RUCH PRAWNICZY, EKONOMICZNY I SOCJOLOGICZNY
Rok LXXXV – zeszyt 4 – 2023
https://doi.org/10.14746/rpeis.2023.85.4.14

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REFERENCES TO SEX AND GENDER DIFFERENCES IN THE SOCIAL SCIENCES: ANALYSIS OF JOURNAL PUBLICATION RECORDS (1971–2021)[1]

ODWOŁANIA DO RÓŻNIC PŁCIOWYCH I GENDEROWYCH W NAUKACH SPOŁECZNYCH: ANALIZA PUBLIKACJI CZASOPISM NAUKOWYCH (1971–2021)

Based on the publication records of journal articles indexed in the Web of Science Social Sciences Citation Index, our analysis examines the underlying factors influencing the usage of 'sex differences' over 'gender differences' in Titles and Author Keywords. Our search query identified 16,362 articles published in 1971–2021 that use either of the phrases and have at least one of their Research Areas belonging to the Social Sciences. In concurrence with earlier research, we find a substantial shift towards using 'gender' in the 1980s. However, for records published after 1992, the Publication Year has a negligible aggregate impact on the likelihood of 'gender' over 'sex', although meaningful trend differences occur across subsets defined by article-level disciplinary associations. Using the available publication meta-data (Publication Year, Research Area, Publication Journal) as well as the results of topic modelling (LDA) on Titles and Abstracts, we implement multi-level regression modelling to demonstrate that the likelihood of referring to 'gender' rather than 'sex' is strongly influenced by article-level disciplinary associations and their topical classification. We find that Psychology articles, by far the most numerous, exhibit a lower propensity to use 'gender' than all the other Social Sciences, especially when collaborating with Life Sciences & Biomedicine.

Keywords: sex differences; gender differences; Web of Science; social sciences; topic modelling

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[1] The article was prepared within a research project 'Reflecting Europeanisation: cumulative data bases of cross-country surveys as a tool for monitoring European public opinion trends,' funded by National Science Centre, Poland, grant no 2018/31/B/HS6/00403 (2019.07.05–2023.07.04).

RPEiS 85(4), 2023: 275–297. *ISSN (Online) 2543-9170 ISSN (Print) 0035-9629*

Na podstawie archiwów publikacji artykułów indeksowanych w Web of Science Social Sciences Citation Index artykuł analizuje czynniki preferencji w używaniu zwrotu „różnice płciowe" wobec „różnice genderowe" w tytułach oraz słowach kluczowych wybieranych przez autorów. Nasza kwerenda zidentyfikowała 16 362 artykuły, które używają któregoś z tych zwrotów oraz są zaliczane do przynajmniej jednej z dziedzin badań związanych z naukami społecznymi i które zostały opublikowane w latach 1971–2021. W zgodzie z wcześniejszymi badaniami stwierdzamy znaczące przesunięcie w kierunku używania terminu „gender" w latach osiemdziesiątych. Jednakże dla artykułów opublikowanych po 1992 r. rok publikacji ma znikomy wpływ na prawdopodobieństwo użycia terminu „gender" zamiast „sex", chociaż znaczące różnice trendów występują w podzbiorach zdefiniowanych przez klasyfikacje dyscyplinarne na poziomie artykułu. Wykorzystując dostępne metadane publikacji (rok publikacji, obszar badań, czasopismo publikacji) oraz wyniki modelowania tematycznego (LDA) na tytułach i abstraktach, implementujemy wielopoziomowe modelowanie regresji, aby wykazać, że prawdopodobieństwo odnoszenia się do „gender" zamiast „sex" podlega silnemu oddziaływaniu asocjacji dyscyplinarnych na poziomie artykułu oraz ich klasyfikacji tematycznej. Stwierdzamy, że artykuły z psychologii, które pozostają zdecydowanie najliczniejsze, wykazują niższą skłonność do używania terminu „gender" niż wszystkie inne nauki społeczne, szczególnie przy współpracy z naukami o życiu i biomedycyną.

Słowa kluczowe: różnice płciowe; różnice genderowe; Web of Science; nauki społeczne; modelowanie tematów

I. INTRODUCTION

Investigating differences between men and women remains a vital topic of interest in the contemporary social sciences.[2] Convictions regarding those differences influence policy choices and individual behaviour patterns,[3] and their study constitutes one of the principal pathways to explain the social order.[4] However, especially yet not exclusively within the social sciences, researchers studying these differences face the dilemma of whether to account for them in terms of 'sex' (referring to biological differences associated with being male or female) or 'gender' (comprising the social and cultural differences associated with being man or woman). While such a juxtaposition seems to remain mainstream in social-scientific research,[5] it does not stand uncontested.[6] The choice of terms depends on several factors, including the established practices within particular research areas and the specific research questions.[7]

The mainstream terminological distinction between 'sex' and 'gender' boasts a long and contested academic pedigree. In the 1950s, it was first systematically spelt out in John Money's pioneering research on intersexuality.[8] Over the following decades, the distinction gained recognition in the psycho-

