environment provided by supporting cells: granulosa cells in the ovary and Sertoli cells in the testis. In addition, the gonads are also endocrine organs that contain steroid hormone-producing cells, such as the theca cells in the ovary and the Leydig cells in the testis. The germ cells (gametes) and somatic cells (supporting cells and steroidogenic cells) of the adult ovaries and testes originate from cells present in the embryonic gonads, themselves derived from precursors of the undifferentiated gonad (Rotgers *et al.*, 2018).

The undifferentiated gonad appears around GW5 in humans (E10 in mice) as a thickening of the coelomic wall in the midbody region, close to the mesonephros, the transient embryonic kidney (Nef *et al.*, 2019). Cells from the coelomic epithelium and the mesonephros proliferate and migrate into the gonad, giving rise to undifferentiated progenitor cells capable of forming all somatic cell types of the testis and ovary (Figure 7.2). However, at this stage, the gene expression and epigenetic markers of these undifferentiated precursors are identical in both XX and XY embryos (Dupont and Capel, 2021). In mice, mutations in factors that control specification, proliferation, survival and/or migration of undifferentiated gonadal precursors result in gonadal agenesis or progressive gonadal loss (Stévant and Nef, 2019). Some of these factors, such as the transcriptional regulators GATA4, NR5A1 and WT1, have also been associated with the occurrence of DSDs (Eggers *et al.*, 2016).

The development of high-throughput sequencing techniques and associated bioinformatics analyses has made it possible to establish gene expression profiles (i.e. the transcriptome) of individual cells (Stévant and Nef, 2018; Estermann and Smith, 2020). Applied to the study of the developing embryonic gonad, these approaches have made it possible to trace the lineage relationships of somatic cells within the gonad (Sasaki *et al.*, 2021; Mayère *et al.*, 2022; Stévant *et al.*, 2019; Neirijnck *et al.*, 2023; Garcia-Alonso *et al.*, 2022). Undifferentiated somatic precursors initially form two cell populations common to both XX and XY gonads: supporting cell precursors and interstitial steroidogenic cell precursors. From GW6 onwards in humans (E11 in mice), sex-specific genetic programmes are activated, and the gonads begin ovarian or testicular differentiation, leading to the emergence of pre-granulosa cells in the ovary and Sertoli cells in the testis.

Unlike somatic cells, germ cells are specified outside the gonad (Saitou and Hayashi, 2021). Primordial germ cells appear early (GW2-3 in humans, E6 in mice) in the caudal part of the embryo, then undergo proliferation and migration along the hindgut and dorsal mesentery to colonise the undifferentiated gonads at GW5 in humans (E10 in mice, Figure 7.2). After this initial common phase, the fate of primordial germ cells becomes sexually dimorphic under the influence of gonadal somatic cell signals. In the embryonic testis, male germ cells divide and then enter a state of quiescence until the initiation of spermatogenesis and the cycles of proliferation and meiosis that continue throughout the individual's life. In the ovary, however, there is a single proliferative phase of germ cells during early embryogenesis, which establishes the individual's finite ovarian reserve.

From GW10 onwards in humans (E13 in mice), female germ cells initiate meiosis, after which they are arrested until this process resumes during ovulation in each menstrual cycle from puberty until menopause.

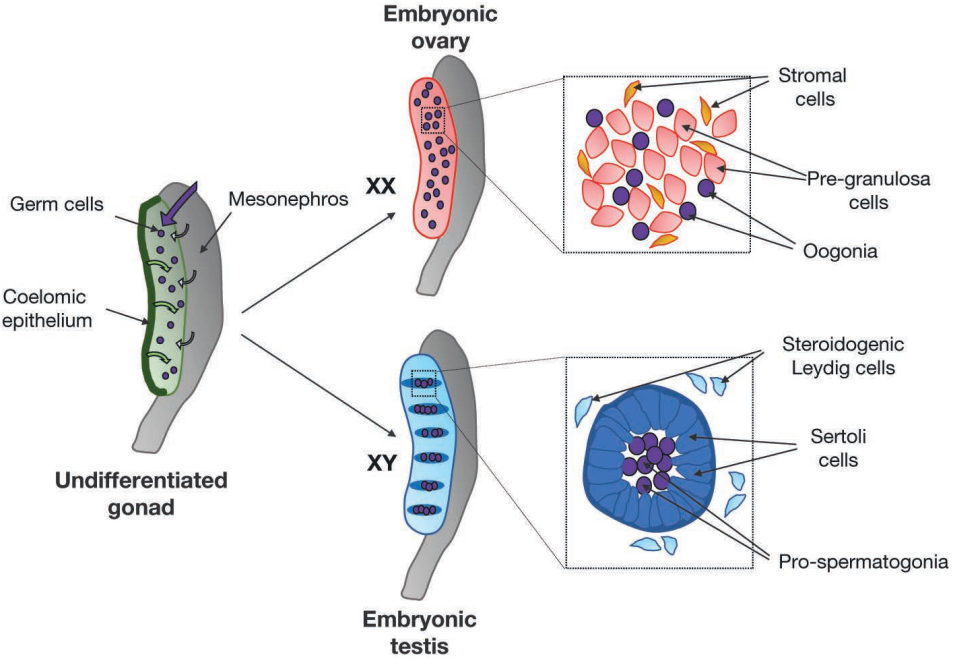

Figure 7.2. Differentiation of the testis and embryonic ovary from the undifferentiated gonad.

Precursors of coelomic and mesonephric origin give rise to the somatic cells of the gonad. Germ cells invade the undifferentiated gonad at E10 in the mouse. In the XY gonad, from E12.5, testicular cords formed by pro-spermatogonia are surrounded by Sertoli cells, while steroidogenic Leydig cells differentiate in response to signals from the Sertoli cells. In XX embryos, meiotically arrested oogonia, pre-granulosa cells and stromal cells are present without any recognisable morphological organisation.

Morphogenesis of the embryonic testis and the male genital tract

Cell lineage experiments, consisting of marking a single cell of the gonadal coelomic epithelium with a fluorescent tracer and tracking the fate of its descendants, were conducted at various developmental stages on cultured mouse testes (Karl and Capel, 1998). This work highlighted the dynamic differentiation capacity of gonadal precursors, a finding since confirmed by single-cell transcriptomic analyses (Mayère *et al.*, 2022; Stévant *et al.*, 2019). Until E11.5, coelomic precursors in the testis are bipotent. After migration into the gonad, they can differentiate into both Sertoli cells and interstitial Leydig cell precursors. Between E11.5 and E12.5, coelomic epithelial precursors produce only interstitial cells, and from E12.5 onwards, they cease all delamination. In addition to the major contribution of coelomic progenitors, the embryonic testis also receives cells migrating from the mesonephros, specifically, endothelial cells that will form the coelomic vessel, and a subpopulation of foetal Leydig cell precursors (Martineau *et al.*, 1997; Kumar and DeFalco, 2018).

Following the initiation of the male genetic programme, Sertoli cells are the first testicular cell type to differentiate, at embryonic day 11.5 (E11.5) (Rotgers *et al.*, 2018; Stévant and Nef, 2019; Mäkelä *et al.*, 2019) (Figure 7.2). Growth factors produced by Sertoli cells orchestrate testicular morphogenesis and differentiation. For example, FGF9 and prostaglandin stimulate Sertoli cell proliferation; DHH and PDGF control Leydig cell differentiation; and inhibin B regulates endothelial cell migration from the adjacent mesonephros. The Sertoli cells acquire epithelial characteristics and organise into testicular cords (the future seminiferous tubules), where they encapsulate the germ cells. The testicular cords are surrounded by a layer of peritubular myoid cells, which are smooth muscle-like cells whose contractions, from puberty onwards, help expel sperm from the seminiferous tubules. Sertoli cells and peritubular myoid cells also secrete extracellular proteins that form a basement membrane, which protects the germ cells inside the testicular cords.

Before GW7 in humans (E12 in mice), the genital tracts of XX and XY embryos are identical, with both the precursor tissues of the female genital tract (the Müllerian ducts) and the male genital tract (the Wolffian ducts) (Zhao and Yao, 2019). In XY embryos, Sertoli cells produce anti-Müllerian hormone (AMH) which acts via its receptor AMHR2 on the target tissues of the Müllerian ducts, triggering their degeneration before GW10. In contrast, in XX embryos, the Müllerian ducts continue to develop into the fallopian tubes (oviducts), uterus and the upper part of the vagina (Figure 7.1). Defects in the production or reception of the AMH signal result in persistent Müllerian duct syndrome (PMDS), a form of 46,XY DSD in which affected individuals have typically male genitalia but also associated with the presence of fallopian tubes and a uterus (Brunello and Rey, 2021).

Sertoli cells and foetal Leydig cells contribute to the synthesis of androgens, including testosterone, which act via the androgen receptor (AR) to promote the survival of Wolffian duct derivatives (epididymis, vas deferens and seminal vesicles) specifically in XY embryos; in XX embryos, these structures degenerate. In addition, dihydrotestosterone (DHT), synthesised locally from circulating androgens by the enzyme 5 alpha-reductase type II, controls the formation of male external genitalia (penis and scrotum). Mutations in the gene encoding the androgen receptor lead to complete or partial androgen insensitivity syndrome, a form of 46,XY DSD in which the internal and external genitalia are feminised to varying degrees, despite the presence of testes and the production of testosterone (Hornig and Holterhus, 2021).

Finally, Sertoli cells produce the hormone INSL3, which, together with androgens, regulates testicular descent in several phases, from the initial abdominal position to the final scrotal position. Abnormalities in this descent process lead to the absence of one or both testes in the scrotum (cryptorchidism) (Eggers *et al.*, 2016).

Morphogenesis of the embryonic ovary and female genital tract

In XX gonads, the coelomic epithelium also contributes to the formation of the ovary's somatic cell lineages. Specification of the ovarian supporting cells (pre-granulosa cells, then later granulosa cells) takes place between E12 and E12.5, one day after specification of the Sertoli cells. The differentiation of pre-granulosa and granulosa cells continues beyond the embryonic period. Cell tracing experiments and single-cell transcriptomic analyses have shown that two types of supporting cells are formed in the mouse ovary (Stévant *et al.*, 2019; Niu and Spradling, 2020; Mork *et al.*, 2012). Cells derived from the

coelomic epithelium during embryonic life form follicles in the central region of the ovary, or medulla, which may be involved in ovarian hormone synthesis before puberty. A second population of granulosa cells is formed from cells expressing the LGR5 receptor. These cells, derived in particular from the surface ovarian epithelium after birth in mice, contribute to the second wave of folliculogenesis, producing activated cortical follicles throughout the individual's reproductive life, constituting the adult ovarian reserve. In both cases, ovarian supporting cells are initially quiescent in mitotic arrest (pre-granulosa cells), then enter into division and differentiate into mature granulosa cells expressing AMH and AR at the onset of folliculogenesis.

Unlike the testis, the embryonic ovary has no easily identifiable structures such as testicular cords (Figure 7.2). This absence of morphological landmarks has made the study of ovarian development more complex than that of the male gonad. In addition to pre-granulosa cells and germ cells, the embryonic ovary contains a small number of so-called 'stromal' cells of coelomic and mesonephric origin. These are the likely precursors of the steroid hormone-producing theca cells, which differentiate only after birth (Rotgers *et al.*, 2018). As a result, the mouse embryonic ovary does not produce steroid hormones. In the absence of testosterone, Wolffian duct derivatives degenerate, and the external genitalia develop as female-type structures (clitoris and labia). Furthermore, in the absence of AMH production by the embryonic ovary, the Müllerian duct continues to develop, giving rise to the internal female genitalia (fallopian tubes, uterus and vagina). Finally, the massive migration of endothelial cells observed in the testis does not occur in the ovary. Embryological and genetic experiments have shown that follistatin, expressed specifically in the ovary under the control of WNT4, inhibits the action of inhibin B, which is necessary for endothelial cell migration from the mesonephros (Yao *et al.*, 2004; 2006).

