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Are there gender differences among researchers from industrial/organizational psychology?

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Abstract

Questions about gender differences in the workplace usually attract much attention—but often generate more heat than light. To examine gender differences in several facets of scientific productivity and impact, a quantitative, scientometric approach is employed. Analyzing a sample of industrial and organizational psychologists ($N_{authors}$ = 4,234; $N_{publications}$ = 46,656), this study raises both questions and concerns about gender differences in research, by showing that female and male I-O psychologists differ with regard to publication output (fewer publications authored by female researchers), impact (heterogeneous, indicator-dependent gender differences), their publication career courses (male researchers' periods of active publishing last longer and show longer interruptions), and research interests (only marginal gender differences). In order to get a glimpse of future developments, we repeated all analyses with the student subsample and found nearly no gender differences, suggesting a more gender-balanced future. Thus, this study gives an overview over the status quo of gender differences in an entire psychological sub-discipline. Future research will have to examine whether these gender differences are volitional in nature or the manifestation of external constraints.

Keywords: gender differences; research productivity; scientific productivity; impact; psychology

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Are there gender differences among researchers from industrial/organizational psychology?

Introduction

Differences between men and women have always attracted much attention. Innumerable studies looking at gender differences have been conducted in relation to a myriad of variables, ranging from driving (e.g., Zhang et al. 2011) to the experience of emotions (e.g., Else-Quest et al. 2012) and political preferences (e.g., Condon and Wichowsky 2015; for general overviews on gender differences see Hyde 2014, and Zell et al. 2015). Gender differences have also aroused the interest of scientometricians, who wish to know how similar or dissimilar men and women are regarding their scientific productivity (e.g., Larivière et al. 2013).

A considerable number of studies have addressed the number and the impact of publications of women and men in several fields, but the results have been inconclusive: Although the majority of papers have found differences in favor of men (e.g., Garg and Kumar 2014; Larivière et al. 2013; Prpić 2002; Puuska 2010), others have documented differences in favor of women (e.g., Powell et al. 2009), and others still have found no differences or mixed effects (e.g., Borrego et al. 2010; Joy 2006; Long 1992; Sotudeh and Khoshian 2014). Furthermore, it has been questioned whether gender differences have been disappearing over recent years (van Arensbergen et al. 2012).

The aim of this study is therefore to contribute to this important field of science studies (e.g., Directorate-General for Research and Innovation & European Commission 2004) by analyzing a large dataset of $N = 4{,}234$ industrial and organizational (I-O) psychologists and their 46,656 publications (from 1948 to 2013). This dataset allows us to scientometrically test for

gender differences in their scientific productivity and also in their research interests. Furthermore, a separate analysis of students in I-O psychology permits a glimpse into future developments within I-O psychology.

Background

The continuous underrepresentation of females in science has long been a worry to many people, including policy makers, who have tried to set up systems to support women to become more interested in science and to help them climb the ranks (e.g., become full professors), especially given the vast evidence of a general gender wage gap in favor of men (e.g., Henderson et al. 2014; Mussida and Picchio 2014). For example, the European Union has launched several initiatives to increase equality between women and men, which also address the gender imbalance in science and research (European Commission 2014).

To document the status quo regarding gender differences in science, several scientometric papers have compared men's and women's scientific productivity. These papers have covered many different fields, ranging from material sciences (Mauleón and Bordons 2006) to construction research (Powell et al. 2009), invasion ecology (Heidi Prozesky and Boshoff 2012), and social sciences in general (e.g., van Arensbergen et al. 2012). Furthermore, researchers have obtained data for researchers in many countries, including Canada (e.g., Larivière et al. 2011), Croatia (Prpić 2002), Finland (Puuska 2010), India (Garg and Kumar 2014), Russia (Paul-Hus et al. 2015), South Africa (Heidi Prozesky and Boshoff 2012), Spain (e.g., Barrios et al. 2013), and the US (e.g., Joy 2006).

Overall, the results of these studies suggest that men outperform women (e.g., Garg and Kumar 2014; Larivière et al. 2013; Malouff et al. 2010; Prpić 2002). However, other studies were unable to replicate the male advantage, at least not on all performance indicators (e.g.,

Borrego et al. 2010; Powell et al. 2009; Sotudeh and Khoshian 2014). Performance indicators which have been used in previous studies are the number of publications, the number of publications in relationship to the journals' impact factors, the number of citations, and the number of first authorships[1]. The inconsistent findings regarding men's and women's scientific productivity suggests that more studies are needed.

Furthermore, the gap between men's and women's productivity might have begun to close (van Arensbergen et al. 2012). Indeed, a change in recent years might also be expected given the signs that women are surpassing men in terms of educational outcomes – that men are falling behind (e.g., Buchmann et al. 2008). For example, in most industrialized societies, women outnumber men among recent college graduates (Buchmann et al. 2008). However, it should be noted that other results (e.g., Barrios et al. 2013) do not indicate a change over time and rather suggest persistent gender differences.

I-O psychology is a particularly interesting field to analyze because its gender composition is near parity (cf. Method section), which reduces potentially distorting selection effects. Furthermore, I-O psychology is situated between psychology and management. It is part of psychology, as indicated by its name (which is, incidentally, "work and organizational psychology" in Europe), and psychology has become a field in which both students and young researchers are nowadays predominantly female, at least in Australia (Malouff et al. 2010), Italy (D'Amico et al. 2011), and the Netherlands (van Arensbergen et al. 2012). I-O psychology is also

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[1] Although the first two indicators are probably the most famous, first authorship is also a common indicator of scientific success, for example but not only, in psychology (e.g., Adair and Huynh 2012; Barrios et al. 2013; Venkatraman 2010). The indicator is based on the idea that "[t]he general rule is that the name of principal contributor should appear first" (American Psychological Association 2009b, p. 19).

part of the field of management, because I-O psychologists are increasingly working in management departments of business schools (Aguinis et al. 2014a), and the field of management is dominated more by males (see Podsakoff et al. 2008). Furthermore, I-O psychology is an attractive field among students because it is typically associated with many career and employment opportunities (Van Hoye et al. 2014).