[2] Biernat, Deaux (2012); Fox et al. (2022).
[3] Hyde (2014).
[4] Poeschl (2021).
[5] Chrisler (2007); Helliwell (2018).
[6] Hood-Williams (1996).
[7] Belingheri et al. (2021).
[8] Money, Hampson, Hampson (1955): 302.

logical literature.[9] It also became incorporated into the feminist discourse,[10] with gender typically perceived as emancipatory: liberating from the apparent determinism of biology. The exposition of socio-cultural factors underpinning the constructs of femininity and masculinity would not typically amount to a straightforward rejection of biology. The emphasis would instead fall on the statement that 'biology is not destiny – that many of the apparent differences between women and men might be societally imposed rather than natural or inevitable'.[11] In the 1990s, the established 'sex' vs 'gender' distinction would come under sustained criticism from strongly constructivist positions. For instance, Judith Butler insisted that 'sex' is as culturally constructed as 'gender',[12] while Thomas Laqueur exposed the impact of historically changeable scientific worldviews on the understanding of both 'sex' and 'gender'.[13] Furthermore, the development of queer studies[14] and feminist biology,[15] which voiced resonant opinions that not only are the two categories socially constructed but are not even dichotomous.[16] Thus, from positions espousing strong constructivist assumptions, all differences would prove historically malleable in their socio-cultural definitions.[17] On the other hand, recent controversies over trans-gender identities and rights have pushed the interest in the sex-gender distinction to the forefront in some strands of feminist thought[18] as well as in Sport Studies.[19] Nevertheless, the mainstream distinction seems to have retained its intuitive appeal, especially in those research areas that do not focus on the discursive nuances and that have not adopted a critical approach to terminology.[20]

This paper investigates the usage patterns of the terms 'sex differences' and 'gender differences' in academic journal articles published over the last fifty years, based on publication records derived from the Web of Science Social Sciences Citation Index (WoS SSCI). The search query identified articles published in 1971–2021 associated with the Social Sciences containing the expression 'sex differences' or 'gender differences' in their Titles or Author Keywords. For this fifty-year time series, the query identified 16,362 usable records; however, the main thrust of our analysis focuses on the topics of 13,907 articles published after 1991. In addition to the research-query fields, the study also encompasses the Abstracts, classified into content clusters through topic-modelling, and selected meta-data provided in publication records: Publication Year, Research Areas and Publication Journal. The study

[9] Stoller (1968); Unger (1979).
[10] Oakley (1972); Rubin (1975).
[11] Crawford (2006): 26.
[12] Butler (1990); Butler (1993).
[13] Laqueur (1992).
[14] Medhurst, Munt (1997).
[15] Fausto-Sterling (1993).
[16] Carlson (2016); Costello (2020).
[17] Brickell (2006); Freud (1994).
[18] Hines (2019); Pearce, Erikainen, Vincent (2020).
[19] Hilton, Lundberg (2021); Torgrimson, Minson (2005).
[20] Helliwell (2018); Lips (2020).

addresses three research questions concerning the propensity to use 'sex differences' or 'gender differences' in academic journal publications: (1) How did the gender fraction of articles change over time in the social sciences in the period 1971–2021? (2) How did the disciplinary association of the article influence the likelihood of using 'gender differences' rather than 'sex differences'? (3) Is this likelihood differentiated by the topical classification of articles into content clusters? For research questions 2 and 3, the time frame of the analysis had to be restricted to the period 1992–2021 due to limitations in the WoS SSCI meta-data availability for earlier records.

II. USAGE OF THE TERMS 'SEX' OR 'GENDER' IN ACADEMIC DISCOURSE

Regarding the juxtaposition of 'sex' and 'gender', the evolving patterns of terminological usage have been studied through the historical records of academic publishing. Existing large-scale literature reviews have typically focused on the occurrences of generic terms 'sex' and 'gender' in the titles of academic papers. For example, Haig[21] performed a large-scale study of 30 million titles of papers indexed in the Web of Science (WoS) databases in 1945–2001, which identified 59,262 sex-containing titles and 29,941 gender-containing titles. It provided evidence for a substantial increase in the proportion of titles containing references to 'sex' or 'gender'. The analysis identified a steady decline in the sex-to-gender fraction originating in the 1980s, with the rise of gender especially pronounced in the WoS SSCI. The steady rise of references to gender has also been documented by studies focusing on specific disciplines of the social or life sciences, for example in psychological[22] or physiological journals,[23] or on the role of women in specific professional fields, for example in science and engineering.[24] Existing historical reviews of academic publications typically document the rising interest in the study of social phenomena from the vantage point of the differences between men and women as well as the steady rise of the popularity of 'gender' in such studies over time.[25]

Our study relies on the WoS SSCI database, covering over 3,400 journals across 58 social sciences research areas. We implement the established approach to journal article classification based on their Title and Author Keywords. An analysis could be attempted based on the broader WoS Core Collection, including a much larger representation of disciplines and journals. In such a scenario, restricting the study to articles associated with the Social Sciences would no longer seem warranted, and such an approach would exceed our interests and expertise. Reliance on titles for studying 'sex' and 'gender'