⏩ Control of gonad differentiation by antagonistic genetic cascades

SRY and SOX9 in testicular differentiation

In the late 1950s, the study of patients with Turner syndrome (female phenotype with a single X chromosome, 45,X0) or Klinefelter syndrome (male phenotype, with two X chromosomes and one Y chromosome, 47,XXY) established that male phenotype determination is linked to the presence of the Y chromosome, and not to the number of X chromosomes. Over the following decades, numerous studies attempted to identify the Y chromosome gene responsible for testicular determination (McLaren, 1990). In 1990, the *SRY* gene (sex determining region Y) was identified in a short fragment of the Y chromosome that was abnormally present in XX patients who had developed testes and a male phenotype (Sinclair *et al.*, 1990; Gubbay *et al.*, 1990). Definitive proof of *SRY*'s role in male determination came from studies on transgenic mice. When the murine homologue *Sry* was forcibly expressed, the mice developed testes and a male phenotype, demonstrating that *SRY* is sufficient to initiate male development (Koopman *et al.*, 1991). Mutations identified in mice or in 46,XY DSD patients have also demonstrated that *SRY* is required for testicular determination (Larney *et al.*, 2014; Miyawaki *et al.*, 2020).

SRY is a SOX family transcription factor with an HMG domain that enables it to recognise and bind to DNA sequences and regulate the expression of target genes. *SRY* is expressed in undifferentiated gonadal supporting cell precursors, where it activates a genetic cascade leading to Sertoli cell specification (Koopman *et al.*, 2016) (Figure 7.3).

SRY expression in the mouse embryonic testis is highly transient (between E10 and E12), but its action is crucial during a critical six-hour time window, during which it initiates the expression of another HMG-domain transcription factor, *Sox9* (Sekido *et al.*, 2004; Hiramatsu *et al.*, 2009; Gonen *et al.*, 2018). *Sox9* expression is maintained throughout Sertoli cell development and regulates their specification, differentiation and maintenance. XY individuals carrying mutations in *SOX9* develop ovaries instead of testes (Chaboissier *et al.*, 2004; Barrionuevo *et al.*, 2006; Vining *et al.*, 2021). Conversely, XX transgenic mice ectopically expressing *Sox9* in the gonads, and 46,XX DSD patients with duplications of the *SOX9* gene, develop testes instead of ovaries (Vining *et al.*, 2021; Vidal *et al.*, 2001). *SOX9* is therefore the main effector of *SRY* and acts as a major determinant of Sertoli cell identity, testicular fate and male differentiation in mammals. This central role of *SOX9* in male sexual differentiation is conserved in many vertebrate species, including those in which the sex determination initiation system is not linked to the presence of a Y chromosome (Vining *et al.*, 2021).

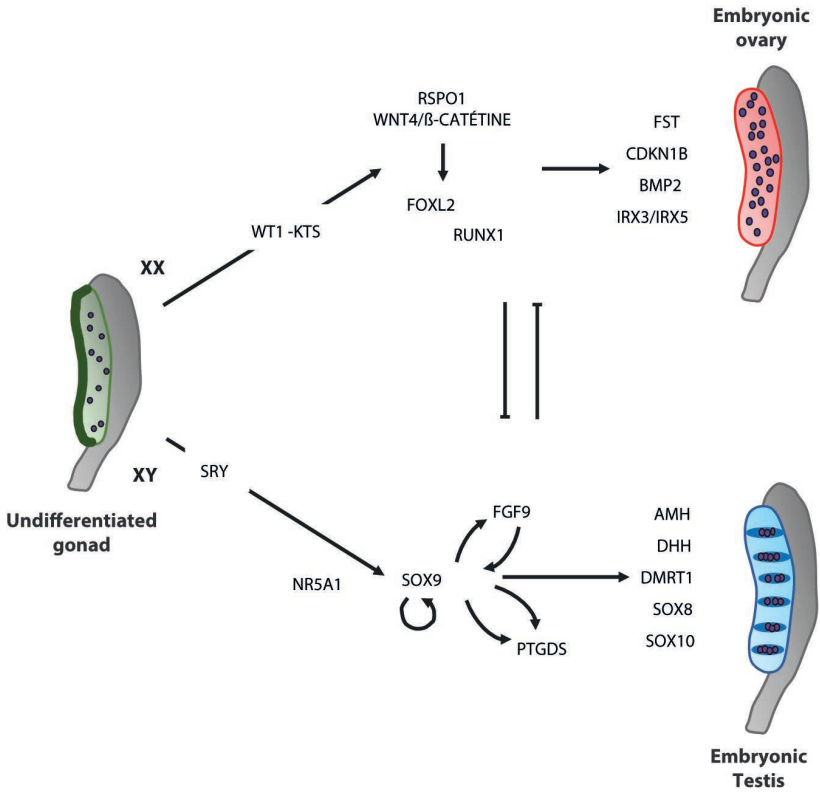

Figure 7.3. The opposing genetic cascades of testicular and ovarian differentiation.

Following the discovery of *SRY* and *SOX9*, numerous studies have aimed to elucidate the genetic cascade both upstream and downstream of these two factors (Vining *et al.*, 2021; Okashita and Tachibana, 2021). *SOX9* and *SRY* act as transcriptional regulators by binding to similar sequences, and many target genes have been identified (Li *et al.*, 2014). *SOX9* maintains its own expression and activates that of multiple genes involved in Sertoli cell differentiation (Rahmoun *et al.*, 2017). It stimulates the proliferation and specification of Sertoli cells via the activation of *FGF9* and *PTGDS* (involved in the synthesis of prostaglandin D2), and supports their epithelialisation by regulating adhesion molecules. In addition, *SOX9* regulates the expression in Sertoli cells of the hormone AMH, which induces Müllerian duct degradation, and the secreted protein DHH, which stimulates Leydig cell differentiation (Figure 7.3).

WNT/ß-catenin signalling in ovarian differentiation

Alfred Jost's pioneering experiments (see section 'The importance of gonadal sex') established that development of the female genital tract occurs in the absence of hormonal signals. The concept of female development by default was mistakenly extended to gonadal development, where it was assumed that ovary formation would also occur by default in the absence of the genetic cascade initiated by *SRY*. However, this view has been challenged by the identification of genes specifically required for ovarian development, mutations of which can result in female/male sex inversion (Figure 7.3).

Giovanna Camerino's team described a consanguineous family in which four brothers, all with a 46, XX karyotype and no *SRY* translocation, exhibited a male genital tract and male external sex organs, suggesting the presence of masculinising testicular hormones (Parma *et al.*, 2006). These individuals carried mutations in the *R-SPONDIN-1* (*RSPO1*) gene, now recognised as essential for ovarian development. Mutations in the *RSPO1* gene have since been identified in other 46,XX DSD patients, including one case in which the gonad, an ovotestis, contained both ovarian and testicular tissue (Tomaselli *et al.*, 2008; Naasse *et al.*, 2017; Tallapaka *et al.*, 2018).

RSPO1 encodes a secreted protein belonging to the family of R-SPONDIN proteins, conserved in vertebrates and involved in the activation of the canonical WNT/ß-catenin signalling pathway. WNT ligands bind to their membrane receptors, LRP and FRIZZLED, and activate a transduction cascade that results in ß-catenin protein stabilisation and transcription of target genes (de Lau *et al.*, 2014). The different members of the *RSPO* family share a similar structure, with a type I thrombospondin domain (potentially involved in interactions with extracellular matrix proteins) and furin domains, responsible for interaction with LGR4, LGR5 and LGR6 receptors. After recruitment to the membrane by LGRs, RSPO proteins can bind the transmembrane RING finger E3 ubiquitin ligase ZNRF3 and its homolog RNF43, two negative regulators of the WNT pathway involved in clearance of LRP and FRIZZLED receptors from the membrane. R-SPONDINs therefore act as potentiators of the canonical WNT/ß-catenin pathway. Consistent with the role of WNT/ß-catenin signalling in ovarian development, mutations in the *WNT4* gene have also been identified in 46,XX DSD patients who show masculinisation of the internal genitalia and/or development of oocytes (Biason-Lauber *et al.*, 2004: Mandel *et al.*, 2008).

In mice, *RSPO1* and *WNT4* are expressed in the coelomic epithelium of the undifferentiated gonad, where they activate WNT/ß-catenin signalling and stimulate proliferation

of somatic gonadal precursors (Chassot *et al.*, 2012). Expression of *RSPO1* and *WNT4* and activation of WNT/ß-catenin signalling are maintained in the developing ovary, whereas they are restricted to the coelomic epithelium during testicular differentiation (Stévant *et al.*, 2019; Parma *et al.*, 2006; Chassot *et al.*, 2012). Similarly, in the human foetus, *RSPO1* expression is maintained in the ovary, whereas it is greatly reduced in the testis (Tomaselli *et al.*, 2011; Lecluze *et al.*, 2020).

XX mice mutant for *RSPO1*, *WNT4* or *CTNNB1* (the gene encoding ß-catenin) present ovotestes in adulthood; these are gonads comprising both ovarian tissue and testis-like structures formed by Sertoli cell-like cells (Chassot *et al.*, 2008; Vainio *et al.*, 1999; Liu *et al.*, 2009; Tomizuka *et al.*, 2008). It has been shown that the masculinisation of gonads deficient in WNT/ß-catenin signalling is a sequential phenomenon. Initially, mutant pre-granulosa cells differentiate prematurely at E15.5. These cells emerge from quiescence and express markers of mature granulosa cells such as AMH and AR, which are normally expressed only in follicles activated after birth. In a second stage, at E17.5, the granulosa cells transdifferentiate into Sertoli-like cells marked by *SOX9* expression and their organisation into abnormal seminiferous tubules (Maatouk *et al.*, 2013).

In addition to defects in masculinisation of supporting cells, the oocytes of XX individuals mutant for *RSPO1*, *WNT4* or *CTNNB1* are characterised by the presence of a male-like coelomic vessel, progressive loss of germ cells, and abnormal synthesis of androgens, leading to maintenance of Wolffian duct derivatives and masculinisation of the internal genital tract (Chassot *et al.*, 2008; Vainio *et al.*, 1999; Liu *et al.*, 2009; Tomizuka *et al.*, 2008). *WNT4* expression is strongly decreased in XX gonads mutant for *RSPO1* and *CTNNB1*, indicating the presence of a positive feedback loop of WNT/ß-catenin signalling (Chassot *et al.*, 2008; Liu *et al.*, 2009). Taken together, these data suggest that WNT/ß-catenin signalling is essential for ovarian development.

The transcription factor FOXL2 is one of the earliest markers of ovarian identity (Figure 7.3). *FOXL2* is expressed in pre-granulosa cells from their specification at E12-E12.5, and its expression is maintained in mature granulosa cells of growing follicles after birth (Schmidt *et al.*, 2004). *FOXL2* expression is strongly decreased in XX gonads mutant for *RSPO1*, *WNT4* and *CTNNB1* (Maatouk *et al.*, 2013; Auguste *et al.*, 2011; Nicol and Yao, 2015), indicating that *FOXL2* is potentially a target of WNT/ß-catenin signalling. In goats, loss of *FOXL2* expression leads to female-to-male sex reversal (Boulanger *et al.*, 2014), whereas in mice, loss of *FOXL2* function has no impact on ovarian development during embryogenesis (Schmidt *et al.*, 2004; Uda *et al.*, 2004; Ottolenghi *et al.*, 2005). However, the ovotesticular phenotype of murine *RSPO1/FOXL2* and *WNT4/FOXL2* double mutants is worsened compared to that of *RSPO1* or *WNT4* single mutants, indicating that the WNT/ß-catenin and FOXL2 pathways cooperate during embryonic ovarian differentiation in mice (Auguste *et al.*, 2011; Ottolenghi *et al.*, 2007). Furthermore, *FOXL2* and the transcription factor RUNX1 regulate common targets involved in granulosa cell differentiation, and *FOXL2/RUNX1* double mutant XX gonads are masculinised (Nicol *et al.*, 2019).

The –KTS variant of *WT1*, essential for ovarian determination in mice

Although WNT/ß-catenin signalling and the FOXL2 and RUNX1 transcription factors are necessary for the progression of ovarian differentiation, the genes responsible for initiating the female gonadal programme have long remained unknown. In 2023,

our research team, with the support of the ANR SexDiff programme, established that the –KTS variant of *WT1* (Wilms tumour suppressor) is essential for ovarian determination in mice (Gregoire *et al.*, 2023). The *WT1* gene, essential for gonadal development, encodes two major isoforms obtained by alternative splicing, which include or exclude the amino acids lysine (K), threonine (T) and serine (S) between the last two zinc fingers (Hammes *et al.*, 2001). The –KTS isoform acts primarily as a transcription factor, while the +KTS isoform binds to RNA and is thought to act as a post-transcriptional regulator.