Both psychology and management have been the focus of several scientometric studies. Probably the earliest study in psychology was the study by Guyer and Fidell (1973), who found that male psychologists published more articles than female psychologists in the years 1964-1968 (although differences were only found at the professor and associate professor level). In Joy's (2006) study, female psychologists were found to publish less than male psychologists prior to getting tenure, but more afterwards. Malouff et al. (2010) analyzed publication rates of Australian psychologists and found the typical male advantage (see also D'Amico et al. 2011 for Italian data). Nosek et al. (2010) found only weak gender differences among social psychologists, at least if they accounted for career span differences, whereas a second study among social psychologists (Cikara et al. 2012) found clear evidence of gender differences. Barrios et al. (2013) reported that among Spanish psychologists, gender differences in favor of men can still be found. In the field of management, studies have also touched on gender differences between researchers' productivity. Judge et al. (2004) mentioned a clear advantage for male researchers with regard to number of publications and citations. In the study by Podsakoff et al. (2008), women had a lower number of publications, but there were no gender differences regarding citations.

The most important and largest association in the field of I-O psychology is the Society of Industrial and Organizational Psychology (SIOP), which is also Division 14 of the American

Psychological Association. It currently has more than 8,000 members, predominantly from the US. SIOP members are researchers and practitioners alike, because the field adheres to the scientist-practitioner model (i.e., I-O psychologists "are to be trained in a way that integrates science and practice such that activities in one domain would inform activities in the other domain", Rupp and Beal 2007, p. 35). Furthermore, SIOP organizes an annual conference, which is the largest conference with a focus on I-O psychology. Thus, this study attempts to answer the following research questions: *Do male and female SIOP members differ with regard to the number of publications (RQ1), the impact of their publications (i.e., number of citations, impact factors; RQ2, RQ3), and the number as well as the percentage of their first authorships (RQ4a, RQ4b)?*

One of the reasons given for findings that men outperform women in their scientific productivity is the persevering traditional role expectation that it is the mother rather than the father who has to care for children (Rhoads and Rhoads 2012). Even male professors with an egalitarian view on gender roles seem to invest less time in childcare than their wives (Rhoads and Rhoads 2012). Role expectations might thus cause female researchers to put their career on hold in order to have more time for childcare, resulting in publication career disruptions (McElrath 1992; Stack 2004). Therefore, this study also attempts to answer the following research questions: *Do male and female SIOP members differ with regard to the courses of their publication careers (i.e., publication career length, maximum length of disruptions; RQ5, RQ6)?*

In addition, our data also allowed us to study gender differences in research interests among I-O psychologists, because gender differences in terms of interests are among the most pronounced (Hyde 2014). In particular, Su et al. (2009) conducted a meta-analysis of the literature on gender differences in interest. They summed up their findings by stating "Men and

things, women and people" (p. 859), describing that men are more interested in things like machines and their mechanisms, whereas women are more interested in people (e.g., understanding emotions) (see also Prediger 1982). These differences might also be relevant for the choice of research topics within a field such as I-O psychology. Therefore, this study attempts to answer the following additional research questions: *Do male and female SIOP members differ with regard to their research topics and research focus, respectively, within psychological research (RQ7a, RQ8a), and within I-O psychological research (RQ7b, RQ8b)?*

Method

All analyses were conducted using R (R Core Team 2015). We used the following additional packages: descr (Aquino 2014), plyr (Wickham 2011), compute.es (Del Re 2013), lattice (Sarkar 2008), reshape (Wickham 2007), psych (Revelle 2015), pwr (Champely 2015), car (Fox and Weisberg 2011), XML (Temple Lang 2013b), RCurl (Temple Lang 2013a), and stringr (Wickham 2012). Unless otherwise noted, all tests of significance were performed at a significance level of $p < .01$.

Sample

SIOP provided us with a list of all of their 8,620 members in 2013, which also included gender-specific titles (e.g., "Mr."). In the 3,728 cases with no gender-specific title, we first checked whether the first name clearly indicates gender (e.g., "Elizabeth"); if not, we searched the internet for information about a person's gender (e.g., photo on webpage). In 0.3% of cases, we were not absolutely certain about the gender, and we therefore removed these 24 individuals from the sample. We discovered five member duplicates in the SIOP list, which were also removed. Since we were interested in the researchers' publishing activities, we had to exclude

the 4,233 SIOP members (60% female) who have yet not published anything at all, $\chi^2(1) = 195.96$, $d = 0.31$, $CI_{95\%}(d) = [0.26;0.35]$. Thus, our sample only comprises only those SIOP members who have previously published.

Furthermore, we took two steps to deal with problems of technical limitations of scientometric data collection. In order to attenuate problems of author name ambiguities (e.g., Bauer et al. 2013; Milojević 2013; Strotmann and Zhao 2012), we (a) checked, as mentioned above, whether there were any researchers with the same PsycINFO query because this would have indicated name duplicates (*homonyms*; White 2001), and (b) excluded the 1% of the author sample with the highest publication counts (*range* [130;577], $M = 204.43$, $Mdn = 189.50$, $SD = 84.14$) because they may be cases of author name merging (Milojević 2013); further steps of dealing with author name ambiguities are described in the Database section. Due to the indexing time lag of databases (Diodato 1994/2012), we limited our analysis to publications published no later than 2013 (year before data collection[2]) and excluded 945 publications. Assuming scientific authors are at least 18 years old, authors of publications before 1991 were about 42 years old in the years of data collection, which seems rather unlikely for student members. Thus, we finally excluded 453 publications that were supposedly authored by student SIOP members earlier than 1991.

The final sample consisted of 4,234 publishing SIOP members with an average amount of 11.02 publications (*range* [1;123], $Mdn = 4$, $SD = 17.78$). Of these, 1,920 were female (45%) and

[2] Due to a technical problem, queries of 53 SIOP members failed and were repeated in March/April 2015. This data collection complemented the initial data set with 455 publications (authored by 49 SIOP members). Inclusion criteria were applied to the complete data set.

2,314 male (55%), and 249 were international affiliates (i.e., SIOP members/associates outside the US; see also Variables section).

Database

To collect data on the publishing activities of our sample, we used PsycINFO, the database provided by the American Psychological Association which covers over 3 million bibliographic records of publications (e.g., journals, books, or dissertations) in psychology and related fields (American Psychological Association 2015). In contrast to several other databases, which only provide an author's surname and initial(s), PsycINFO provides, wherever available, an author's last name, first name (or initial), middle name (or initial), and suffix (American Psychological Association 2012). Thus, name-based data retrieval in PsycINFO was based on queries that included an author's last name, first name plus first initial, if applicable; middle names or further initials were truncated with an asterisk after the first character (American Psychological Association 2014). However, there were 481 author names in the SIOP member list in which we invested further manual maintenance before submitting them to PsycINFO: Of all SIOP members, 1% possessed a suffix (e.g., Jr., III) to their name. We searched the internet for valid publication information about these 94 authors, and succeeded in 12 cases. On average, 74% of their publications did not include suffixes, indicating that including suffixes into the PsycINFO query would unnecessarily limit authors' amount of publications. Thus, we dropped the suffixes. Furthermore, the last names of 5% of the SIOP members included special characters. These special characters fell into two categories. If SIOP members had a double-barreled name (e.g., hyphen, blanks, or even brackets), we manually searched for all possible combinations. If necessary, we used several OR combinations for one SIOP member. Moreover, we ensured that PsycINFO was able to process queries that included certain other special

characters (e.g., umlauts, accents). Our comparatively extensive procedure of generating the PsycINFO queries per author attempted to reach an optimal approximation of the real quantity of the author's output, while avoiding under- or overestimation of her or his publications.