[21] Haig (2004).
[22] Muehlenhard, Peterson (2011).
[23] Torgrimson, Minson (2005).
[24] Fox et al. (2022).
[25] Eagly et al. (2012); Söderlund, Madison (2015).

usage patterns has a well-established place in literature,[26] based on the assumption that the title constitutes the primary attention-triggering content advertisement.[27] The inclusion of Author Keywords for article classification was motivated by the clear research interest in 'sex' or 'gender', which is not always explicitly advertised in the article's title. Based on the contents of the two fields, each article is classified as either using 'sex differences' or 'gender differences' (for details, see section III.2 and Online Appendix 2.2). While evidence exists that some authors could combine the use of different terms in the title and the body of the paper,[28] our analysis did not encompass the full texts and could not systematically verify such claims, but a cursory examination of our corpus deemed such instances incidental.

Our analysis introduces a new perspective by (1) restricting the search query to 'sex differences' and 'gender differences' rather than relying on generic searches for 'sex' and 'gender', (2) using the available WoS metadata on article-associated research areas to focus exclusively on publications within the Social Sciences (see section III.4), (3) applying topic modelling to article abstracts to classify them into distinct content clusters (see section III.5), and (4) implementing multi-level regression analysis to recognize the factors impacting the usage patterns in journal articles (see section III.6). Therefore, our study of the historical term-usage trends would consider both the disciplinary context of production and the substantive focus of research. The choice of restrictive rather than generic search query was crucial for our approach as the phrasal search made it possible to avoid the ambiguity resulting from situations when the two generic terms are not in free variation. For instance, whenever 'sex' refers to sexual acts, 'gender' is not available as a competing option. We considered extending our investigation to other terms, such as 'identity' or 'role', both of which seem to function in strong collocations with 'gender' (although there is no unanimity in the latter case).[29] However, by focusing on the phrases 'sex differences' and 'gender differences', the search is narrowed to cases when the author(s) have a choice of terms uncompelled by stylistic or grammatical requirements. Furthermore, we decided against including the Abstract field as the terms 'sex differences' and 'gender differences' routinely feature in empirical articles while listing control variables.

III. DATA AND METHODS

1. Data acquisition

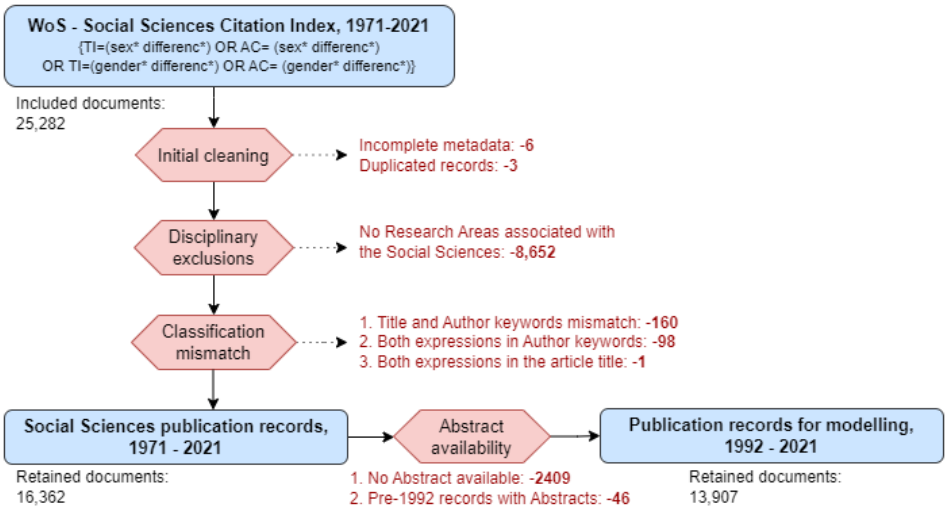
The search WoS SSCI yielded 25,282 publication records of Articles or Review Articles published in English from 1971 to 2021 (accessed 12 May 2022).

[26] Haig (2004); Whissell (2012).
[27] Milojević et al. (2011).
[28] Pryzgoda, Chrisler (2000).
[29] Chrisler (2007).