Frasier syndrome, a human disorder characterised by, among other things, impaired renal function and feminisation of the genital tract in XY patients, is caused by an imbalance in the production of *WT1* isoforms favouring –KTS (Barbaux *et al.*, 1997; Klamt *et al.*, 1998). Our team analysed mouse models carrying mutations in either *WT1* isoform. In the absence of *WT1* –KTS, XX gonads do not differentiate into ovaries: progenitor cells of supporting cells are specified but do not differentiate into pre-granulosa cells. In the absence of *WT1* +KTS, XY gonads differentiate into ovaries. We have shown that this sex reversal is due to excess production of –KTS isoforms, which accelerate ovarian development, preventing *SRY* activation and initiation of the testicular programme. The –KTS isoform of *WT1* is therefore necessary and sufficient to initiate the ovarian differentiation programme.

Male and female genetic cascades clash

Loss- or gain-of-function mutations in the molecular players of gonadal differentiation have revealed that XY gonadal cells can respond to ovarian differentiation signals, and that XX precursors are able to follow the testicular programme. Thus, in the gonads of XY mice carrying mutations in the *SRY* or *SOX9* genes, not only does testicular development fail to take place, but a programme of ovarian development is initiated (Miyawaki *et al.*, 2020; Chaboissier *et al.*, 2004; Barrionuevo *et al.*, 2006). Ectopic activation of WNT/ß-catenin signalling or *FOXL2* in XY mouse gonads disrupts testicular development and leads to differentiation of oocytes (Ottolenghi *et al.*, 2007; Maatouk *et al.*, 2008; Nicol *et al.*, 2018). Similarly, testicular development and genital virilisation are impaired in 46,XY DSD patients carrying duplications of part of chromosome 1 containing the *WNT4* and *RSPO1* genes (Jordan *et al.*, 2001). Conversely, overexpression of *SRY* or *SOX9* in XX gonadal cells in transgenic mice or 46,XX DSD patients carrying a translocation of *SRY* or a duplication of *SOX9*, prevents ovarian differentiation in favour of testis formation (Koopman *et al.*, 1991; Miyawaki *et al.*, 2020; Vidal *et al.*, 2001; Huang *et al.*, 1999).

These observations highlight the ability of XX and XY cells to respond to differentiation signals from the opposite gonadal sex. Analyses of the epigenetic landscape of mouse gonadal precursors provide a molecular basis for this phenomenon. It has been shown that gene expression and chromatin accessibility in undifferentiated XX and XY gonadal precursors are very similar (Stévant *et al.*, 2019; Garcia-Moreno *et al.*, 2018). At this stage, key sex determination genes controlling male (*SOX9*, *FGF9*, *DMRT1*) and female (*WNT4*, *RSPO1*, *FOXL2*) development are bivalent, carrying both activating (H3K4me3) and repressive (H3K27me3) chromatin marks. These genes are either weakly expressed or ready to be activated, conferring on the undifferentiated XX and XY gonads the ability to respond to the genetic cascades controlling testicular and ovarian development (Garcia-Moreno *et al.*, 2018; 2019). Interestingly, many genes specific to Sertoli or granulosa

cells retain this bivalent character and the ability to be expressed, even when ovarian and testicular differentiation are well advanced, respectively. Thus, if one of the genetic programmes for sexual differentiation is disrupted, the alternative programme takes over.

Genetic data have revealed that the ovarian differentiation programme must be actively suppressed in XY gonads for testicular development to occur. ZNRF3, the ubiquitin ligase involved in the internalisation and degradation of WNT ligand-receptor complexes, whose action is counteracted by *RSPO1*, is an essential factor in inhibiting WNT/ß-catenin signalling in differentiating testes. XY individuals carrying mutations in ZNRF3 exhibit abnormal activation of WNT/ß-catenin signalling in the gonad, abnormal testicular development and impaired masculinisation of the genitalia (Harris *et al.*, 2018). In addition, XY gonads mutant for the transcriptional regulator CBX2, which is involved, among other functions, in the repression of LEF1, an activator of WNT/ß-catenin signalling, develop as atrophied ovaries (Garcia-Moreno *et al.*, 2019).

The importance of the mechanisms that suppress ovarian development in XY gonads is illustrated by the analysis of double mutants deficient in both testicular and ovarian differentiation genes. Testicular development is impaired in XY gonads deficient for *CBX2*, for the *SRY* regulator *Gadd45g*, for the *FGF9* signal or for the *FGFR2* receptor, all of which are involved in the amplification of *SOX9* expression and Sertoli cell proliferation. In contrast, testicular development is enhanced when the players in ovarian differentiation are also inactivated, as seen in *CBX2*/*WNT4*, *GADD45g/RSPO1*, *FGF9/WNT4*, *FGFR2/WNT4* or *FGFR2/FOXL2* double mutants (Garcia-Moreno *et al.*, 2019; Jameson *et al.*, 2012; Warr *et al.*, 2022; Bagheri-Fam *et al.*, 2017). Mutation of WNT/ß-catenin pathway components is not sufficient to restore normal testicular development in the absence of *SOX9*. Nevertheless, XY *SOX9/RSPO1*, *SOX9/CTNNB1* and *SOX9/WNT4* double mutants form ovotestes, where other *SOX* family genes can induce Sertoli cell differentiation (Nicol and Yao, 2015; Lavery *et al.*, 2012; Tang *et al.*, 2020; Richardson *et al.*, 2020).

How are the genetic cascades of ovarian and testicular differentiation opposed from a molecular point of view? WNT/ß-catenin signalling interferes with the activation of *SOX9* transcription by NR5A1 (Bernard *et al.*, 2012). In addition, FOXL2 binds to regulatory regions potentially involved in the repression of *SOX9* and *DMRT1* expression (Nicol *et al.*, 2018). Conversely, SOX9 and SRY inhibit WNT/ß-catenin signalling by regulating the localisation, degradation and/or activity of ß-catenin or its cofactors LEF/TCF, through mechanisms dependent on and independent of their function as transcriptional regulators (Bernard *et al.*, 2008; Sinha *et al.*, 2021; Kormish *et al.*, 2010). Finally, SOX9 binds to regulatory regions of *FOXL2*, where it could act as a repressor (Rahmoun *et al.*, 2017), and SOX9 and FOXL2 bind to common chromatin regions where they may antagonistically regulate shared targets (Nicol *et al.*, 2018).

Gonadal sex maintenance in adults

Epigenetic landscape analyses have revealed that ovarian differentiation genes such as *RSPO1*, *WNT4* or *FOXL2* retain a bivalent chromatin state in adult Sertoli cells, suggesting these cells retain an epigenetic memory of their bipotential character during embryogenesis (Garcia-Moreno *et al.*, 2019). Thus, when essential regulators of Sertoli cell identity, such as the transcription factors DMRT1, SOX9 or SOX8, are mutated in adults,

Sertoli cells lose their identity and transdifferentiate into granulosa cells (Barrionuevo *et al.*, 2016; Matson *et al.*, 2011). Similarly, mutation in adult ovaries of *FOXL2*; the genes encoding the oestrogen receptors *ESR1/ESR2*; the *CYP19A1* gene, which encodes the enzyme critical for oestrogen synthesis; or *TRIM28*, which encodes an epigenetic regulator, result in loss of granulosa cell identity and transdifferentiation into Sertoli cells, with activation of *SOX9* expression (Uhlenhaut *et al.*, 2009; Couse *et al.*, 1999; Britt *et al.*, 2002; Rossitto *et al.*, 2022). It therefore appears that the antagonism between the male and female genetic cascades persists well after the embryonic stages of gonad differentiation, and that sex determination factors must remain active to maintain the identity of Sertoli or granulosa cells in adult gonads (Jiménez *et al.*, 2021).

The objectives of the ANR SexDiff project

The ANR SexDiff project, «Regulation of sex determination and ovarian differentiation: implications for disorders of sexual development», is a collaborative project between three research teams led by Marie-Christine Chaboissier at the *Institut de Biologie Valrose* (iBV) in Nice, France; Fréderic Chalmel at the *Institut de Recherche en Santé, Environnement et Travail* (Irset) in Rennes, France; and Anu Bashamboo at the *Institut Pasteur* in Paris, France. These partners have pooled their respective expertise in the study of mouse models of sex determination, bioinformatics analysis of gonadal differentiation, and the pathophysiology and modelling of DSDs. The research objectives are:
– to identify the players involved in initiating ovarian differentiation and activating the genetic cascade of female sexual determination (Gregoire *et al.*, 2023);
– to elucidate the genetic cascade downstream of the *RSPO1* gene, with the aim of determining the factors essential for the differentiation of ovarian cell lineages;
– to integrate the results of bioinformatics analyses of mouse models and DSD patients with the data available in the literature, and make them publicly available as a database on the genetic networks of gonadal differentiation.

The results of this project will help to fill the knowledge gap in the process of ovarian differentiation and have potential implications for the diagnosis of 46,XX DSD.

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Chapter 8

Using gender to improve understanding of links between agriculture and food in farming households

Emmanuelle Bouquet, Sandrine Dury

This chapter offers a reflective analysis of how gender was integrated into a research project on the relationship between agriculture and food in Burkina Faso. This case study presents the project's orientations, achievements, and the challenges encountered, and shares lessons and perspectives that extend beyond the scope of the project itself.

The chapter begins by situating the approach within a broader, institution-led global reflection on integrating gender into research content. It is then organised around three main themes:
– gender in the production of knowledge;
– gender in the operational implications of research;
– gender in project management.

Particular emphasis is placed on the links between these dimensions.

⏩ General framework

The European GenderSmart project, led by CIRAD (the French Agricultural Research Centre for International Development),[59] aims to promote gender equality in European agricultural research and higher education institutions by addressing both the working conditions within these institutions and the gender dimensions of the research content and teaching developed there.

To support the second aim, integrating gender into research and teaching content, a Community of Practice (COP) on gender in CIRAD projects was set up in 2020. The COP is based on the assumption that integrating gender can lead to improvements in research practices and outcomes, both in terms of expanding knowledge and increasing the relevance and impact of development actions and public policies.

The common challenge is to engage in gender-sensitive approaches (or, where appropriate, to make these approaches more visible), by building shared knowledge and expertise.

59. The GenderSmart project (https://cordis.europa.eu/project/id/824546/fr) is funded by the European Commission under the Horizon 2020 programme. CIRAD is France's agricultural research and international cooperation agency for the sustainable development of tropical and Mediterranean regions (https://www.cirad.fr/).

This is achieved through external educational resources, as well as existing in-house practices and experiences. The COP's work is based on a reflective approach, structured around a common analytical framework. This framework considers various ways of integrating gender across three dimensions (knowledge, management and impact) and at all stages of the project cycle.

This chapter applies this reflexive analytical framework to a specific project coordinated by CIRAD between 2017 and 2021: the Relax project.[60]

Figure 8.1 illustrates how a gender-sensitive approach can be adopted at various phases of the project cycle (whether research-based, expertise-driven or development-oriented with an action-research component). Two dimensions are considered:
– research (in red): Refers to the scientific method and the production of knowledge;
– management (in yellow): Refers to team composition and the interactions among the various project stakeholders.

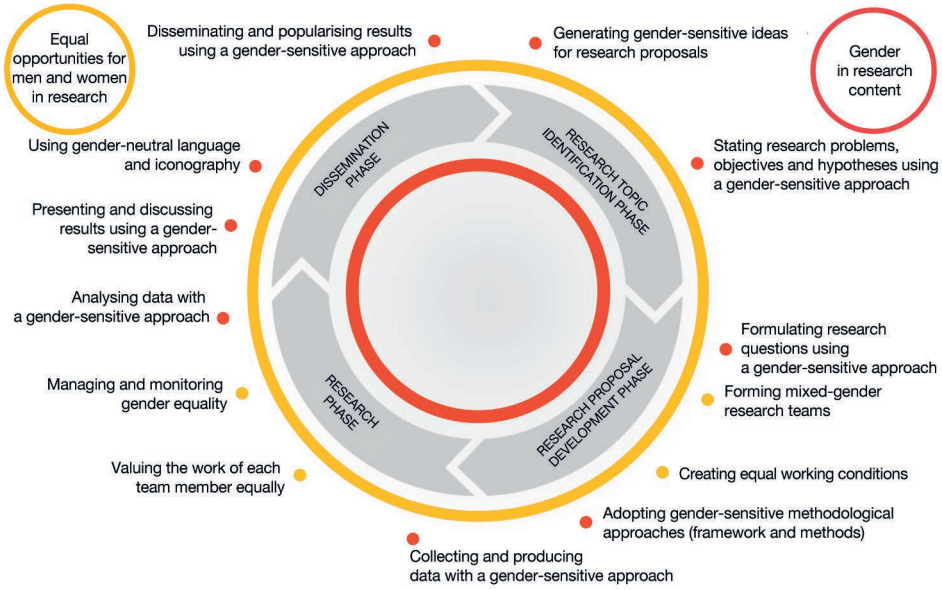

Figure 8.1. Gender-sensitive research cycle (source: Yellow Window, 2009).

