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Gender representation and homophily as barriers to women's career advancement in science

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Extended Abstract

In the last few decades, women's participation in academia has greatly increased. As a result, new research priorities have been realized such as the recognition of women's health as a priority in medicine [1], and the use of women's experiences in designing interventions and public policies to mitigate social inequalities [2]. However, the increase in women's participation and integration has not been equal across different fields and career stages. For instance, there is still low participation of women in positions of power and decision-making [3], which affects resource availability, recognition, and representation of women, and in general the entire society. Here, we focus on studying the representation of women in top-ranked positions for fields with different rates of women's participation. Furthermore, we examine how women's participation and representation in top-ranked positions are intertwined with gender homophily in order to understand the integration of women in each academic field.

We analyse the gender participation and co-authorship networks formed by more than 200 million papers published from 1955 to 2020 divided into 19 academic fields from the Semantic Scholar Open Research Corpus [4]. Specifically, we concentrate on women's participation in different career stages, the gender differences in drop-out rates, and women's representation in top-ranking positions considering productivity (number of papers), citations, and degree (number of co-authors). Finally, we use the Mixing Matrix and Adjusted Mixing Matrix to estimate gender homophily, assortativity and adjusted assortativity [5] per field.

We plot in Figure 1 the characteristics of three fields organized by women participation: Physics with 14% (lowest), philosophy with 24% (median), and psychology with 39% (highest). Interestingly, these fields' order in relation to women's participation put areas of expertise together, for example, STEMS, humanities and social sciences. The proportion of women in early and medium career stages grow over time (humanities and social sciences are the fastest). But, just social sciences have a constant growth of women in senior stages (Figure 1**A**). We measure the representation of women(men) in top-ranked positions as the proportion of women(men) in the $x\%$ top-ranking of each metric over the proportion of women(men) in each field. Here, smaller(larger) values than one refer to under(over) representation. Women are underrepresented in the highest percentiles and when the participation of women increases, the transition from under to fair representation is smoother (see the case of psychology in Figure 1**B**). Finally, our results show a relationship between women's participation and homophily. As expected, when we increase the participation of women, there is a higher proportion of women-women and women-men co-authorships (top panel going from lighter to darker yellows, Figure 1**C**). Interestingly, when the participation of women increases their homophily decreases while for men the homophily values remain constant. Also, we found that gender assortativity (r) increases when the participation of women increases but when correcting it by their group size (r_{adj}) [6], the values remain high but constant.

Our work aligns with previous evidence about shorter careers for women as an indicator of the under-representation of women in top-ranked positions and the low participation in senior

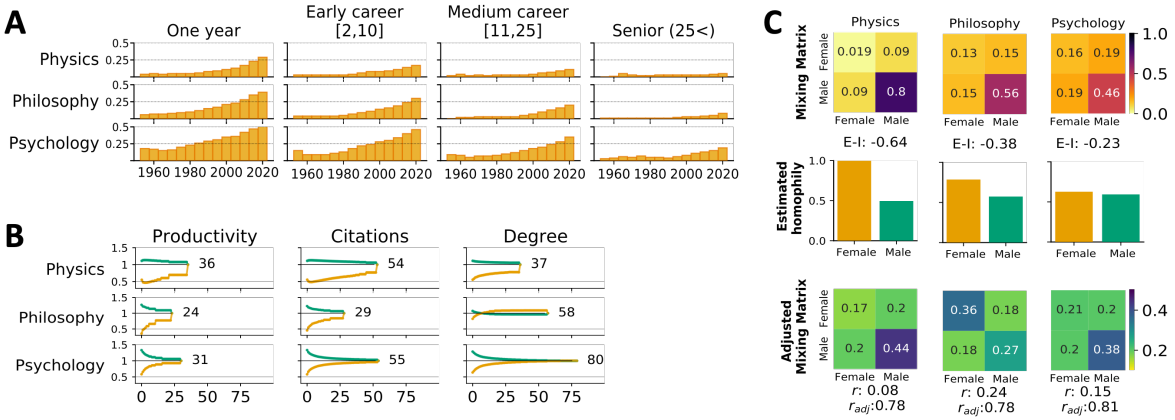

Figure 1: Gender participation, representation and homophily in Physics, Philosophy and Psychology. **(A)** Women participation in different career stages. **(B)** Top-ranking representation for women and men in productivity, citations and degree. **(C)** Mixing Matrix, estimated homophily, and adjusted Mixing matrix. $E-I$ represents the External minus Internal connections, r refers to assortativity and r_{adj} to adjusted asortativity.

career stages [3]. However, we also observe that for many fields, the increase in women's participation seems to plug the "leaky pipeline" and retain women in more long-lasting careers, with better representation in top-ranking positions and more diverse research groups with smaller values of internal homophily.

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