For each SIOP member and each of her or his publication(s), we extracted the metadata from PsycINFO (cf. American Psychological Association 2012) which were relevant for this project (e.g., content classification codes, number of times cited in PsycINFO, the International Standard Serial Number [ISSN] of the journal etc.). Analyzing publications (citations) at the low level of individual authors, we relied on whole counting (e.g., Gauffriau et al. 2008; Javitz et al. 2010). More precisely, every publication (citation) counts as 1 for every writing co-author. Thus, if a publication was written (cited) by 10 colleagues, every writing co-author would receive 1 publication (citation) out of this publication. We are aware that whole counting is not without limitations but potential benefits from the alternative fractional counting are unclear in cases of low levels of analysis, whereas the main advantages of whole counting are clear (Waltman and Eck 2015): It does not punish collaborations and is easy to understand.

Variables

Gender. Information on whether a SIOP member was male or female[3] was either available in the SIOP list in the first place or we tried to obtain it by internet search (see Sample section for more information).

Status. There are six SIOP statuses available (e.g., Student Affiliate). Prospective members have to meet certain, mostly scientific requirements (SIOP 2015b). Regular members have to (a) also be a member/associate of another psychological association (APA, APS, CPA, or

[3] Although SIOP members' gender was either male or female in our data, we acknowledge the existence of more than two sex or gender categories (American Psychological Association 2011).

EAWOP), (b) hold a doctoral degree, and (c) engage in professional activities (e.g., research, practice). Rather than a doctoral degree, associates have to hold a Master's degree. International Affiliates have to meet all requirements for members/associates and have to live outside the US. Student Affiliates must be active (under)graduate students of I-O psychology and provide contact information of their advisor. Especially esteemed and outstanding SIOP members can be awarded with Fellow status. There is also a membership for retired former Members, Associates, International Affiliates, and Fellows.

Number of Publications. To measure publication output, we counted (full count method) the number of publications in PsycINFO of every SIOP member. The majority (74%) of publications were journal articles, of which the majority (98%) were published in peer reviewed journals. Unless otherwise noted, all publication types were included.

Publication impact. We used two measures for the impact of a SIOP member: (a) We calculated the average number of citations in PsycINFO across the member's publications. Citation count in PsycINFO was available for 21,093 publications (written by 2,865 researchers; 94% journal articles followed by 4% comments/replies), which allowed us to calculate the average citation count per SIOP member. (b) We added two-year Journal Impact Factor (JIF) values to our dataset. JIF values were taken from 2012 Journal Citation Report, Science Edition and 2012 Journal Citation Report, Social Sciences Edition (Thomson Reuters 2013a, 2013b). Thomson Reuters is the owning company of the Institute for Scientific Information, which in turn provides the JIF. Combining PsycINFO and Journal Citation Reports data was possible because both databases use ISSN numbers, which distinctly identify periodical publications (e.g., journals). JIF values were available for 32,520 publications (written by 3,304 researchers; 92%

journal articles followed by 4% comments/replies), which allowed us to calculate the average JIF per researcher[4].

Publication career length. To measure the length of the publication career (in years), we calculated the span between an author's first and last publication. As 2013 is the last year of data collection rather than the end of a researcher's publication career, we included only SIOP members with publications no later than 2012 (i.e., n = 1,620 were not included).

Publication career disruption. To measure publication career disruption length (years), we calculated the longest span between two consecutive publications of an author; 1,097 authors with only one publication and 116 authors with implausibly long disruptions (longer than 19 years, $M_{\text{disruption}}$ = 25.67) were not included.

First authorships. To measure first authorships, we calculated how often (in absolute and relative terms) a SIOP member was first author of her or his publications.

Research topics. To operationalize the research topics within psychological and I-O psychological research, respectively, we individually calculated for every SIOP member the relative frequency of each of the 22 major classification categories and the seven classification subcategories of the major classification category "Industrial & Organizational Psychology" (American Psychological Association 2009a), respectively. For example: If all publications of an author were described by a total of 50 classification categories, of which 10 belong to "Psychometrics & Statistics & Methodology", the relative frequency for the latter would be .20.

Research focus. To operationalize the research focuses within psychological and I-O psychological research, respectively, we individually determined for every SIOP member the

[4] We are aware that calculating individual researchers' JIF has been rightfully criticized (e.g., Moed 2002). We discuss this issue in detail in the Limitations section.

major classification category and the classification subcategory of the major classification category “Industrial & Organizational Psychology” (American Psychological Association 2009a), respectively, that is assigned the most often to its publications. For example: If all publications of an author were described by a total of 50 classification subcategories of the major classification category “Industrial & Organizational Psychology”, of which 10 belong to “Occupational Interests & Guidance”, 10 to “Personnel Management & Selection & Training”, and 30 to “Personnel Evaluation & Job Performance”, the I-O psychological research focus of this author would be “Personnel Evaluation & Job Performance”, because this subcategory appears most often among the classification subcategories (i.e., .60). Of the total sample, 22% authors were not included because they had not authored any “Industrial & Organizational Psychology” publication. As one reviewer noted, the fact that 933 SIOP members (47% female) have authored on average 4.41 publications but none on I-O psychological topics might require some explanation. The majority of those authors are regular (44%) or student (39%) members. As might have been expected, those authors are authors who work in adjacent areas that are relevant for I-O psychology, such as, “Psychological & Physical Disorders” (12%), “Health & Mental Health Treatment & Prevention” (12%), or “Psychometrics & Statistics & Methodology” (11%).