The records were selected based on the presence of phrases 'gender* differenc*' *OR* 'sex* differenc*' in the Title or Author Keywords (for details, see Appendix 2.1). The initial download was downsized in four steps (see Chart 1) based on metadata contents and availability (with details of the data preprocessing steps presented in the diagram below). Firstly, we filtered out 6 records with incomplete metadata (missing research area) and 3 duplicated records. Secondly, we removed 8,652 (34%) records without any Research Areas from the Social Sciences – with the bulk of those falling under the disciplinary categorization of Life Sciences & Biomedicine (see section III.4) for details regarding the Research Area – Discipline categorization of records). Thirdly, 259 records were removed for which unambiguous classification as 'sex differences' or 'gender differences' proved impossible (see III.3 for details). Following the first three steps, the corpus retained 16,362 article records for 1971–2021 (for descriptive analysis, see section IV.1). However, to implement topic modelling, the presence of an Abstract was necessary, which proved elusive in the pre-1992 records. In 1971–1991, only 2% of article records contained an Abstract; in 1992–2021, that was true of 99% of records. Therefore, a cut-off year was set at 1992 for the principal analysis, sacrificing time-series breadth for analytical depth. However, it is essential to note that this temporal cut-off seems to correspond with the stabilization in the fraction of articles using 'gender differences' (henceforth, gender fraction) following its precipitous growth from the early 1980s.

Chart 1

Publication records processing workflow



Source: the authors' elaboration.

2. Measures

The WoS SSCI provides metadata characterizing each publication record. Our analysis incorporates some of the information verbatim: Publication Year and Journal Title; other source variables undergo substantial transformations. Firstly, the dependent variable 'sex-or-gender' is computed based on the presence of 'sex differences' or 'gender differences' based on the contents of the Title and Author Keywords fields. An unambiguous assignment to either of the values allows for calculating aggregate gender fractions and gender likelihood ratios (see section III.3). Secondly, we compute the explanatory variable Discipline, which assigns each article to one of six categories based on the contents of their Research Area field (see section III.4). Thirdly, we implemented topic modelling on the contents of the Title and Abstract fields to classify each article into one of the thirty-one 'topics' identified by the Latent Dirichlet Allocation (LDA) algorithm (see section III.5).

3. Dependent variable: sex-or-gender

A regular-expression query of the Title and Author Keywords (for details, see the online supplementary materials) distinguished between five categories of papers: 1) consistent use of 'sex differences' (6,536), 2) consistent use of 'gender differences' (9,826), 3) expression mismatches in the title and author keywords (160), 4) the presence of both expressions in author keywords (98), 5) the presence of both expressions in the article's title (1). We only retained articles belonging to the first and second categories for quantitative analysis, as unambiguous classification allows for calculating aggregate gender fractions or odds ratios. The excluded instances of inconsistent usage proved infrequent (1.5%). In all nonparametric analyses, we use gender fractions: the per cent share of 'gender differences' articles within any given data cross-section. In turn, in parametric analyses, we use gender likelihood ratios: the odds ratio of using the term 'gender differences' over 'sex-differences'.

4. Explanatory variables: Publication Year and Discipline

The WoS metadata associates each publication with one or more Research Areas classified into five more general Disciplines.[30] Three of those disciplines have only a negligible presence: Arts & Humanities (106), Physical Sciences (60) and Technology (316), with Life Sciences & Biomedicine (6,272) and Social Sciences (20,252) accounting for the bulk of disciplinary associations. As already mentioned, to be retained in the corpus for analysis, an article must have at least one of its Research Areas from the disciplinary domain of the Social Sciences. Crucially, however, Psychology – a Research Area within the Social Sciences – is treated in our analysis as a Discipline of its own due to its outsized presence in the corpus. This terminological amendment allows

[30] Birkle et al. (2020); Singh et al. (2021).

for each record to be unambiguously classified into one of the six disciplinary clusters: 1) Psychology, 2) Psychology and Life Sciences & Biomedicine, 3) Psychology and Social Sciences, 4) Psychology and Social Sciences and Life Sciences & Biomedicine, 5) Social Sciences and Life Sciences & Biomedicine, and 6) Social Sciences.

Our analysis also incorporates the Publication Year as the second variable for explaining variability in gender fractions over time. In descriptive analyses, the Publication Year value features as provided by the WoS, but for modelling (see section III.6) the variable was recalculated by setting 1992 at 0.

5. The nested structure of the corpus: the classification of articles into latent content clusters using topic modelling

Based on the contents of the Title and Abstract fields of the corpus, a topic modelling algorithm assigned each article to one of the thirty-one distinct content clusters (topics). Topic modelling, a relatively recent advance in Natural Language Processing (NLP), employs Latent Dirichlet Allocation (LDA)[31] to discern common themes in a textual corpus and estimate their distribution across its constituent documents.[32] Our analysis uses a particular LDA approach, Structured Topic Modelling, implemented in the R environment[33] through the STM package.[34] In our analysis, the STM algorithm seeks a relatively low number of general topics, with the final model identifying 31 distinct topics (for details of parameter settings and data pre-processing, please consult Appendix 4.1–4.4). In the regression analysis, topic modelling results serve as document-level classifiers, with descriptive analysis provided in section IV.2.