Figure 8.2 presents three-dimensional models of gender mainstreaming, adapted from the IGWG (Interagency Gender Working Group) and USAID (US Agency for International Development) continuum (2017), which originally applied to the field of intervention and impact. Here, it extends to include the dimensions of knowledge and management, as presented above.

60. The Relax project: 'Promoting resilience in the African rural households: Food systems at a crossroads', is funded through the Thought for Food initiative by the Agropolis Fondation (under the Investissement d'Avenir programme), Fondazione Cariplo and Fondation Daniel et Nina Carasso. Led by CIRAD, the project brings together the following research and operational partners: Institut de Recherche pour le Développement (IRD), Institut de l'Environnement et de Recherches Agricoles du Burkina Faso (Inera), Institut de Recherche en Sciences Appliquées et Technologies du Burkina Faso (Irsat), Institut de Recherches et d'Applications des Méthodes de Développement (IRAM), and GRET.

The COP's stance is normative; it encourages questioning one's own positioning and the relevance of moving away from gender-blind toward gender-sensitive approaches. However, Figure 8.2 illustrates the diversity of possible paths across the different dimensions and the range of approaches within each. The COP's position recognises this diversity, and the legitimacy of occupying different points on the continuum (including at its origin), as long as such choices are intentional and informed rather than made by default. This approach differs from that of gender-sensitive development practitioners, who see gender mainstreaming methods as hierarchical and sequential steps towards a common goal of gender equality.

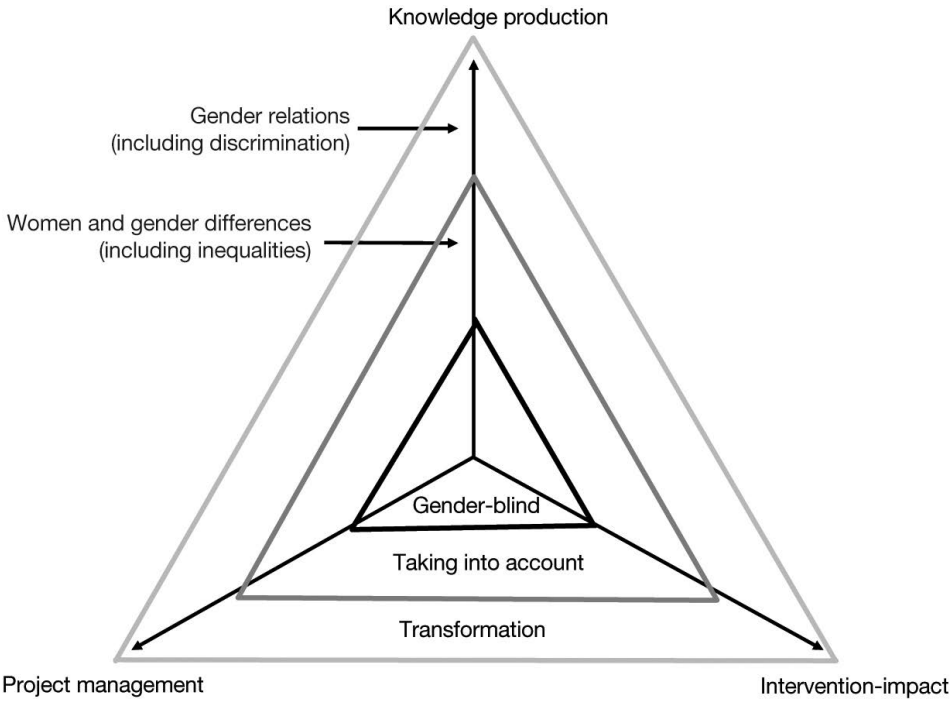

Figure 8.2. Continuum of gender mainstreaming in projects (source: after IGWG and USAID, 2017).

Intervention-Impact axis

This axis distinguishes between two main approaches (excluding the central 'gender-blind' zone):

– gender accommodating: This 'taking into account' option recognises gender dynamics in intervention contexts, aiming to avoid harm (so not including the problematic category of 'gender exploitive', not represented here) and/or identify levers for achieving development objectives (which are not generally formulated in terms of gender equality);

– gender transformating*:* Aimed at transforming gender situations and relations in the field, including by denouncing and reducing inequalities and discrimination, promoting empowerment,[61] etc. These types of interventions promote women's access to resources (economic, social, political), with particular attention on control over

61. In this chapter, we use the concept of empowerment as developed by Kabeer (1999), which is based on the notions of resources, agency and achievements.

those resources and related income. Gender equality is a stated goal of such projects, even if it may be linked to other economic, environmental or social aims.

Management axis

This axis examines gender equality issues in the day-to-day functioning of a project (such as team makeup, distribution of roles and responsibilities, conduct of activities, running of meetings, resource management and human relations). The same methods of the intervention-impact axis (accommodation versus transformation) can be used to assess management approaches.

Knowledge axis

This axis has two distinct options, which are formulated differently from the other axes to better align with the specific nature of research:
– **option 1:** Producing knowledge about women: This involves documenting and analysing differences not only between women and men, but also between women themselves. This may involve counting women or making detailed comparisons across different variables (an approach that requires, at minimum, including a respondent's gender variable in the data collection). It may also involve incorporating women's situations, practices and perspectives through empirical methods that amplify women's voices, e.g. use of specific sampling strategies or survey tools.

A key point in CIRAD's COP approach is that differences between the sexes can, be interpreted in terms of inequality, e.g. differences in income for equal work, but this is not always the case. For example, women may evaluate a new plant variety or agricultural technologies with different criteria because their needs and motivations differ from men's (see Chapter 9). However, power dynamics within the household can be used to explain how men's criteria often take precedence.

– **option 2:** Taking into account gender relations: This approach considers the actions, logic, opportunities and constraints experienced by women in their relations with others, especially the men in their family, social or economic environment. This option is often part of analyses aimed at identifying, qualifying and measuring inequalities or discrimination; therefore, it shares similarities with the transformative approach of the intervention-impact axis. But once again, the COP's approach to knowledge production does not seek to confine women to the role of victim from the outset but rather aims to characterise relationships in all their complexity.[62]

Intersections between the axes

Figure 8.2 illustrates the interconnections between the axes, with links between the knowledge axis and the intervention-impact axis being the most immediately apparent. Much of CIRAD's research lends itself to direct operational application or to recommendations for decision-makers and practitioners, and conversely, CIRAD also conducts ex-post impact evaluations of public policies or development interventions. Gender issues raise a number of questions at this intersection between knowledge and action:
– do observed differences represent inequalities?
– what type or level of inequality warrants intervention?
– should these interventions target individual behaviour (i.e. changing practices) or structural change (e.g. societal rules)?

62. See Doss *et al.* (2018) for an illuminating discussion of the need and importance of conducting nuanced, data-driven analysis.

The work of the COP also highlights links with the management theme, which had not been anticipated at the outset but which we feel are worth noting. For example, attention to gender when managing a project can influence how research questions are framed, survey methods, etc. Conversely, focusing on gender inequality in the field may prompt teams to re-evaluate gender relations in their own professional settings more broadly and in terms of management of the project in particular.

Intersectionality in gender research

In the community of gender-sensitive researchers and practitioners, the gender approach has recently been enriched by the growing recognition of considering interactions between multiple potential sources of difference and/or inequality, through the use of the concept of intersectionality. This concept can be applied as an analytical category across the three fields considered in Figure 8.2:
– knowledge production: Analysing, for example, how conditions of access to land vary based on ethnicity or an individual's position within a farming household (particularly their relationship to the head of the household or lineage);
– intervention-impact: The intersectional criteria can be used to target interventions (e.g. women who are heads of single-parent families, or vulnerable women);
– project management: Used to identify potential inequalities (e.g. paying attention to symbolic and material disparities in working conditions and contracts that may arise from partnership affiliations).

⏩ Gender in research content: design and implementation

Issues, objectives and hypotheses

The Relax project is based on the observation of a paradox: in the relatively favoured agricultural regions of West Africa, where agronomic progress has resulted in increased cereal production, sufficient to meet calorie requirements and eliminate acute malnutrition, populations continue to show alarming levels of chronic malnutrition. This is linked to micronutrient deficiencies caused by insufficient dietary diversity (Lourme-Ruiz *et al.*, 2016).

This public health problem raises issues of knowledge and development around the agriculture-food nexus. In terms of knowledge, gaining a better understanding of this nexus requires examining the production and activity systems of farming households, considering the individuals and sub-groups that make up these households, and analysing how food is supplied throughout the year: through plant and animal production, participation in markets and access to food gathered from natural environments, which may be more or less shaped by human activity).

In terms of development, the aim is to identify the opportunities and constraints for achieving a satisfactory level of dietary diversity, both seasonally and over the long term. It is also about clarifying the controversies surrounding the levers for improving dietary diversity of farm households through 'nutrition-sensitive agricultural interventions'.[63] Is it better to prioritise food supply via on-farm consumption or via

63. This expression has been used since the 2010s initially by nutritionists (Ruel and Alderman, 2013; Ruel *et al.*, 2018), and increasingly by agricultural economists (Sibathu and Qaim, 2018).

market access? Is it better to specialise or to diversify production systems? How can we both enhance and preserve the biodiversity and nutritional potential of the ecosystems and areas in which farming takes place? Targeting strategies also raises questions. What is the most appropriate level for intervention: Is it the farm, understood as a unit of production? The household, as a unit of food consumption? Or is it specific groups or individuals identified as more vulnerable to chronic malnutrition (e.g. women of childbearing age, young children)?

Finally, if we consider the entry point for interventions, should the focus be more on issues of awareness and education, emphasising the importance of dietary diversity and the means of achieving it? Or should priority be given to technical and economic issues, including production, processing and storage of seasonal and perishable products of high nutritional value, such as fruit and vegetables? Alternatively, should the emphasis be on intra-household dynamics, particularly the distribution of roles, resources and decision-making and action capacities of men and women in the fields of agriculture and food?

To sum up, the project seeks to characterise the respective contributions of self-consumption, market purchases and food gathered from the wild, in order to better understand of the determinants of dietary diversity, or its absence, across different time scales (throughout the year and over the long term) and at different levels (individuals, particularly women; households; farms). The project attaches particular importance to the relationships between agricultural decisions and food-related decisions at these various levels, using a multidisciplinary approach that includes epidemiology and nutrition sciences, agricultural economics, agronomy, socio-anthropology, geography and political science.[64]

This brief presentation illustrates how gender issues were integrated at the outset of the project. From the beginning, gender was not treated as a central focus, but rather as a means of addressing broader questions about the internal dynamics of farms and farm households. In order to explore the links between agriculture and food within these groups or household units, which for the purposes of observation and analysis are often treated as if they make decisions as a single entity, we decided to open up these 'black boxes' and examine the rationale and decisions of the various individuals or sub-groups that make them up, as well as the underlying economic, social and familial relationships.

In this context, partitioning these groups and household units along gender lines naturally appeared relevant, as it allowed us to formulate working hypotheses on the nature of the obstacles to improved dietary diversity. In addition to potential constraints related to the level, composition and seasonality of food availability and sources of cash income, a plausible set of constraints concerns the role of women in the processes of decision-making and control over key resources associated with dietary diversity.

The division of the project into work packages also lent itself well to a breaking down of gender relations according to different, interconnected decision-making locations (both in the literal and figurative sense), which can have either a positive or negative impact on dietary diversity. These include the kitchen (where food stocks and budgets are managed, meals are planned and prepared, and food consumption practices take place); the farm (including various agricultural and livestock activities, access to production factors,

64. The project also included a component analysing the links between agricultural public policies and food and nutrition security policies. Although gender issues can also be addressed at this level, a reflective analysis of this component falls outside the scope of this chapter.

and labour allocation); markets (where agricultural products, both plant and animal, are sold, and food products are purchased); and 'nature' as a possible source of access (under various conditions) to wild or semi-domesticated plant and animal products.