Results

Table 1 provides a first insight into the results by showing the correlations between all relevant variables. Authors’ publication output (i.e., total number of publications) is positively but only weakly correlated with the number of citations (r = .12) and its average JIF (r = .09). With regard to the number of first authorships, the table reveals an interesting finding: The absolute number of first authorships (which can be considered as a by-product of publication

output) is, in line with expectation, highly correlated with publication output (r = .90). However, there is only a weak negative correlation between output and the percentage of first authorships (r = -.10), which is a rather qualitatively measure of publication output. Publication output has a strong relationship with publication career length (r = .67), but only a slight correlation (r = -.05) with the maximum length of publication career disruptions (i.e., phase without publications). The rather modest correlation between the two measures of publication impact ($r_{\text{no. of citations, JIF}}$ = .21) calls into question the suitability of an author's average JIF for measuring its research impact. The correlations between the two measures of publication impact and the two measures of first authorships are surprisingly small ($-.04 \leq r \leq .12$). The length of an author's publication career does not seem to be a beneficial factor either for being often cited ($r = .03^{ns}$) or for average publication impact ($r = .04^{ns}$).

Table 2 shows results of the tests of the first research questions. With regard to RQ1, the test reveals that male researchers, who (co-)authored on average 13.41 publications, produce 1.65 times more publications then female researchers (d = -0.31), who (co-)authored on average 8.14 publications.

In the case of publication impact, the results are heterogeneous. Male authors' publications are cited 1.21 times more often than those of women, meaning that RQ2 can be answered in the affirmative. However, there is no gender difference with regard to the authors' mean JIF (RQ3). Thus, men and women do not differ in terms of the prestige of their publication channels ($1-\beta_{d = .20}$ = 0.99991).

Although male researchers are 1.79 times more often first authors (absolute frequencies, RQ4a), the gender difference with regard to the percentages of first authorships (relative to publication output, RQ4b) is modest (1.11 times, d = -0.16).

RQ5 and RQ6 asked whether there are gender differences with regard to the length of publication career and the maximum length of publication career disruptions, respectively. As can be seen in Table 2, male researchers pursue their publication careers for a longer time (1.83 times, d = -0.44), meaning that RQ5 can be answered in the affirmative. Table 2 also shows that women have shorter publication career disruptions (i.e., the maximum lengths of time without publications are shorter, .81 times, d = -0.24), which answers RQ6 in an unexpected way.

Figure 1 depicts the distribution of (I-O) psychological research topics of both genders. A visual inspection of Figure 1a reveals only two gender differences in psychological research topics (RQ7a). First, male researchers' publications are more often classified as "Psychometrics & Statistics & Methodology"—which perhaps reflects rather prototypical topics according to Su et al.'s (2009) "things" pole ($\Delta_{female\text{-}male}$ = -3%). Second, female researchers' publications are more often classified as "Industrial & Organizational Psychology" ($\Delta_{female\text{-}male}$ = 4%). Figure 1b depicts the distribution of I-O psychological research topics (RQ7b). As can be seen, "Personnel Management & Selection & Training" ($\Delta_{female\text{-}male}$ = -3%) and "Personnel Attitudes & Job Satisfaction" ($\Delta_{female\text{-}male}$ = 3%) seem to be the only I-O psychological research topics that give further support to Su et al.'s (2009) "Men and things, women and people" (p. 859) hypothesis.

Next, we distinguish between the two genders with regard to their research focuses, within psychological research topics (RQ8a) and I-O psychological research topics (RQ8b), respectively. Echoing the results on research topics, Table 3 reveals that (a) "Psychometrics & Statistics & Methodology" is the only psychological research focus (RQ8a) with an at least slight gender difference, and that (b) "Personnel Management & Selection & Training" and "Industrial & Organizational Psychology (General)" are the only I-O psychological research focus (RQ8a) with an at least slight gender difference ($|\Delta_{female\text{-}male}| \geq 3\%$).

Additional Analysis

In order to get a glimpse of future developments in the field of I-O psychology, we repeated all analyses with the student subsample[5] ($n_{\text{student members}}$ = 827, 58% female) with their 3,801 publications; the same inclusion criteria were applied. Table 4 shows the main results. In contrast to the full sample, there was only one significant gender difference for any of the first six research questions ($-2.09 \leq t \leq 0.11$). Visual inspection of bar charts revealed no gender differences with regard to the psychological research topics (see Figure 1c) and slightly more gender differences than in the total sample with regard to the I-O psychological research topics (see Figure 1d): Male students' publications are more often classified as "Industrial & Organizational Psychology (General)" ($\Delta_{\text{female-male}} \geq -6\%$), whereas female students' publications are more often classified as "Personnel Attitudes & Job Satisfaction" ($\Delta_{\text{female-male}} \geq 3\%$) and "Working Conditions & Industrial Safety" ($\Delta_{\text{female-male}} \geq 4\%$).

Although broadly echoing the results of the total sample, students were slightly more heterogeneous with regard to research focuses (see Table 5): The research focuses of male researchers were more likely to lie in the psychological research topics of "Psychometrics & Statistics & Methodology" ($\Delta_{\text{female-male}} = -5\%$) and "Human Experimental Psychology" ($\Delta_{\text{female-male}} = -3\%$), while the research focuses of female researchers were more commonly found in the psychological research topics of "Social Processes & Social Issues" ($\Delta_{\text{female-male}} = 3\%$) and "Health & Mental Health Treatment & Prevention" ($\Delta_{\text{female-male}} = 3\%$). In comparison to the total sample, the student sample also revealed slight differences in the gender-specific emphasis of I-O psychological research focuses: Males' research focuses were more frequently found in

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[5] Analyses for RQ1-RQ6 were also repeated with the subsample of peer-reviewed journals. The results matched those of the full sample.

"Industrial & Organizational Psychology (General)" ($\Delta_{female\text{-}male}$ = -4%) and "Personnel Evaluation & Job Performance" ($\Delta_{female\text{-}male}$ = -3%), while females' research I-O psychological research focuses lay more in "Personnel Attitudes & Job Satisfaction" ($\Delta_{female\text{-}male}$ = 4%) and "Working Conditions & Industrial Safety" ($\Delta_{female\text{-}male}$ = 3%). In the student sample, evidence in favor of Su et al. (2009) is also rather weak.

Discussion

The aim of this study was to examine gender differences among researchers within a comprehensive sample of researchers in one field of psychology (i.e., I-O psychology) with regard to (a) scientific productivity (number of publications, impact, first authorships), (b) publication careers (length, disruptions), and (c) fields of research (topics, focus). Overall, the results of this study show that there are indeed several gender differences. These differences confirm concerns (e.g., smaller number of publications authored by women) but also question them (e.g., longer publication career disruptions among men) and point out their complexity.