6. Analytical approach

We implemented two complementary analytical approaches to analyse the effects of explanatory variables on gender fraction and gender likelihood ratio in the journal papers indexed in the WoS SSCI. The first (nonparametric) strategy is to graphically demonstrate the effects of Publication Year and Discipline on gender fraction by implementing generalized additive models with integrated smoothness estimation[35] as implemented in the R package ggplot2.[36] The second (parametric) approach uses logistic regression to test the effect of Publication Year and Discipline on the gender likelihood ratio. As we found the gender fraction to be likely similar within 31 distinct topics (see the results section IV.2), we used extracted topics to cluster journal articles

[31] Blei, Ng, Jordan (2003); Silge, Robinson (2017): 89–108.
[32] Baranowski, Cichocki (2021).
[33] R Core Team (2022).
[34] Roberts, Stewart, Tingley (2019).
[35] Wood, Augustin (2002).
[36] Wickham (2011).

and finally implemented the two-level logistic regressions specified below. The modelling was conducted in the R package lme4.[37]

We defined the dependent variable $sexORgender_{ij}$ such that $\mathrm{E}(sexORgender_{ij} = 1) = \pi_{1ij}$ is a probability of using 'gender differences' rather than 'sex differences' in paper i (level-1) within topic j (level-2), and $\mathrm{E}(sexORgender_{ij} = 0) = (1 - \pi_{1ij})$ is the probability of the opposite event. Additionally, we transformed the probabilities defined above by the implementation of the logit link function, where the logit coefficient $\eta_{ij} = \log(\pi_{1ij}/1 - \pi_{1ij})$ is the log of the odds of the event $sexORgender_{ij} = 1$ as opposed to $sexORgender_{ij} = 0$. We build our regression models step-by-step. We started with the null model (which excludes all explanatory variables from the regression), allowing us to assess the proportion of variance attributed to the paper's association with the topic (see the Intraclass Correlation Coefficient, hereafter ICC). Following Hox et al.,[38] we expressed the ICC as $\sigma_j^2/(\sigma_j^2 + 3.29)$, where σ_j^2 is a between-topic variance component. In Model 1, we assumed random intercepts at a topic level and fixed beta coefficient for two level-1 explanatory variables: Publication Year (with 1992 transformed to 0) and Discipline (with Psychology set up as a reference category). Finally, Model 2 adds the standardized fraction of articles associated (within each of the topic) with the Social Sciences as a level-2 contextual variable that aims to explain between-topic differences in the gender ratio. We defined the topic-level contextual variable as below:

$$\mathrm{SocScie\_z\_scored\_fraction}_j = \frac{\mathrm{SocScie\_fraction}_j - \mathrm{mean}(\cdot)}{\mathrm{SE}(\cdot)} \sim N(0;1) \quad (1)$$

where $\mathrm{SocScie\_fraction}_j$ is the fraction of articles with Social Sciences association within *j*-topic, mean(·) denotes the global fraction of Social Sciences association across all documents, and SE(·) is a standard error of the global fraction.

Our assumed multi-level mixed model 2 for paper i nested within topic j is as follows:

$$\eta_{ij} = \beta_0 + \gamma_{0j} + \beta_1 \times \mathrm{Publication\_Year}_{ij} + \beta_2 \times \mathrm{Discipline}_{ij} + \beta_3 \times \mathrm{SocScie\_z\_scored\_fraction}_j \quad (2)$$

where β_0 is the grand intercept, γ_{0j} represents between-topic random intercepts, and β_1, β_2, and β_3 are regression coefficients for the Publication Year, Discipline, and the within-topic standardized fraction of articles associated with the Social Sciences, respectively. The random effects are assumed to be mutually independent and normally distributed with a zero mean, such that $\gamma_{0j} \sim \mathrm{N}(0; \sigma_j^2)$.

[37] Bates et al. (2015).

[38] Hox, Moerbeek, Van de Schoot (2010).