Data production

The intensive production of original data was central to the Relax project. The approach adopted combined qualitative and quantitative methods, as well as multiple disciplinary perspectives. The importance attached to data production was not solely a question of incorporating gender, even though this dimension inherently requires greater empirical investment. Above all, the project aimed to document the links between agriculture and food, two areas that are rarely studied together in a single research programme, and to take seasonality into account in detail. This required making regular field visits throughout the year to avoid making unrealistic demands on respondents' memories.

In this chapter, we illustrate the inclusion of gender in the data production phase from two perspectives: first, the work of conceptualising and characterising the units of analysis; and second, the role of women within the survey and observation systems.

Analysis units

Studying production and consumption units in rural Africa presents several challenges related to conceptualisation, the definition of boundaries and taking into account the interrelationships between different decision-making spheres and activities across various scales. These problems have long been acknowledged. Some highly relevant contributions date back to the 1970s and 1980s (Ancey, 1976; Gastellu, 1980). While these works shed light on the issues, they are careful not to provide ready-made solutions for constructing a survey system. However, the choices made early on largely determine the relevance of the data produced, particularly in quantitative surveys, which require a rigid framework for sampling and respondent identification.[65]

These issues were revisited as part of the Relax project, with particular emphasis on the interactions between agriculture and food on the one hand, and the gender dimension on the other. The directions taken also reflect the influence of disciplinary cultures. At the risk of oversimplifying, we present here three archetypes: economists, nutritionists and agronomists.

The team's economists considered the 'agricultural household' as a livelihood unit that combines residence, economic activities (including, but not limited to, agriculture) and consumption (including, but not limited to, food). They also examined the individual level, focusing on one woman and one man in each household.

For the team's nutritionists, the 'household' was approached primarily as a unit of food consumption, always coupled with an input from individuals. In the case of Relax, these individuals were not reduced to biological organisms (e.g. women of childbearing age) whose health status was assessed using anthropometric measures and blood tests. Rather, they were also, if not primarily, considered as economic and social actors, which fostered

65. Qualitative approaches are, of course, not immune to problems, but their flexibility gives them greater potential for adaptation, including along the way.

closer collaboration with economists through a joint quantitative survey (see Women's participation in field surveys).

Nutritionists also use a standardised indicator to assess dietary diversity. This takes the form of a score counting the number of food groups consumed over the last 24 hours. The construction and interpretation of this score vary depending on whether the unit of analysis is the individual or the household. This approach reflects a conception of the household that goes beyond a simple sum of its individual members (Kennedy *et al.*, 2011).

The project's agronomists, working with a socio-anthropologist colleague, considered the 'family farm' primarily as a decision-making and production management unit, but with an emphasis on the end use of products, whether for sale or self-consumption. They also examined sub-units according to different divisions, such as plots, crops, livestock activities, granaries, and meals, as well as family sub-groups and/or individuals (women and men) in charge of various resources and tasks on the farm. This detailed work enabled them to highlight different organisational models depending on family structure (large versus small families, polygamy versus monogamy), and sometimes depending on the time of year (dry season versus cropping season) (Figure 8.3).

The representation in Figure 8.3 has the advantage of explicitly positioning women (in this case, wives) within a network of exchanges and decisions concerning different resources (land, labour, cereals). It also illustrates the ambivalence involved in dividing units of analysis for survey purposes. Depending on the time of year, the same farm household (understood as a livelihood unit) can be split into two households (understood as food consumption units).

Women's participation in field surveys

All of the surveys and observation methods used in the Relax project gave a prominent place to women, alongside men.

A quantitative survey, conducted jointly by economists and nutritionists on a random sample of 300 farm households, included a substantial section on women. The nutritionists used the category of 'women of childbearing age', defined as those between 15 and 49 years old. When multiple women in the household met this criterion, lots were drawn to select the individual to whom the questionnaire would be administered. Consequently, the woman surveyed was not always the wife of the farm manager. A variable in the questionnaire recorded the nature of the family relationship between the individuals surveyed within each household.

The questionnaire aimed to collect a range of variables at the individual level, relying on multiple respondents depending on the module. For the agricultural module, questions related to the farm were addressed to the individual identified as the farm manager (in practice, most often a man and very rarely a woman), while the woman answered questions about her specific activities. The module on individual dietary diversity was addressed to the woman, as well as to a man and a child (girl or boy) from the household, chosen at random. The man surveyed about dietary diversity was not necessarily the farm manager.

For those in charge of the survey, the practice of identifying the respondents most likely to respond to the various modules of a multi-theme survey was not new in itself. However,

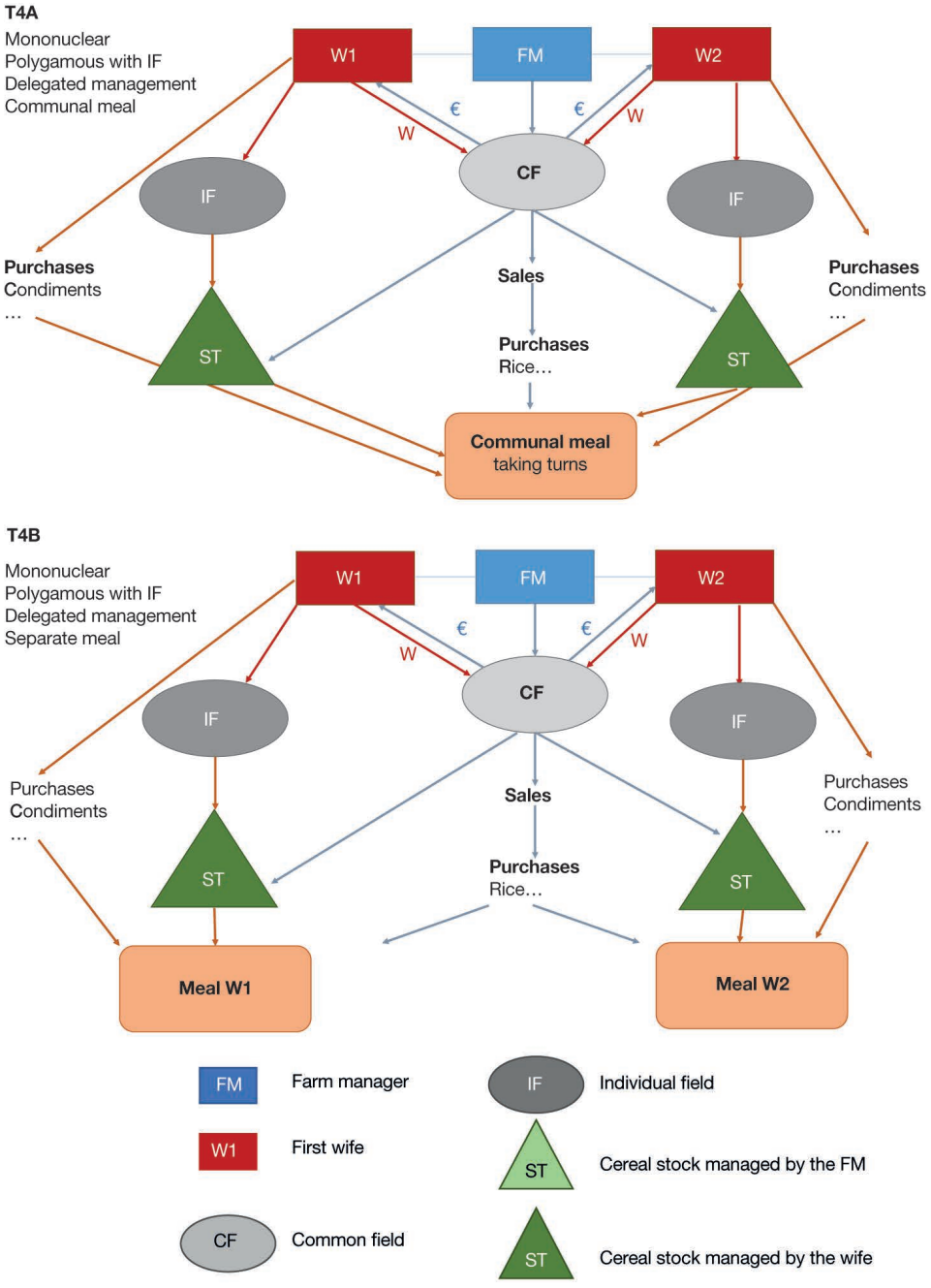

Figure 8.3. Gendered modelling of farm households (source: Le Gal *et al.*, 2018).

Polygamous household where the women have individual fields, and management of the common cereal stock is delegated by Farm Manager (CE), with either a shared meal (T4A) or separate meals (T4B). W: work. Note: In some farms, the T4A scheme is applied during the rainy season, followed by T4B in the dry season.

the inclusion of gender introduced changes in how the questionnaire was constructed, through the addition of several sections aimed at capturing:
– the position/status of the women surveyed within the household;
– the contributions of both women and men to different types of agricultural and food-related decisions (agricultural activities, decision regards the sale, consumption and/or storage of agricultural production, food purchases);
– the normative frameworks associated with this distribution of roles and decision-making powers (levels of control over resources, level of information, 'local habits').

At the same time, a mixed survey combining quantitative and qualitative modules, conducted by the project's agronomists and sociologists, covered 43 farms, with data collected from both farm managers and their wives. This broadening of the range of interlocutors within the same farm represented a new approach, allowing the field of conventional farm operation data to be expanded to include information on food practices and, in an innovative way, on the flows of resources (labour, money), agricultural products and food within the farms. This in itself constitutes a contribution to the project's results (see Figure 8.3). The explicit aim of linking quantitative and qualitative data was to complement the characterisation of decisions and practices with information on rationales and trade-offs, the links between the agricultural and food sectors, decision-making processes, and the involvement of men and women in these rationales and processes.

A research-action initiative, led by agronomists, aimed to promote diversification of the agricultural production system in ways that were compatible with diversification of food self-sufficiency. The project involved distributing vegetable and pulse seeds to male farm managers, followed by training workshops for their wives on how to process the produce for food. Both women and men were then interviewed about the advantages and disadvantages of these new crops (according to various agronomic, economic and food-related criteria), and about how the crops had been used (processing, self-consumption, sale).

Finally, several qualitative studies have also been carried out by colleagues from other social science disciplines. Using interviews, focus groups and direct observation as appropriate to each situation, these studies focused on listening to women, in order to document their practices and perspectives.

Discussion

The empirical set-up of the Relax project covers various levels along the 'knowledge axis' presented in the 'General framework' section. It was not simply a question of collecting data disaggregated according to the sex of the respondents, although this was done, for example, to document differences in dietary diversity indicators. Particular attention was paid to the specific activities and views of women. We also sought to capture dimensions of interaction between genders, to complement or interpret findings at the individual level.

The action-research project, aimed at promoting diversification of the farm's agricultural products, began from a socially shared, conventional understanding of the gendered division of roles: agriculture as the domain of men, and food as the responsibility of women. This corresponded to a typical gender accommodating approach, one that works within existing gender norms rather than seeking to transform them. This gender accommodating dimension was also present in the project's overall empirical strategy. All tools were designed based on prior knowledge of the roles and positioning of women

and men within broader groups, to improve the relevance of our questions and target the respondents most likely to provide quality data.

Differences emerge depending on the tools used and the disciplines concerned. For example, economists and nutritionists placed women at the centre of their analyses, using data provided by men more as structural explanatory variables, related to their productive activities or dietary diversity. The diversity of variables collected at the individual level also makes it possible to capture the heterogeneity within the category of 'women' and to incorporate an intersectoral perspective. The agronomists, for their part, focused more on the decisions and practices of men in relation to those of women, and examined the internal functioning of the farm.

From a practical and ethical point of view, interviewing women did not pose any particular problems for the Relax project. The subjects discussed could be sensitive (particularly in cases of high vulnerability and/or food insecurity), but rarely conflictual (particularly with the men in the family). Generally speaking, the women appreciated being given a voice and having their situation considered as worthy of interest. In a way, the surveys can even be seen as a source of empowerment, both in themselves (increased self-esteem) and through the possibilities opened up by the questions, which allowed women to view their everyday practices from a different perspective. However, schemes involving repeated visits throughout year could also lead to a weariness effect, due to the repetitive nature of the questions and the opportunity cost of the time spent with interviewers (Bouquet *et al.*, 2021).