Regarding the quantity of publications, we found that male I-O psychologists outperform female I-O psychologists. There were significantly more women among the excluded SIOP members without any publications female (60%), but male psychologists had also written an average of thirteen publications, and female psychologists only eight. This rather conservatively estimated effect[6] is consistent with much previous research in psychology and other fields (e.g., D'Amico et al. 2011; Garg and Kumar 2014; Larivière et al. 2013; Malouff et al. 2010; Prpić 2002). Given the gender balance in SIOP and the attractiveness of psychology for female students (e.g., D'Amico et al. 2011), our clear finding can be considered as surprising and a

[6] As one reviewer correctly pointed out, excluding mostly female researchers who have not published yet from the sample could even underestimate the true gender differences in scientific productivity.

future societal challenge if viewed from the standpoint that society should achieve (at least more) gender equality.

However, quantity of publications should surely not be the only criterion, and we thus used four other indicators for measuring scientific performance: the average JIF per researcher, the number of citations, the number of first authorships, and the percentage of first authorships. These four indicators show a more complex picture. We found no significant differences between the two genders for the average JIF per researcher, only slight differences in favor of men for the number of citations and the percentage of first authorships, and a clear male advantage regarding the number of first authorships. The latter can be attributed to the general dominance of male authors in our sample, because number of publications and number of first authorships were correlated at .90. The other three indicators suggest no or only weak differences, which implies that the impact of female authors in I-O psychology is fairly similar to that of their male counterparts (cf. Borrego et al. 2010; Sotudeh and Khoshian 2014).

Furthermore, when we restricted our analyses to the student members of SIOP – in other words: to the future main players in the field – nearly all gender differences disappeared. This was even the case for the number of publications (for which we found a Cohen's *d* of .31 for the full sample) and despite a large sample size of 827 authors. If this is taken as an indicator of how the field might develop, it appears that the future of the field could become more gender-balanced. Such a development is also consistent with other scientometric studies (e.g., van Arensbergen et al. 2012, but see Barrios et al. 2013).

The idea of a male majority in the old days and a trend towards gender equalization in I-O psychology is supported by two more post-hoc analyses: (1) Roughly eliminating possible effects of having more male (than female) experienced senior researchers and more female (than

male) young researchers, we examined the subsample of 797 of today's SIOP members who began their research publication careers (year of first publication) in 2000-2005. In this subsample, only the absolute amounts of publications ($d_{\text{female-male}}$ =-0.28) and first authorships ($d_{\text{female-male}}$ = -0.28) revealed significant gender differences. (2) Examining the years when today's SIOP members' publication careers began, an interesting pattern was revealed (Figure 2): Until the 1990s, the majority of those beginning a publication career in the field were male. However since the 2000s onwards, there have been more females. Both of these findings might be considered as evidence for a more gender-balanced I-O psychology in the future. Nevertheless, yesterday's clear male prominence might have been sufficiently large enough to cause today's greater number of publications/first authorships of male researchers (i.e., more experienced senior male researchers, longer publication careers).

Similarly, our study revealed only very small differences in research topics and research focuses of female and male I-O psychologists. The overall picture therefore does not seem to confirm the "Men and things, women and people" hypothesis of Su et al. (2009, p. 859) regarding interest differences, although the slight male preference for statistical topics could be interpreted in favor of this hypothesis if we were to cherry-pick only this result. Su et al.'s meta-analysis is based on huge sample size of half a million people, and we thus do not wish to question their results, but it is possible that there are no pronounced gender differences in choice of research topics and focuses within one field (i.e., I-O psychology), even if it covers many and such diverging topics (from burnout to lying in job interviews to cross-cultural teams).

Our data additionally allowed for an analysis of gender differences with regard to the courses of the publication careers of I-O psychologists. This is important because gender differences might be driven by the traditional role expectation that it is the mother rather than the

father who is responsible for childcare (Rhoads and Rhoads 2012). However, in our full sample, the results were inconsistent: Whereas male authors had longer publication careers, publication career disruptions were also longer among male authors, which is contrary to what might be expected. We can only speculate about the reasons for this latter finding, but it is possible that academic career disruption in I-O psychology might be used not only for childcare but also for working in industry or consulting; those reasons, of course, could also be gender dependent (e.g., H. Prozesky 2008). Given the adherence of the field of I-O psychology to the scientist-practitioner model, switches between academia and practice are reasonably common.

Limitations

Like all studies, this study has limitations that need to be mentioned. First, we retrieved publications using name-based queries, a strategy that has the disadvantage of possible name ambiguities (cf. Moed 2002; Tang and Walsh 2010). However, ambiguities can be assumed to be only a minor problem for this study, because SIOP members (i.e., authors) themselves put their names in the division's member list and their names are thus probably correctly spelled and chosen in a way that maximizes visibility and disambiguity. Moreover, publication data were collected in PsycINFO, the unquestioned main resource for international psychology (García-Pérez 2010). Thus, the likelihood of having authors with the same name is further reduced, in comparison to collecting data in databases that cover a rather heterogeneous field of disciplines. Finally, relying on PsycINFO, we were able to include surname, first name, and if available even initials. Name ambiguity (i.e., homonyms) would have needed authors who share both surname and first name. Thus, the problem of name ambiguity is more problematic in databases that force users to send rather ambiguous queries, for example surname and initials (e.g., Milojević 2013). However, we also took several other steps to further improve the precision of our dataset.

Second, the use of only one main database (i.e., PsycINFO) could be seen as limitation (e.g., Moed 2002). Indeed, there might be cases where publications of an author are not fully indexed in PsycINFO (e.g., authors who work in a strongly interdisciplinary manner; see also García-Pérez 2010). However, previous studies show that this seems to be only a minor problem in I-O psychology (e.g., Bowling and Burns 2010; Landers 2009; Tubr et al. 2001), whose typical representative is a SIOP member.

Third, several authors have warned against relying unquestioningly on JIF (e.g., Opthof 1997; Roediger 2013). Applying JIF to evaluate the impact of individual authors has been subject to even more criticism (e.g., Moed 2002; Opthof 1997). However, the use of researchers' average JIF is still not uncommon in academia (cf. Arencibia-Jorge and Rousseau 2009). Thus, we decided to mainly rely on average citations per publication in PsycINFO (cf. Adams and Simonson 2004; Anderson 2006; Schui and Krampen 2010) and use average JIFs to supplement and contrast.

Forth, one may object that the results of our study have limited validity for non-US I-O psychologists. As we stated previously, only 6% of SIOP members were international affiliates—probably mostly scientists. Thus, it remains to be tested how much our results generalize to I-O psychologists samples from other countries. However, it should be kept in mind that I-O psychology strongly orients itself to the US – a phenomenon that has regularly been described (e.g., König and Melchers 2005) and often lamented (e.g., Üsdiken and Wasti 2009).