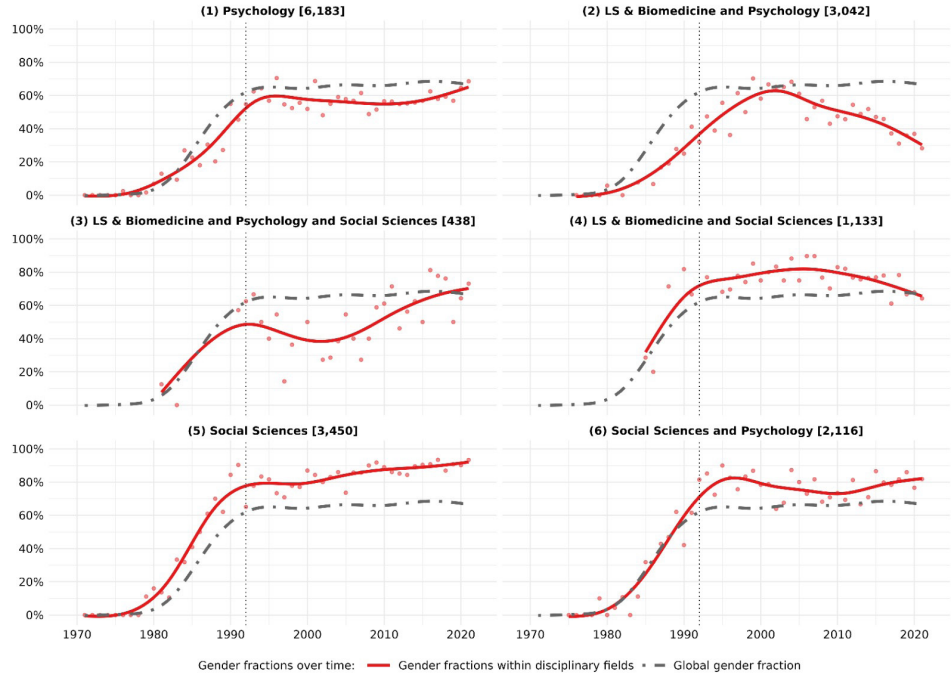
IV. RESULTS

1. Sex vs. gender differences across disciplines (1971–2021)

Graphs 1–6 presents the per-year gender fractions across disciplinary fields from 1971 to 2021. In each panel, the dots represent the gender fraction per year, with the solid trend line drawn using a local regression algorithm. The dashed grey trend line represents the global gender fraction, i.e., calculated for all disciplinary fields taken together. A vertical dotted line was added in 1992 to mark the inflexion point in the time-series trends. Years with fewer than five publications per disciplinary field were treated as missing to avoid calculating gender fractions biased by individual observations – resulting in the exclusion of 48 data points.

Graphs 1–6

Gender fractions across disciplinary fields – 1971 to 2021



Source: the authors' elaboration.

The time series breaks down into two distinct periods: 1) a precipitous rise of the gender fraction (from the early 1970s until the early 1990s), and the following 2) plateau of stability (from the early 1990s until 2021). In the first period, the gender fraction starts at zero in the early 1970s, with the relatively infrequent articles exclusively using the term 'sex differences'; however, only a few years

later, the term 'gender differences' is first registered, and in the 1980s, the gender fraction proceeds to move decisively upwards so that in the early 1990s articles using 'gender differences' begin to outnumber those using 'sex differences'. In the second period, however, the global gender fraction proves remarkably stable over time (with approximately two-thirds of all papers using 'gender differences').

The trend consistency of the global gender fraction results from the composition of distinct trends visible in particular disciplinary fields. For articles associated exclusively with the Social Sciences, a steady rise in the gender fraction continues after the early 1990s. Regarding Psychology, the post-1990s gender fraction of articles remains stable and below the global gender fraction. The trend is stable and above the global fraction whenever Psychology co-occurs with research areas from the Social Sciences. When it comes to articles with a mixed disciplinary association, an even faster and steeper decline in the gender fraction occurs whenever research areas from Life Sciences & Biomedicine co-occur with Psychology. Conversely, a mild downward trend features in cases of their co-occurrence with research areas from the Social Sciences. The cases of tripartite cooperation seem to constitute an apparent outlier; however, the overall number of articles with research areas from all three disciplinary fields remains very low, which results in a strong year-to-year variation in the observed gender fraction.

2. Classification of articles into latent content clusters (1992–2021)

The application of the STM algorithm identified 31 distinct topics in the documents based on their Titles and Abstracts. Topic modelling operates within the 'bag-of-words' paradigm,[39] whereby each document comprises an unordered list of tokens (words reduced to their semantic roots). A topic model comprises two output matrices of likelihood: 'beta' (token-over-topic) and 'gamma' (document-over-topic).[40] The beta matrix specifies token-topic linkage – as every token is assigned a probability of belonging to every identified topic. In practice, a topic is usually defined by a relatively small number of strongly associated tokens, with the probability assigned to most of the remaining tokens being close to zero. The set of high-beta tokens is the foundation for naming every topic in human-understandable terms. On the other hand, the matrix gamma links documents to topics – with the probability of prevalence in every document assigned to each topic. High-gamma documents play a secondary role in naming topics, as such lists of publications provide a topic consistency check. In using STM to classify the documents into distinct content clusters, we make a consequential assumption regarding the monotopicality of documents (i.e. the expectation that a single topic would likely be dominant within every document). This assumption follows from both the corpus characteristics (tokenized abstracts make for short and focused documents) and research aims (topical classification of journal articles). The top-

[39] Wallach (2006).

[40] Blei, Lafferty (2009).

topic approach assumes a singular document-topic association and does not differentiate those associations in terms of strength.

In Table 1, the top-tokens column lists eleven tokens most strongly associated with each topic based on token frequency and exclusivity.[41] In the manual-name column, we name the topics based on the top tokens and a manual inspection of documents and journals associated with each topic. The topic size provides the number of documents having the topic as its top association, and the gender fraction is the per-topic fraction of documents categorized as using 'gender differences'. The identified topics were analysed from the vantage point of their dominant disciplinary fields, using hierarchical clustering, which identified five distinctive groups. In the table, the group number is indicated by the first digit in the topic code, with the second digit representing the within-group enumeration. The clustering algorithm did not have access to per-topic gender fractions. However, due to apparent differences in the usage patterns across disciplinary fields, the resulting cluster-level gender fractions are substantially different: T.1 – Life Sciences & Biomedicine and Psychology (50.9%), T.2 – Life Sciences & Biomedicine and Social Sciences (74.9%), T.3 – Psychology (55.9%), T.4 – Social Sciences and Psychology (75.9%), T.5 – Social Sciences (84.3%).