A final point (which also relates to questions of management) concerns the relationship with the populations surveyed. Most of the surveys presented in this section do not involve a participatory approach. However, a series of feedback sessions with the respondents was planned as part of an inclusive and participatory effort to discuss the results. Unfortunately, the deterioration of the security situation in Burkina Faso in recent years meant that these activities could not be carried out as initially planned. Finally, it should be noted that the gender of the individuals in charge of data collection was not the subject of specific strategies at the project level, beyond an objective of ensuring gender diversity.

⏩ Gender in research content: results

Many of the results of the Relax project incorporate a gender perspective, confirming that gender is important for better understanding the agriculture-food nexus and the determinants and barriers to dietary diversity. This section presents a selection of the most salient findings.

Firstly, the project has shown that there are multiple and overlapping roles within the agriculture-food nexus. Women cook and manage food, but they are also growers on behalf of men as well as on their own account, and they are particularly involved in crops of nutritional interest, such as vegetables and pulses. These crops are also of commercial interest and are partly or fully geared toward generating cash income. Men, in turn, not only grow these crops but also assume certain food-related responsibilities: managing cereal granaries (with the aim of stabilising consumption over the year and avoiding or limiting the hunger gap), contributing to food budgets, and purchasing certain food items.

The project has identified three main areas of interaction between women and men in relation to food[66]: management of food stocks (mainly cereals, but also pulses and dried leaves); allocation and management of the food expenditure budget; and the allocation and management of both collective and individual fields. Gender relations are embedded in households and farms that are themselves complex and diverse in terms of structure, wealth and vulnerability. However, because women remain responsible for preparing the sauces that accompany the staple family dish (*tô* of maize), they are effectively in charge of dietary diversity, for themselves and for members of their household (Yaméogo *et al.*, 2022).

Secondly, the project confirmed the existence of significant risks of chronic malnutrition within farming households in the study region, across all categories of individuals surveyed, and particularly for women. Their average dietary diversity score is even lower than that of men and children. However, data on the origin of food consumed showed that these inequalities, to the detriment of women, are not attributable to discrimination during shared household meals. Rather, they can be explained by individual consumption outside the home: children eat more legumes (cowpeas) when they attend school canteens, and men eat more meat in small restaurants when they go to the market (Lirvat, 2018).

Starting from the premise that women do not form a homogenous category, the project sought to highlight the individual determinants of dietary diversity. It found that women's dietary diversity is positively associated with their empowerment, measured by access to and control over resources such as land, granaries and off-farm economic activities (Lourme-Ruiz *et al.*, 2021). However, the magnitude of the effect is relatively small. This is not surprising in itself: the causal path between empowerment and dietary diversity is long and complex, and depends on the internal organisation of households and farms. Theoretical work on causal pathways has certainly progressed within the project, but it is far from complete.

It is also important to bear in mind that empowerment is a useful concept for addressing gender issues, but one that is extremely difficult to capture in field data, especially quantitative data. For example, current analyses suggest that in some households, women's access to economic resources is more a signal of vulnerability (reflecting an increased burden of responsibility) than a sign of empowerment. Heterogeneity of this nature is likely to result in very different effects of the indicator on dietary diversity, and complicates the interpretation of aggregated results based on averages.

Even if dietary diversity is objectively too low for the majority of the population, the project has shown that dietary diversity, as defined by the nutritional score (the standardised indicator used by nutritionists), is not a category of thought, and therefore not an objective in itself, for either men or women. Instead, where possible, the aim is to vary menus, but this may involve switching from maize to rice, which has no impact on the score, as both foods belong to the same cereal group. Dietary diversity or variety criteria also do not seem to influence decisions about cropping and livestock systems, unlike technical and economic criteria, or criteria related to food security in the quantitative sense, i.e. the quantity of cereals produced, stock management in granaries and stabilising of consumption from one harvest to the next (Bruelle *et al.*, 2021).

66. Alongside the analysis of field data, modelling of these areas of interaction was carried out by project colleagues (Bousquet and Dury, 2020).

The data made it possible to construct stylised facts about the internal functioning of households and farms (Figure 8.3), the distribution and interdependence of gender roles, and to gain a better understanding of the structure and determinants of inter-individual differences in dietary diversity scores, particularly according to sex, age and access to individualised economic resources. The data collected should also allow, in a second phase of analysis, for a more detailed consideration of intersectionality, particularly based on status within the family group. The exploration of gender relations could be enriched by the analysis of variables related to decision-making conditions and associated normative frameworks. However, the very nature of these gender relations (in particular the degrees of cooperation and conflict depending on the action situations and the characteristics of the individuals involved) has been the subject of theoretical modelling but has not been explored empirically as part of this project. This is an important avenue for the future.

⏩ Operational implications

The formulation of the operational implications of the project's results, aimed at strengthening the links between agriculture and nutrition, provided a further opportunity to reflect on how gender was integrated into the project. First, the focus is on issues related to women's empowerment. Second, gender is considered across the board, based on a 'nutrition-sensitive' agriculture project. Finally, attention is given to how gender is taken into account in the practical implementation of interventions.

Promoting women's empowerment

The project has shown that women's access to economic resources is associated with greater dietary diversity, a finding that is in line with other recent studies in Burkina Faso (Lourme-Ruiz *et al.*, 2016; Lourme-Ruiz, 2017; Nikiema and Sakurai, 2021). Gender-transformative interventions focusing on women's empowerment, particularly through access to agricultural, natural and economic resources, therefore appear to be relevant. However, translating the Relax project's research results into proposals of this type is not straightforward. On the one hand, while the project establishes a statistically significant link between access to economic resources and dietary diversity scores, a better understanding of the underlying mechanisms is necessary, since these mechanisms are the actual levers for action.

The first difficulty of translating the research into actionable proposals lies in the fact that dietary diversity is not, as such, an objective pursued by women. Empowerment can therefore serve other objectives for women, such as raising children or purchasing personal consumer goods. A second difficulty relates to the diversity of food supply methods: the effects of empowerment on the different combinations of self-consumption, purchases and wild harvesting are still poorly understood.

A further complication is that, as we have seen above, while the statistical relationship is significant, the magnitude of the effect is relatively small. This raises the complex issue of the heterogeneity of women and their households, and calls into question

the effectiveness of an empowerment-based approach, compared to other options for improving dietary diversity.[67]

A final point concerns the nature of gender relations within households and farms. Whether the approach is gender accommodating or gender transforming, a more detailed characterisation of areas of cooperation and areas of antagonism could help to identify the levers to be activated and the obstacles to be circumvented or removed.

Designing interventions that are sensitive to agriculture, nutrition… and gender

The first sub-area builds on one of the project's key findings: the lack of consideration for dietary diversity in the strategies of women and men in farming households, whether in terms of food or production decisions. It therefore seems appropriate to design awareness-raising and training activities focused on food diversity issues, and on the various ways of achieving it, based on local contexts and existing knowledge.

A second sub-area concerns the design and promotion of activity and food systems that are sensitive to agriculture and nutrition. Diversifying diets throughout the year requires complementary interventions to influence the conditions of self-sufficiency (agricultural production, animal husbandry, natural resources) and the conditions of access to food markets (physical accessibility, product availability and, of course, the financial capacity of households) in order to obtain diversified foods of good nutritional quality.

The results of the project suggest that the concept of the farming system, as generally used by agronomists, should be understood more broadly. It can include small-scale market gardening (such as home or family gardens), foraging and hunting activities, as well as the range of possible non-agricultural income-generating activities (small-scale agri-food processing, small-scale trade, crafts, etc.[68]).

These questions of rural economics are classic and align with current debates on the desirable degree of diversification in activity systems in general, and in agricultural production in particular (Bellon *et al.*, 2020). Beyond the potential diversity of foods produced, the relevance of diversification relative to specialisation is based on two types of rationale observed in the project study area: stabilising cash flow and supplies over the seasons, and reducing production and marketing risks. The choice of crop and livestock production needs to be carefully considered, taking into account not only nutritional aspects, but also income (with the emphasis on versatility, so as to combine self-consumption and sales), and a low level of technical and financial risk.

Conversely, productive specialisation (cotton in our study area) can also represent a strategy compatible with dietary diversification if cash income actually enables diversified food to be obtained on markets throughout the year, and if individuals who control the use of this income choose to engage in a dietary diversity strategy for themselves and the members of their household.

67. The issue of measurement errors in empowerment as assessed through conventional indicators has already been mentioned above.
68. This broader concept is, in fact, similar to notion of the livelihood proposed by Ellis (2000).

Finally, a literature review (Koffi *et al.*, 2020) and qualitative work on resilience (Sanon, 2018) have highlighted the important, yet uneven and fragile, contribution of natural resources, with a clear deterioration observed over time. These examples clearly illustrate the importance of simultaneously considering the issues of agricultural development (in the broadest sense, including biodiversity considerations) and nutrition.

More specifically, the pooling of results from the project's different disciplinary approaches (economics, nutrition, socio-anthropology, agronomy, geography) supports the promotion of the production, storage and/or consumption of affordable, locally available and culturally accepted nutritious food groups that are currently under-consumed by the households surveyed. The project identified five food groups (and specific foods within these groups) that could be targeted, while also highlighting the constraints within the current system: pulses (particularly cowpeas and soya), small-scale livestock (poultry, guinea pigs), milk, eggs and vitamin A-rich fruits (such as mango).

With the exception of soya and guinea pigs, which are relatively innovative, these foods are already present in many production systems and on local markets. Some are expensive to buy or, when they are produced, represent a source of income that leads to trade-offs in favour of selling (as with cowpeas) or saving (as with animals), rather than self-consumption. Milk and dairy products are more closely associated with the dietary practices of a specific ethnic group that specialises in dairy cattle rearing. Highly perishable foods, such as leafy vegetables and fruit, are already commonly consumed, but their availability could be extended over more months of the year through the development of accessible drying and storage technologies on a larger scale.

Gender considerations are important in these discussions, because the relevance of various criteria and the capacity to implement recommendations vary depending on whether the focus is on the farm, the household or certain individuals in the household, particularly women. It is clear that access to resources (land, inputs, independent activities, but also available time), control over their use and the income they generate, and more generally the conditions of decision-making, determine the prospects for adopting the proposals and achieving the intended impact pathways. As the project has highlighted a variety of possible strategies for improving dietary diversity (combining to varying degrees self-consumption, market purchases and natural food sources), it is important that each strategy be assessed in terms of its implications for women within farming households.

We also need to take into account the potentially gendered perceptions surrounding food and what makes it practicable, acceptable or desirable (for oneself and for different members of the household: men/women, elderly/adults/children). The results of the socio-anthropological observations carried out by the participants highlight the importance of promoting local and traditional knowledge and foods (which are sometimes devalued or forgotten), of using recipes rather than food groups as such, and of considering preparation times.

The approach envisaged here is essentially gender accommodating, in the sense that the proposed interventions would not have the primary objective of transforming gender relations, even if indirect impacts can be anticipated through the very fact of reflecting on these relations during awareness-raising and training activities linked to the agriculture-food nexus. The idea is rather to rely on an understanding of the context to avoid design and implementation errors, maximise the potential for adoption and impact of the proposed interventions, including for women, and avoid doing harming, for example by depriving them of access to certain resources or increasing their workload.

Gender and implementation of interventions

Gender issues influence not only the content but also the implementation of interventions. A now classic question is whether an empowerment approach targeting women should involve systematic gender segregation in the activities offered. In the Relax project, questions arose about the relevance of designing differentiated content and/or organising separate sessions for men and women. The results of the project suggest that systematic segregation would run counter to empirical realities, which are marked by close day-to-day interactions between women and men in the realms of agriculture and food: around food, money, information, work and productive resources, etc. While women's empowerment is certainly a priority for women, it is also a concern for men. And while it can be viewed as a goal in itself, an approach that encourages women and men to think together about solutions that can be implemented within their households and farms seems a promising way forward (Bezner Kerr *et al.*, 2019).

The project's experience led us to adopt a pragmatic approach, aiming to build on these interactions, in particular through mixed activities. This approach does not exclude the organisation of gender-specific workshops on certain themes and/or activities, but it does emphasise the need to contextualise the results in order to take account of gender relations, as well as the family and production context in which these relations take place.

One important point concerns the skills profile for awareness-raising and training workshop leaders, which needs to be developed beyond traditional technical and facilitation aspects. The facilitators themselves must be trained to work with all-female, all-male or mixed audiences, to take account of gender asymmetries in knowledge, rights, obligations and social restrictions, willingness and ability to speak in public, scheduling constraints and so on, and, ultimately, to ensure that all target audiences can contribute fully to the activities on offer and derive maximum benefit from them.