Fifth, as one reviewer correctly pointed out, an author can have more than one last name. Different last names for one author do not exclusively imply inconsistencies (i.e., *allonyms*) but also married names (White 2001) when one spouse takes the other's last name – sometimes without indicating it by a double-barreled last name. If scientometrics solely relied on the former

last name, they could wrongly conclude that the author's publication career has ended. This is also why last name changing is an important issue for scientometrics as well as for scientists (e.g., appointments). In non same-sex marriages, women often feel oblige to take their husbands' last names, with the possible adverse consequences for their scientific careers (e.g., Lee, 2012).

Future Research

This study makes important contributions to the examination of gender differences in research and could also be a stepping stone for future research ideas. While we relied on a rather common operationalization of researchers' publication output and impact, future studies should use broader measures of these constructs in order to further specify possible gender differences. In particular, so-called "altmetrics" could be used (e.g., Priem 2013, p. 438). For example, Aguinis et al. (2014b) recommended several other potentially fruitful sources for impact indicators, such as paper downloads, invitations to events, amount of funding, and followers on social media.

Future research should also test the generalizability of our results. First, it should be examined whether the pattern of gender differences found in I-O psychology research holds true for other disciplines in psychology. Scientometric analyses among other divisions of the American Psychological Association could be the next step. According to Larivière et al. (2013), gender differences might be emphasized in disciplines where research is especially expensive. In I-O psychology, research is comparably inexpensive, but this might be completely different in disciplines such as experimental psychology or neuropsychology, which often require special laboratories or certain imaging systems for their work. Furthermore, the generalizability of our results could be tested by using other databases. To increase the completeness of citations, García-Pérez (2010) proposed an iterative three-step strategy of data collection in different

databases. Thus, future studies could also test their incremental utility for understanding gender differences. Finally, as one reviewer pointed out, the temporal generalizability of our results could be tested. Given the fact that PsycINFO covers publications from the 1800s on (American Psychological Association 2015), it would be possible to examine longitudinal developments of gender differences in I-O psychological research by applying the analysis approach of this study to every annual SIOP member sample since SIOP's establishment in 1982 (SIOP 2015a).

Although our large dataset enables us to document gender differences among female and male scientists, future research should test the reasons for these differences. Henderson et al. (2014) suggested that discrimination could cause gender differences, whereas Ceci and Williams (2011) questioned the relevance of discrimination and emphasized the role of women's decisions—whether they are made freely or constrained. Future studies could therefore aim at delving more deeply into the reasons, for example by accompanying scientometric data with a survey.

Conclusion

With data from the field of I-O psychology, our results show that gender inequality continues to be an important issue. If female authors are still underrepresented, at least with regard to the number of publications, it seems at least questionable whether the field is maximizing its human intellectual capital.

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Table 1

Means, Standard Deviations, and Correlations of Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Gender (female = 0, male = 1)	0.55	0.50							
2. No. of publications	11.02	17.78	.15 (n = 4,234)						
3. Mean no. of citations	19.58	35.92	.05 (n = 2,865)	.12 (n = 2,865)					
4. Mean JIF	2.53	1.99	.02[ns] (n = 3,304)	.09 (n = 3,304)	.21 (n = 2,761)				
5. No. of 1st-authorships	5.32	9.17	.16 (n = 4,234)	.90 (n = 4,234)	.12 (n = 2,865)	.07 (n = 3,304)			
6. Percentage of 1st-authorships	53.63	34.10	.08 (n = 4,234)	-.10 (n = 4,234)	.02[ns] (n = 2,865)	-.04[a] (n = 3,304)	.08 (n = 4,234)		
7. Publication career lengths	8.09	11.13	.21 (n = 2,614)	.67 (n = 2,614)	.03[ns] (n = 1,518)	.04[ns] (n = 1,809)	.64 (n = 2,614)	-.08 (n = 2,614)	
8. Max. length of publication career disruptions	4.33	3.75	.12 (n = 3,021)	-.05 (n = 3,021)	-.01[ns] (n = 2,577)	-.01[ns] (n = 2,838)	-.01[ns] (n = 3,021)	.14 (n = 3,021)	.57 (n = 1,612)

Note. JIF = Journal Impact Factor (Thomson Reuters 2013a, 2013b). Unless otherwise noted, correlations are significant at $p < .01$.

[a] $p < .05$.

Table 2

Gender differences with regard to number of publications, number of citations, impact factors, first authorship, lengths of publication careers, and publication career disruptions

	M_{female}	M_{male}	*t*	*df*	*d* [95% *CI*]
Do male and female SIOP members differ with regard to the …					
… no. of publications? (RQ1)	8.14	13.41	-10.09	4005.85	-0.31
(n_{female} = 1,920, n_{male} = 2,314)					[-0.37;-0.25]
… impact of their publications?					
No. of citations (RQ2)	17.59	21.23	-2.77	2848.88	-0.10
(n_{female} = 1,300, n_{male} = 1,565)					[-0.18;-0.03]
JIF (RQ3)	2.49	2.57	$-1.19^{n.s}$	3200.72	-0.04
(n_{female} = 1,488, n_{male} = 1,816)					[-0.11;0.03]
No. of 1st authorships (RQ4a)	3.72	6.66	-10.98	3847.93	-0.34
(n_{female} = 1,920, n_{male} = 2,314)					[-0.40;-0.28]
Percentage of 1st authorships (RQ4b)	50.71	56.06	-5.06	3966.45	-0.16
(n_{female} = 1,920, n_{male} = 2,314)					[-0.22;-0.10]
… course of their publication careers?					
Publication career length (RQ5)	5.54	10.14	-11.23	2492.97	-0.44
(n_{female} = 1,165 , n_{male} = 1,449)					[-0.52;-0.36]
Max. length of publication career disruptions (RQ6)	3.84	4.73	-6.65	3015.06	-0.24
(n_{female} = 1,347, n_{male} = 1,674)					[-0.32;-0.17]

Note. Unless otherwise noted, differences between M_{female} and M_{male} are significant at $p < .01$ (using Welch 's [1947] t-test). JIF = Journal Impact Factor (Thomson Reuters 2013a, 2013b). The unit of analysis is researchers.

Table 3

Gender differences with regard to research focus.