The results summarized in Table 1 provide a snapshot of discourse regarding 'sex differences' or 'gender differences' in the Social Sciences. Section IV.3 investigates the relationship between disciplinary fields, article topics and gender fractions through a multi-level regression analysis. Nevertheless, the topic modelling provides more insights into the underlying discourse than could be expressed in the restrictive set of variables incorporated into regression. Accounting for other available meta-data (e.g., the journal of publication) aided by a manual examination of prominent publications enables a more nuanced picture of each disciplinary cluster of topics.

In cluster T.1, the mixing of the Life Sciences & Biomedicine with Psychology is evident in the topics and their corresponding gender fractions. Topic 1.5 – Animal testing and experimentation – features the lowest gender fraction (16.8%) as well as an exceptionally high concentration of articles in a single journal – *Psychology and Behavior* (42.5%). On the other hand, Topic 1.1 – Addiction and substance abuse – has a gender fraction of 76.4% and is dominated by two journals: *Addictive Behaviors* (16.3%) and *Substance Use and Misuse* (10.7%). While Topic 1.6 – Body perception and self-perception – has a similarly elevated gender fraction (75.8%), with *Sex Roles* (11.7%) and *Journal of Adolescent Health* (8.1%) serving as the leading journals. This heterogeneity of interests results from the multi-faceted nature of collaborations between Psychology and the different fields of the Life Sciences & Biomedicine. Conversely, in topics dominated by the mixing of the latter with the Social Sciences (cluster T.2), the range of common interests appears much narrower, as is the variation in the per-topic gender fractions. These collaborations mainly concern issues of public health and quality of life. Topic 2.4 – Risk in sexual behaviours – registers a very high gender fraction, with the *Journal of Adolescent Health's* publishing 14.6% of its associated articles.

[41] Bischof, Airoldi (2012).

Table 1

Summary of topic modelling results

Topics		Top tokens	Manual name	Size	Gender fraction
LS & Biomedicine and Psychology	T.1.1	cigarette, alcohol, drinking, cannabis, smoker, smoking, tobacco, substance, drug, addiction, gambling	Addiction and substance abuse	516	76.4%
	T.1.2	depression, depression_symptom, suicide, rumination, loneliness, suicide_ideation, somatic, caregiver, stress, stressor, symptom	Depression symptoms and consequences	438	71.5%
	T.1.3	trauma, autism, spectrum, adhd, posttraumatic, autism_spectrum_disorder, disorder, hyperactivity, posttraumatic_stress_disorder, autistic, ptsd	Trauma and neurodevelopmental disorders	514	53.1%
	T.1.4	cortisol, control, reactivity, delay, inhibition, motor, cognitive, eeg, healthy, function, impulsivity	Stress in neuropsychological contexts	232	33.6%
	T.1.5	rat, mouse, food, animal, extinction, female_rat, oxytocin, estradiol, rodent, receptor, novelty	Animal testing and experimentation	487	16.8%
	T.1.6	esteem, weight, body, shame, exercise, identity, dissatisfaction, eat, guilt, bmi, overweight	Body perception and self-perception	248	75.8%
	T.1.7	memory, hemisphere, word, lateralization, visual, cortex, semantic, brain, autobiographical, location, speech	Cognitive functions	524	29.6%
LS & Biomedicine and Social Sciences	T.2.1	attachment, friendship, quality, adult, age, adulthood, leisure, life, activity, close, life_satisfaction	Social relationships and life satisfaction	347	76.7%
	T.2.2	financial, twin, driver, environmental, decision, plan, drive, genetic, knowledge, sensation, entrepreneurial	Risk-taking attitudes	352	66.5%
	T.2.3	mortality, cancer, disease, patient, health, care, coronary, cardiovascular, hospital, diabetes, pain	Disease and health issues	624	71.6%
	T.2.4	HIV risk, religious, youth, protective, religiosity, injury, neighbourhood, infection, urban, prevention	Risk in sexual behaviours	266	85.0%

Tab. 1 (continued)