Cultural considerations and the acceptability to the population (women and men) must also be taken into account, to encourage participation, limit self-censorship and avoid triggering conflicts between spouses, co-spouses or in-laws, which could be detrimental to women. Generally speaking (and this applies equally, and even more so, to approaches based on empowerment), we feel that it is risky to adopt a gender transformative approach without first having a thorough grasp of the knowledge needed to carry it through. We were reminded of this point on numerous occasions by the project's Burkinabé partners, but the question of whether or not the threshold had been reached, or was even attainable, was also the subject of lively controversy among the researchers themselves (with a clearly gendered dividing line). One way forward might be to use the two approaches sequentially: starting with a gender accommodating approach in order to produce useful knowledge that can be mobilised along the way, and then moving on to a gender transformative approach if necessary.

Gender in project management

The project was initiated by Sandrine Dury, following on from previous work that had highlighted the paradoxical situation regarding good agricultural results coexisting with a very high prevalence of chronic malnutrition). The project was set up and jointly managed with Emmanuelle Bouquet.

Particular attention was paid to the composition of the team, incorporating dimensions of intersectionality. The question of gender and gender mix at the various levels of responsibility (from the steering committee to students and field investigators) was explicitly addressed. Gender imbalances were evident within the disciplinary teams: significantly more male colleagues in agronomy, and significantly more female colleagues in nutrition and social sciences. One unanticipated effect of the multidisciplinary approach was that it reintroduced gender diversity into the project team.

The issue of gender diversity went hand in hand with a reflection on the inclusion of partners from the South in the management system, both financial and scientific. An unintentional obstacle arose because of the accounting rules imposed by the project's backers: partners from the South could not be listed as full partners in the agreement, only as service providers. From a purely administrative and financial point of view, this rule had no particular impact. However, the issues of inclusion are also symbolic.

Although it was led and steered by two female researchers, and unlike some of the projects analysed as part of CIRAD's COP, the Relax project was not part of a strategy explicitly thought out in terms of 'governance by women' or 'management by women'. Looking back over the day-to-day running of the project over four years has also helped to challenge certain gender stereotypes, such as the idea that women are more involved in building the group, in fostering high-quality relationships, etc. These qualities appeared to be fairly evenly distributed between the men and women in the team.

On the other hand, working in pairs, because it implies from the outset a sharing of power that has to be continually negotiated as the project progresses, encourages values of flexibility, dialogue, complementarity and inclusion throughout the project. However, it is possible that this interpretation is biased, and a gender-based approach may still be relevant. It could be speculated, for example, that female researchers tend to surround themselves with colleagues (both women and men) whose human as well as scientific qualities they value; and that they may also be more likely to choose paired working arrangements than their male colleagues. The case study of the Relax project does not allow us to determine which of these explanations is more valid.

Like any project, the Relax project has been fraught with misunderstandings, missed opportunities and even overt tensions (particularly around publication projects, which have a real impact on reputation and career development). Once again, gender does not appear to be the most immediate angle from which to analyse the dynamics at work. In nutrition, for example, it is customary to include a long list of authors; in economics, the principle of parsimony prevails, with an inherent risk of generating a feeling of exclusion.

The missed opportunities were also more related to interdisciplinary exchanges and building a common vision than with gender issues per se. Despite the undeniable progress, forms of silo working remain evident in the survey systems, with cascading effects. For example, systems that use different units of analysis or rely on different indicators of productive and dietary diversity make it more difficult to engage in dialogue about pooling results. Another aspect directly concerns the way in which gender is taken into account in research content. As mentioned earlier, all the project's survey systems were based on prior knowledge of the positioning and roles of women and men within broader groups. The essential role played by partners from the South and by colleagues who had been in the field for long periods should be emphasised here. However, the depth

and thematic focus of this knowledge varied across research sub-teams, and it likely would have benefited from being shared more widely.

⏩ Conclusion

A reflective analysis of the Relax[69] project, using the framework proposed in the 'General framework' section, suggests an intermediate positioning on the three axes considered: a gender accommodating approach for the 'management' and 'intervention-impact' axes, and an approach based on differences rather than relationships for the 'knowledge' axis.

The experience of the Relax project confirms the relevance of a gender approach to exploring the agriculture-food nexus in Burkina Faso. The project has produced interesting and convincing results on women's roles and perceptions, on differences in diet quality between women and other sub-groups within farming households (men and children), and also on differences between women in terms of their access to various resources. The documentation of these differences has been accompanied by interpretations that are useful for considering operational implications: the differences between women appear to be linked to issues of empowerment, and the average differences between women, men and children are more closely linked to eating practices outside the home. The Relax project also illustrates how a gender-sensitive approach adds particular depth to the potential and challenges accompanying any multidisciplinary ambition.

Beyond this observation of the relevance of the gender approach, which is hardly surprising given the subject matter of the research, the reflective analysis has revealed limitations and unresolved questions. Firstly, taking a gender approach seriously in a context such as Burkina Faso means revisiting old methodological and epistemological projects with fresh eyes. The project has (re)highlighted the difficulties not only of representing the internal dynamics of households and farms, across different areas (production, resources, food) and over different periods of time, but also of defining the very contours of these units of analysis, and characterising the individuals who make them up. For example, the heterogeneity of women's status is not solely the result of individual characteristics. It is likely that determinants relating to their immediate network (relative position of co-wives, status of spouse on the farm) also come into play.

Secondly, the question of gender relations, although raised at the start of the project, remains largely unexplored. The first challenge relates to data requirements, in connection with the need to document complex decision-making processes involving different sub-collectives (spouses, co-spouses, in-laws, etc.) as well as resource flows that may occur between different sub-units and at different timescales. A second challenge is the conceptual and theoretical framework needed to process and make sense of these data. This framework should be able to take into account the diversity and potentially antagonistic nature of the objectives and criteria for evaluating situations and alternatives; the conditions of access to resources (including time) and control over decisions; and the nature of the relationships (negotiation, cooperation, conflict, etc.) between men and women, but also between the women themselves.

69. https://www.cirad.fr/les-actualites-du-cirad/actualites/2022/relax-diversite-alimentaire-et-malnutrition

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Chapter 9

Improving crops using gender-specific consumer-oriented methods

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Gender equality may not be a subject that immediately springs to mind when thinking about plant breeding. However, there are important gender issues that need to be considered in the breeding of new plants, particularly roots, tubers and bananas (RTBs), which are vital for food and income in sub-Saharan Africa. While plant improvement programmes have significantly increased yield potential, disease and pest resistance and met market demand, gender issues and selection criteria have generally not been included. Furthermore, these stakeholders (women) had neither the same vision for the development of new varieties nor the same expected characteristics. Post-harvest, culinary and consumption preferences are also often neglected, resulting in a low rate of adoption of new varieties according to gender. This poses a problem, as households do not ultimately benefit from the advantages of the varieties made available for their drought tolerance, high yield and resistance to diseases and pests that would otherwise improve the resilience of farming systems and communities.

The lack of consideration of gender in particular and the lack of attention to post-harvest and consumption characteristics are interrelated, as the majority of post-harvest work and expertise is carried out by women. In the countries we are researching, although women are not a homogenous group with homogenous interests, gender norms place greater responsibility and workload on women as a group for post-harvest agricultural activities and food preparation. For this reason, plant breeding can have a significant positive impact on women's lives through selection of traits of interest and impact to them, particularly in the post-harvest stages. For example, any varietal trait that reduces activities that imply a significant amount of female labour, such as weeding, phytosanitary treatment, processing or cooking time, would reduce women's workload. For example, it is only recently, through active and systematic consultation, that the diverse expectations and key needs of women, who often occupy multiple roles in the food value chain, have been incorporated into selection protocols. It was with this in mind that the work carried out as part of the RTBfoods project was developed and conducted (Box 9.1). This work was integrated into component 1 of the project, which aims to respond to the priorities and needs of women linked to their gendered status and which is the focus of this chapter.

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Box 9.1. RTBfoods project

The RTBfoods project (2018-2023) aims to establish a link between local consumer preferences and selection criteria to encourage the adoption of new RTB varieties. More specifically, the aim is to identify the quality criteria for these products that have a leverage effect on their adoption by directly involving consumers, processors and researchers. This information is presented in the form of sex-specific (gender-related) profiles of food products, which will enable breeders to select and guide the choice of the most relevant criteria for a given population and product. The new high-throughput selection tools thus make it easier to select RTB varieties with the required traits. The project focused on cassava, yam, sweet potato and cooking banana (plantain) products in Benin, Cameroon, Côte d'Ivoire, Nigeria and Uganda. The project has five components.

Component 1. Analysis of quality criteria preference factors and development of multi-user profiles for RTB products. Field data on the preferences of users of RTB products will be determined using interdisciplinary survey methods (food science, gender and economics). The preferences of the various user groups involved in the entire chain of these products (production, processing, sale, consumption) will be examined, and the factors influencing these preferences in men, women and other social groups will be identified and prioritised.

Component 2. Biophysical characterisation of quality traits or characteristics. To characterise the chemical compounds of interest in detail, specific biophysical analysis and sensory evaluation protocols will be adapted or developed as required.

Component 3. High-throughput phenotyping protocols (HTPP). On the basis of the primary quantitative analyses, the project will build databases to feed simulations based on Near-Infrared Spectroscopy (NIRS) data and to calibrate HTPP in the various RTB selection programmes in sub-Saharan Africa. NIRS data from new elite clones will enable several quality characteristics to be predicted simultaneously, using a single *in situ* spectral analysis of fresh RTB material to select the varieties most likely to be adopted by end users.

Component 4. End-user oriented integrated breeding for varieties that meet their needs - VUE: variety (V), user (U) and socio-economic environment (E). These HTPPs can also enable genetic association analyses, i.e. Genome-Wide Association Studies (GWAS) and the study of genes for quantitative quality trait loci (QTL). The investment will also considerably reduce phenotyping costs and enable the contribution of genetic factors, environmental factors and growing and processing practices to the quality characteristics of RTB-based end products to be analysed at low cost.

Component 5. Equitable positioning, promotion and performance, regardless of gender. The most promising varieties identified will be tested under real conditions with farmers, processors and other users, including consumers, in order to validate the approach in partnership with the various RTB breeding programmes in sub-Saharan Africa.

A Gender Working Group (GWG) has been set up within Component 1 of the RTBfoods project to integrate collective and collaborative research on gender into varietal improvement and selection methods and tools. The participation of project stakeholders in the GTG is open and voluntary within the project. Its aim is to jointly produce results relating to gender issues and to reflect on these issues in a participatory way, in order to strengthen collective peer learning. The group is made up of 18 members representing 11 institutes, mainly sociologists and economists, but also food scientists with an interest in

gender issues. The members are committed to strengthening the research programme on gender-sensitive varietal improvement and selection. Priorities for data analysis, based on data collected under Component 1, are defined by the WGG at the beginning of the year. The WGG has created a rich network of exchanges and collaborative work that contributes to revisited North-South hierarchies for knowledge production.

⏩ Inclusive approach to the factors determining RTB users' food product profiles

The aim of component 1 is to identify the quality criteria for RTB products for different user groups using robust, participative and interdisciplinary methods. To achieve this, we need to:
– generate new knowledge on quality and choice criteria, on user preferences, on gender issues in food systems in general and on RTB-derived products in order to inform demand-driven breeding programmes for these species;
– develop and document sex- or gender-specific profiles of food products to guide and improve RTB varietal selection.

The aim of this work is to understand the demand for RTB products, and more specifically the criteria expected at each stage in the value chain and in the production of the food product, such as ease of crushing or puréeing, cooking time, taste, aroma or texture in the mouth, and how this leads to the adoption or non-adoption of a variety (hierarchy and interactions between criteria). To obtain this information, a range of stakeholders in the food product chain were consulted on preference criteria, those that are 'non-negotiable' and those that have priority. Some of these criteria could be incorporated into breeding and selection programmes. However, although there are sometimes clear differences between the quality criteria demanded by user groups, some results are often more complex because of the different interests and uses of RTBs. These preferences stem from wider socio-economic and gender dynamics, which are integral to understanding the choice and uses of agricultural products. Men, women, boys and girls play different roles in RTB food value chains, and differ in their attitudes toward access, as well as in their perceptions and use of improved varieties. Gender-specific roles in household food security and marketing mean, for example, that one category may prioritise crop or product conservation criteria (post-harvest) over yield criteria. In addition, in areas where women and men cohabit and share decision-making on farms, as in Uganda, household members may have more decision-making power over crop choice. Different varietal criteria can also influence the level of work and effort required for processing. Consumers have their own sensory preference lists for varieties, and may differ according to their origin, gender, region or food culture. Consequently, criteria that address multiple uses (such as yield and disease resistance) and multiple users (including women and men in all their diversity), or that differentiate between uses are important criteria in breeding programmes for the adoption of new varieties.