	Female	Male
Psychological research focus (RQ8a) (n_{female} = 1,920, n_{male} = 2,314)		
General Psychology	2.19%	1.30%
Psychometrics & Statistics & Methodology	6.72%	10.54%
Human Experimental Psychology	2.71%	4.24%
Physiological Psychology & Neuroscience	2.97%	2.16%
Developmental Psychology	1.72%	1.60%
Social Processes & Social Issues	2.76%	1.64%
Social Psychology	4.48%	4.88%
Personality Psychology	3.80%	4.02%
Psychological & Physical Disorders	4.22%	3.76%
Health & Mental Health Treatment & Prevention	5.47%	3.67%
Professional Psychological & Health Personnel Issues	1.41%	1.25%
Educational Psychology	3.07%	2.94%
Industrial & Organizational Psychology	**56.67%**	**54.80%**
Other	1.82%	3.20%
Research focus within I-O psychology (RQ8b) (n_{female} = 1,485, n_{male} = 1,816)		
Industrial & Organizational Psychology (General)	47.95%	43.78%
Occupational Interests & Guidance	2.49%	2.48%
Personnel Management & Selection & Training	11.31%	15.64%
Personnel Evaluation & Job Performance	5.12%	7.21%
Management & Management Training	7.95%	8.70%
Personnel Attitudes & Job Satisfaction	17.04%	14.37%
Organizational Behavior	5.99%	6.50%
Working Conditions & Industrial Safety	2.15%	1.32%

Note. The unit of analysis is researchers.

Table 4

Gender differences with regard to number of publications, number of citations, impact factors, first authorship, lengths of publication careers, and publication career disruptions in the student subsample.

	M_{female}	M_{male}	*t*	*df*	*d* [95% *CI*]
Do male and female SIOP student members differ with regard to the …					
… no. of publications? (RQ1)	4.36	4.93	-0.93[n.s]	712.19	-0.07
(n_{female} = 480, n_{male} = 347)					[-0.20;0.07]
… impact of their publications?					
No. of citations (RQ2)	6.30	7.37	-1.26[ns]	344.07	-0.11
(n_{female} = 317 n_{male} = 215)					[-0.29;0.06]
JIF (RQ3)	2.60	2.58	0.11[ns]	650.38	0.01
(n_{female} = 401, n_{male} = 290)					[-0.14;0.16]
No. of 1st authorships (RQ4a)	1.44	1.76	-1.35[ns]	674.53	-0.10
(n_{female} = 480, n_{male} = 347)					[-0.23;0.04]
Percentage of 1st authorships (RQ4b)	31.96	37.61	-2.09[a]	730.12	-0.15
(n_{female} = 480, n_{male} = 347)					[-0.29;-0.01]
… course of their publication careers?					
Publication career lengths (RQ5)	2.35	3.41	-1.71[ns]	235.19	-0.19
(n_{female} = 221, n_{male} = 139)					[-0.40;0.03]
Max. length of publication career disruptions (RQ6)	2.72	3.21	-1.59[ns]	374.25	-0.15
(n_{female} = 283, n_{male} = 199					[-0.33;0.04]

Note. Unless otherwise noted, differences between M_{female} and M_{male} are significant at $p < .01$ (using Welch 's [1947] t-test). JIF = Journal Impact Factor (Thomson Reuters 2013a, 2013b). The unit of analysis is student researchers.

[a] $p < .05$.

Table 5

Gender differences with regard to research focus in the student subsample.

	Female	Male
Psychological research focus ($n_{\text{female students}} = 480$, $n_{\text{male students}} = 347$)		
General Psychology	2.71%	2.02%
Psychometrics & Statistics & Methodology	4.38%	9.22%
Human Experimental Psychology	2.50%	5.48%
Physiological Psychology & Neuroscience	8.12%	8.36%
Developmental Psychology	2.29%	2.88%
Social Processes & Social Issues	5.00%	2.31%
Social Psychology	2.92%	2.88%
Personality Psychology	5.62%	5.19%
Psychological & Physical Disorders	8.54%	7.49%
Health & Mental Health Treatment & Prevention	10.62%	7.20%
Professional Psychological & Health Personnel Issues	1.67%	1.44%
Educational Psychology	5.00%	3.46%
Industrial & Organizational Psychology	**38.33%**	**37.75%**
Other	2.29%	4.32%
Research focus within I-O psychology ($n_{\text{female students}} = 266$, $n_{\text{male students}} = 196$)		
Industrial & Organizational Psychology (General)	43.23%	46.94%
Occupational Interests & Guidance	2.63%	3.06%
Personnel Management & Selection & Training	9.02%	9.18%
Personnel Evaluation & Job Performance	4.51%	7.14%
Management & Management Training	10.90%	10.71%
Personnel Attitudes & Job Satisfaction	19.55%	15.31%
Organizational Behavior	7.14%	7.65%
Working Conditions & Industrial Safety	3.01%	0.00%

Note. The unit of analysis is student researchers.