To properly address these gender issues, Component 1 used the gender dimensions framework proposed by Rubin (Rubin *et al.*, 2009; Rubin and Manfre, 2014; Box 9.2). The project partners took these issues into account and share responsibility for aggregation, analysis and reporting within the GTG.

Box 9.2. Component 1 research questions

1. What are the gender roles associated with RTB food products in the food value chain, and how do they influence crop and product quality criteria?

2. Who controls RTB products and who benefits from them at different stages of the food value chain, and how can these data evolve for the criteria to be integrated into varietal improvement?

3. What are the multiple uses of RTB crops and products and the trade-offs between uses and RTB quality criteria associated with the different players in the food value chain?

4. Are there gender-differentiated preferences for RTB product criteria? How do these differ according to culture and region?

5. What are the gender-related constraints and opportunities for creating food product profiles?

Methodology

Component 1 draws on interdisciplinary methods and fields of investigation (food science, gender, and economics) to collect data on the preferences and prioritisation of quality criteria for RTB products among different user groups along the value chain. For example, women may prioritise labour requirements and storage-related criteria over yield criteria. The aim is also to identify the factors that influence these preferences and priorities for men, women and other categories of social differentiation. For this task, several methods must be combined because of the difficulty of gathering evidence on objects that are difficult for participants to characterise, i.e. that involve tacit knowledge. To understand this challenge, it is important to remember the difficulties in describing the aroma or taste of a favourite food, such as the sweetness of a product or the type of sweetness.

The method has been applied and adapted by 12 interdisciplinary teams of food technologists, economists and gender specialists in the five countries participating in the project, as well as in other projects such as Sweetgains and Africa Yam. This mixed, interdisciplinary and participatory method is carried out in five stages, with the main output being a profile of gendered food products (Forsythe *et al.*, 2021). It can be summarised as follows:
– **stage 1.** Research teams analyse the state of knowledge to establish what is known about the product as well as gaps relating to food science, gender and markets in the country context, and to redefine the scope of further studies (Forsythe *et al.*, 2018a);
– **stage 2.** Experts map foods while incorporating a gender-sensitive perspective in rural communities and urban areas. This allows them to identify the respective uses of the agricultural product by different users (e.g. producers, processors, local consumers and retailers) and the associated quality criteria. The study integrates gender issues, market dynamics and quality criteria associated with agricultural production and raw and processed products. The result is a first draft profile of each food product incorporating priority quality criteria by user group, taking into account gender, context and income (Forsythe *et al.*, 2018b);
– **stage 3.** A participatory diagnosis of processing methods and practices is carried out with the active involvement of experienced processors. Both preferred and rejected or excluded varieties were included to provide a wide range of technological

and physico-chemical criteria. The processors commented on and assessed the varieties before, during and after processing in order to determine the quality criteria of interest for both the raw and processed agricultural product. Processing parameters were measured at each stage, making it possible to add new quality criteria to the profile of each food product (Fliedel *et al.*, 2018a);
– **stage 4.** Consumer tests are carried out with around 300 people in rural and urban areas. This enables us to gain a better understanding of consumer demand and to obtain a sensory map of preferences for each product, which could be linked to the most sought-after and least appreciated traits. At this stage, new quality criteria and their prioritisation are added to the Food Product Profile (FPP) (Fliedel *et al.*, 2018b);
– **stage 5.** The gender-responsive food product profile (GRFPP) is essentially a description of a high-quality food product (with high standards) based on an evolving list of sensory, agronomic and processing criteria, defined for a particular region, usually within the same country. The interdisciplinary team finalises the profile, which is shared with the biochemists and breeders for feedback, ultimately improving the list of criteria and the varietal selection methods.

The final step in the Component 1 method is to create a food product profile that can be used to inform food scientists' tests and varietal selection programmes. This is called a 'gendered food product profile'. The RTBfoods project has adapted existing *Demand-Led Breeding* and *G+ Breeding* tools to reflect gender-sensitive methods and a focus on post-harvest and consumption characteristics. Gendered food product profiling needs its own methodology, as each stage involves different participants, methods and experiments. Data cannot be quantitatively aggregated into a gendered food product profile. What is important is that the profile reflects users' preferences, and these preferences may vary from one country to another. Therefore, a subjective and qualitative interpretation of the data is required and must be clearly directed.

> «When breeders prioritize traits to be included in a product, this involves making a choice about whose preferences take priority. A choice about a trait is also a choice about people.» (Ashby and Polar, 2021).

The steps involved in constructing a gendered food product profile are:
– triangulation of the results of the four stages to arrive at the most important agronomic and agri-food criteria;
– bringing together a multidisciplinary 'design team' to select the key criteria required for production and processing of targeted agricultural products, such as RTBs;
– assessment of the gendered food product profile;
– finalise the information in a summary table.

The profile is then examined to determine whether it offers advantages or negative impacts for women, using the assessment of the gender dimension of the product profile. This draws heavily on innovative work in the field leading to the 'gendered food product profile' tool of the Gender in Breeding Initiative (GiB), and on developments and adaptations by the Gender Working Group to focus on processing and consumption in the RTBfoods project. The results of the tool help determine which elements are included and prioritised in the final version of the food product profile, and overall provide a means of validating the key gender issues in food and farming systems to be included in the breeding process. The tool targets women. However, it can be applied to men or

other categories of social groups where this is deemed important and relevant to the context. We recommend that the tool be used by social scientists trained in gender analysis, ideally in interaction with food scientists and plant breeders. Each result should be accompanied by a justification drawn largely from the research and/or documentation of Working Group 1. For this activity, a scoping document, a model, a simulator and a YouTube video presentation have been produced and are available.[71]

Apprenticeships

The project has made considerable progress in the co-production of knowledge on gender issues and the demand for food quality criteria. Initial results from the studies have resulted in 16 peer-reviewed (A-rank) papers and reports collected in a special issue entitled «Consumers have their say: assessing preferred quality traits of roots, tubers and cooking bananas, and implications for breeding» in the *International Journal of Food Science and Technology* and in a Component 1 report on the five-step method mentioned above. There are several important lessons to be learned from this project. The research revealed that an interdisciplinary approach to crop breeding is much more effective in generating new knowledge on agricultural production and food staples for food security. A key point of this approach is the need to build on context-specific gender expertise, and to provide the space, resources and motivation for gender-oriented research within a project.

However, in interdisciplinary projects, gender issues can sometimes, if not often, be relegated to the background. Support from the coordination and project management team is essential to highlight the importance of this work. It usually takes time and specific effort to get interdisciplinary teams on board with these activities. This requires multidisciplinary collaboration, and sufficient time for discussion and commitment to knowledge sharing.

⏩ Conclusion

We found that gender research was essential to understanding the complexities of demand for 'local' food at each stage of the food or supply chain. Women and men play different roles within food and commodity chains because of their respective sex and gender roles. For example, our studies show that, for the food products targeted, women, on the whole, carry out the work of processing and preparing food and can therefore quote many food quality criteria much more accurately than men, who usually do not do this work. This is the essential information that crop improvement programmes need to ensure that their products meet the qualities and standards that consumers expect. In the future, more comprehensive data needs to be collected on gender roles and how they relate to sampling plans and subject matter expertise. Comparing responses between men and women is not enough for gender and sex-based analysis, nor will it inform strategic decisions in breeding and selection programmes, which should be effective not only for men, but also for women and all stakeholders in the RTB agri-food value

71. See the videos of the RTBfoods project: https://www.youtube.com/channel/UCcwrf1cZavIS7arq_qKtu4Q

chain. Data gathering and compiling should also be carried out by gender experts, in conjunction with experts in the other relevant fields (genetics, agronomy, food science, etc.), to ensure quality and relevance.

It is also necessary to go beyond established norms to incorporate areas of divergence and counter-norms that may arise in particular scenarios. For example, if the processors are predominantly women, it is probably not necessary to sample a large number of male processors, but it may be interesting to ask for an interview with some of these men who step outside the norm in order to collect qualitative data and insights into how, why and under what conditions they made different choices. This would enable us to understand when it is socially possible to break gender taboos and how useful this work could be in promoting equitable work-sharing practices. Focusing on why some people participate in the work they do, how this changes or does not change, and who holds power in the organisation of gender roles and tasks would help to make this information more meaningful and should be further integrated into future research.

Often, the most valuable information is found in the context in which the research is carried out. Therefore, an in-depth contextual analysis will enable gender specialists to assess the key priorities for breeding and varietal selection programmes, taking into account the needs and expectations of women, men, ethnic differences, wealth levels and regional preferences. In addition, many surprising and counter-intuitive results challenge stereotypes, particularly when analysed by region, underlining the importance and contribution of the RTBfoods project. In the future, we hope to build on these lessons to provide a more in-depth intersectional analysis to accompany and strengthen breeding programmes for better food security and poverty reduction.

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General conclusion

A number of overall observations can be made from the different contributions to this book, which is undoubtedly rich in diversity of subject matters and methods.

First of all, the major positive aspect of this book and the conference it is an extension of must be emphasised: it is possible to bring together the diverse players in the research ecosystem around the issue of inequalities between men and women. This testifies to the vitality of the issue, as well as to the shared desire to tackle it and find solutions.

It is a point of convergence of all the articles: the road to equality is still paved with obstacles –such as the force of stereotypes and ideological barriers, which govern all areas of social activity, whether professional or private—maintaining and producing inequalities between men and women.

As has been emphasised, the solid methodological and epistemological apparatus of the humanities and social sciences is an essential foundation for deepening our understanding of the processes at work and demonstrating once again that the differences between men and women are not solely the result of biological determinisms, but that they are mainly produced by the entrenched social stereotypes and the ideologies that fuel on them, as much as they perpetuate and reinforce them.

However, as we have seen, all scientific disciplines have a role to play. By considering the sex and/or gender dimension in their research whenever relevant, they can avoid any gender bias in the production of knowledge. Furthermore, it is crucial not only to embed all research in a reflexive approach, but also and above all to favour multi- or interdisciplinary approaches. The case studies presented in this book highlight this particularly well. Making the effort to break down the barriers between disciplines means recognising the complexity of the subject, considering it in its many dimensions and better anticipating the potential consequences of applying research findings.

These efforts must be supported and encouraged by the funding agencies, which have a major role to play in supporting the scientific communities in this necessary evolution of scientific culture. Similarly, it is essential that the evaluation of the research projects they organize takes these considerations into account. Furthermore, as has been shown, the quality of their evaluation processes and criteria also depends on the equal treatment of projects, whether they are submitted by men or by women. In order to guarantee this, they need to carry out new analyses of their submission and selection data, and also to sensitize their evaluators about gender stereotypes, which can introduce unconscious biases into their evaluation work. Training repeatedly emerged in the contributions as a key lever for action.

While each player in the ecosystem does have a role to play, yet, they can only really play it, and it will only be coherent and effective if and only if the framework for their action is supported by a proactive policy of challenging ideologies and transforming society towards equality.

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Whilst women's representation in sciences is on the rise, this increase is not of the same scope across all academic fields, such as mathematics or computer science. In addition, the proportion of women decreases at higher levels of the academic hierarchy.

The persistence of these disparities and inequalities can be explained by the strength of stereotypes and ideological positions maintaining men and women in different and hierarchical social roles. These anchored unconscious stereotypes and gendered representations convey biases that can creep into evaluation processes, be it regarding careers or research projects, and they can also determine and guide scientific approaches.

Given the complexity of the phenomena leading to the (re)production of inequalities, what measures can be enforced? And how can we ensure their efficiency for the ecosystem as a whole?

This book—thought as the extension of the *Gender in Research* colloquium held in December 2020—brings together scientists and funding agencies to address these questions and provide answers. Drawing on a variety of perspectives, depending on whether they emanate from scientists or funders, the contributions offer analyses of different kinds, yet all grounded in a reflexive endeavour.

This diversity allows to reaffirm that equality is a matter for all stakeholders in the research ecosystem, and their ability to engage in dialogue and collaborate is crucial to guarantee the coherence and efficiency of their actions.

This book is intended for all the stakeholders involved in the conduct of research and/or its evaluation, regardless of the scientific discipline.

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