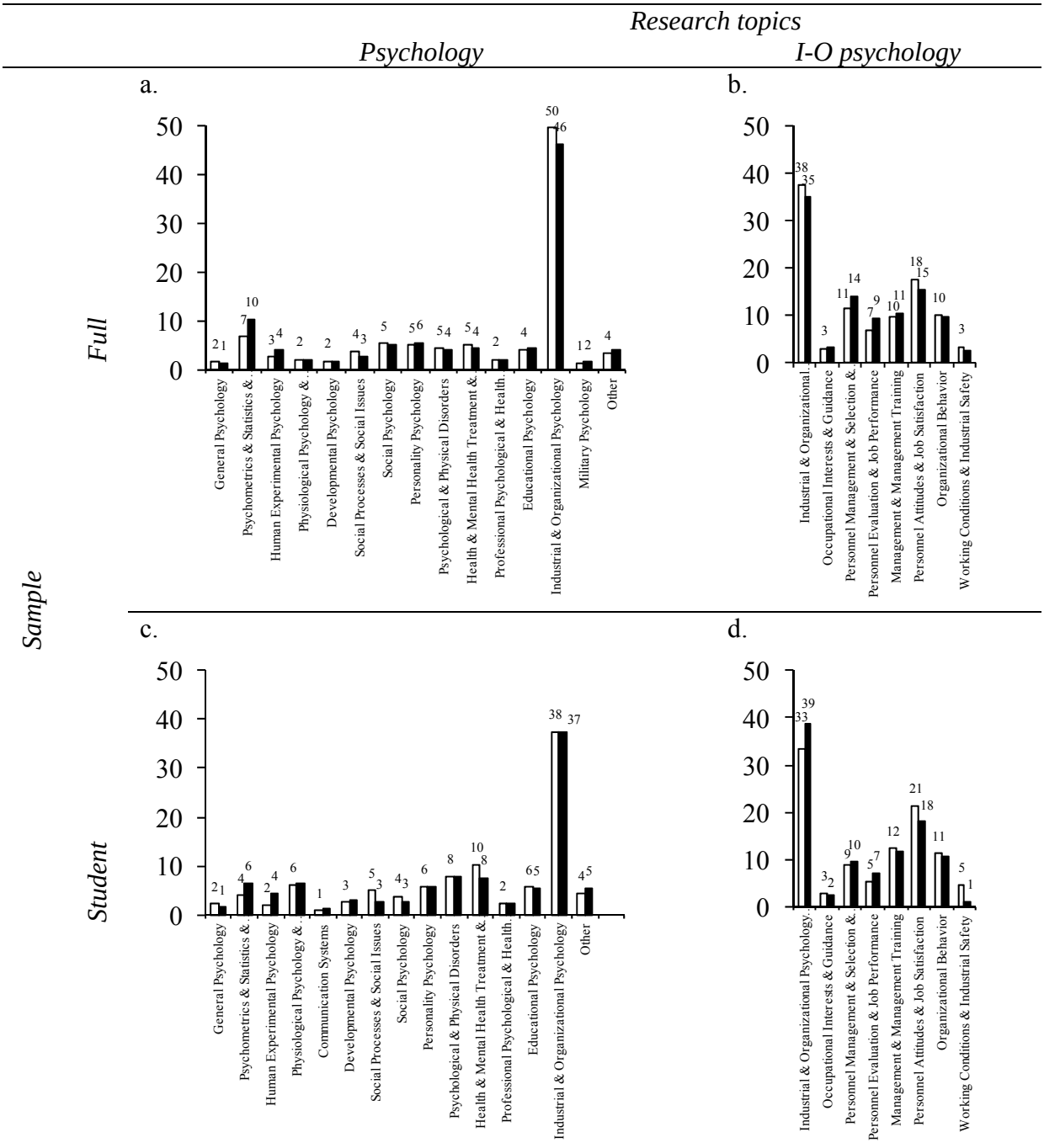

Figure 1. Gender differences (%, □ female, ■ male) with regard to psychological research topics in the full sample (a), I-O psychological research topics in the full sample (b), Psychological research topics in the student sample (c), and I-O psychological research topics in the student sample (d). Single values on bars indicate identical percentages for female and male researchers. The unit of analysis is research topics of each publication.

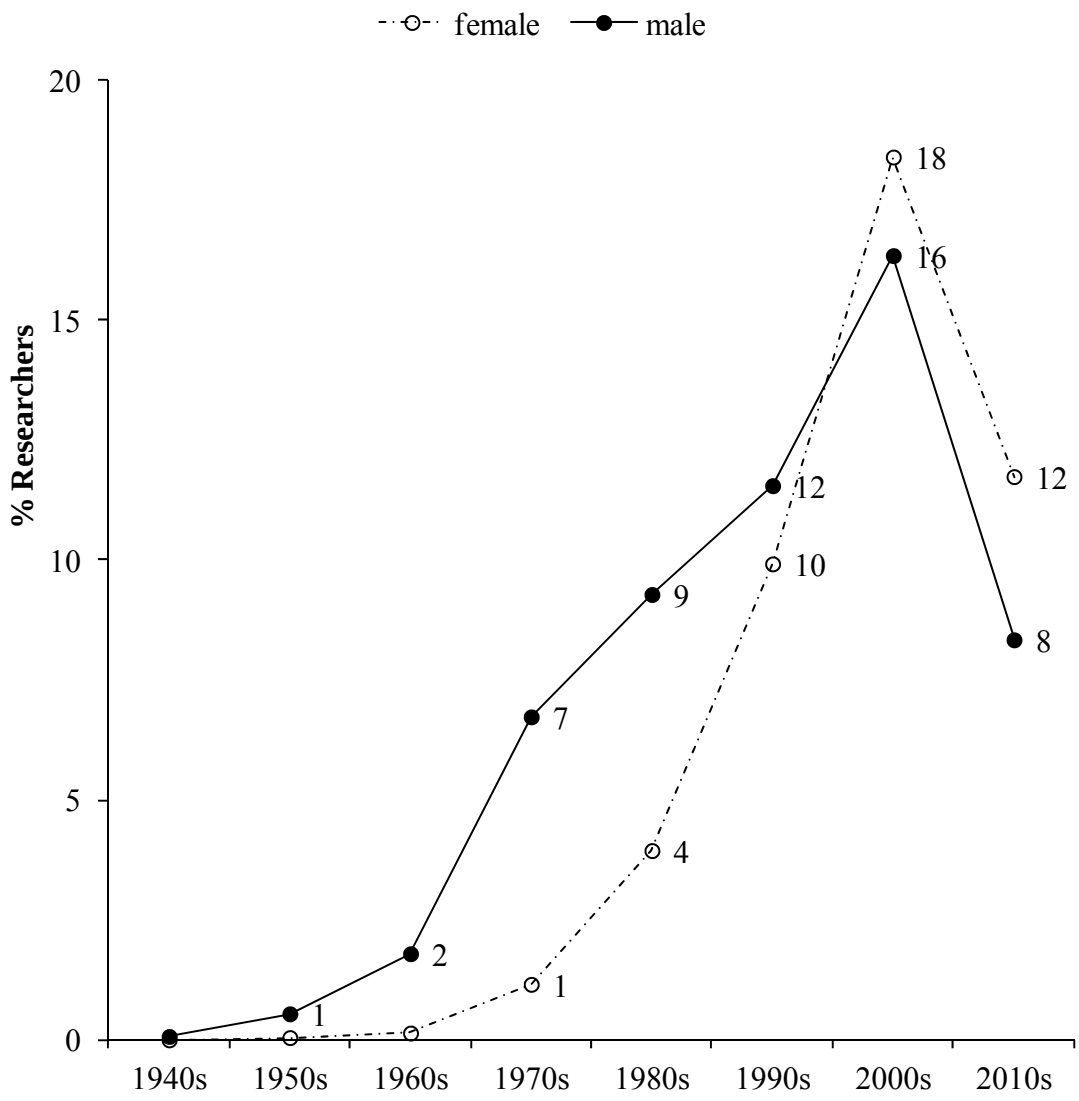

Figure 2. Gender differences with regard to publication career start (single values indicate identical percentages for female and male researchers; missing values indicate zero percent). The unit of analysis is researchers.