Topics		Top tokens	Manual name	Size	Gender fraction
Psychology	T.3.1	rotation, navigation, game, spatial, competition, player, mental_rotation, feedback, performance, virtual, task	Spatial orientation and mental rotation	604	54.1%
	T.3.2	mate, attractiveness, attribution, humour, hostility, evolutionary, style, sexism, tactic, advertisement, mate_preference	Mating preferences and practices	612	38.4%
	T.3.3	movement, hand, colour, testosterone, digit, infant, strength, length, toy, load, finger	Perceptual and motor skills	261	30.7%
	T.3.4	creative, efficacy, feminine, instrument, music, masculine, narcissism, thinking, evaluation, writing, version	Personality differences and psychometrics	228	65.4%
	T.3.5	math, stem _skills, belief, stereotype, mathematic, goal, science, implicit, engineering, worry, anxiety	STEM skills and stereotypes	309	78.3%
	T.3.6	moral, personality, psychological, neuroticism, dimension, extraversion, agreeableness, conscientiousness, meaning, tendency, conceptual	Personality traits	291	69.1%
	T.3.7	intelligence, reason, quotient, standard, ability, numerical, analytic, size, skill, matrix, gifted	Intelligence and skills	319	44.5%
	T.3.8	aggression, peer, adolescent, delinquency, aggression_behaviour, rejection, trajectory, prosocial, adolescent_boy, girl, adolescent_girl	Aggression and delinquency among youth	642	68.4%
	T.3.9	emotional, anger, facial, valence, disgust, affective, arousal, expression, picture, sensitivity, sadness	Emotions and their expressions	462	55.0%
Social Sciences and Psychology	T.4.1	empathy, couple, marital, conflict, marriage, wife, cope, husband, empathic, spouse, distress	Spousal relationships	272	81.2%
	T.4.2	sexual, infidelity, homosexual, gay, lesbian, heterosexual, harassment, intercourse, jealousy, consent, bisexual	Sexual orientation and experiences	564	63.7%
	T.4.3	sport, leadership, athlete, leader, professional, organizational, management, employee, team, burnout, career	Management and organizational leadership	444	84.2%
	T.4.4	mother, father, parent, child, daughter, preschool, son, letter, maternal, paternal, sibling	Parent-child interactions	485	69.7%
	T.4.5	offender, crime, victimization, criminal, violent, prison, violence, homicide, police, bullying, arrest	Violence, victimization and crime	458	81.0%

Topics		Top tokens	Manual name	Size	Gender fraction
Social Sciences	T.5.1	sleep, dream, narrative, content, character, topic, television, story, text, popular, voice	Dreams and cultural narratives	243	74.1%
	T.5.2	motivation, college, university, attitude, computer, female_student, male_student, student, learner, Asian, college_student	Student attitudes and behaviour	420	89.8%
	T.5.3	household, society, political, economic, retirement, feminist, parenthood, party, candidate, policy, family	Politics, economics and the household	589	81.3%
	T.5.4	black, wage, racial, ethnic, immigrant, earning, race, income, negotiation, white, employment	Race and ethnicity on the labour market	572	87.1%
	T.5.5	school, grade, teacher, elementary, secondary, classroom, reading, competence, grader, class, literacy	Educational achievements	646	86.4%
	T.5.6	intention, perceive, support, online, consumer, social_support, internet, norm, brand, network, perception	Internet usage and social networks	432	87.3%

Source: the authors' elaboration.

Cluster T.3, dominated by articles exclusively associated with Psychology, boasts the highest number of associated topics. Given their high diversity in terms of research focus, the resulting variation in their gender fractions should not seem surprising. The topical focus within this cluster comprises 'sex-' or 'gender-based differences' in various skills, personality traits and behaviour patterns. Only one of the topics – STEM skills and stereotypes – has a decidedly high gender fraction (78.3%), while other topics have gender fractions at or below the global average. The articles within the topics of this cluster tend not to concentrate heavily on one specific journal, but two journals have the most visible presence: *Sex Roles* (within top-5 journals in 7 out of 9 topics) and *Frontiers in Psychology* (within top-5 in 5 out of 9 topics).

When it comes to cluster T.4, comprising collaborations between Psychology and the research areas within the Social Sciences, the observed per-topic gender fractions are markedly higher than in cluster T.3. Just as in the case of cluster T.2, collaboration with the Social Sciences tends to increase the propensity for using the term 'gender differences' rather than 'sex differences'. Interestingly, however, in the topics of T.4, the journal *Sex Roles* is also highly prominent (present in 4 out of 5 top-5 journals), and only in the case of Topic 4.2 – Sexual orientation and experiences – another journal seem more prominent: *Archives of Sexual Behavior* (15,4%).

In cluster T.5, dominated by research areas from Social Sciences other than Psychology, an overwhelming majority of articles investigate 'gender differences' – only in the case of Topic 5.1 – Dreams and cultural narratives – does the gender fraction fall under 80%. Notably, this topic also has a relatively strong association with Psychology. Two of the topics in cluster T.5 relate to educational institutions, while others focus on critical social issues and practices. The journal 'Sex roles', again, plays a prominent role across most topics of this cluster.

3. Multi-level relationships between disciplines, topics and the use of 'gender differences'

Table 2 summarizes the results of the multi-level regression models, which account for the hierarchical structure of the analysed corpus of documents (with journal articles nested within content clusters, i.e., distinct latent topics) when assessing the impact of the Publication Year and Discipline on the gender likelihood ratio. The subsequent columns contain information about odds ratios (OR) estimated by three models (Null model, Model 1, and Model 2) specified in section III.6, with their respective standard errors of OR's estimators (SE).

In the Null Model, the ICC coefficient is equal to 0.2, which means that 20% of the total variation in the gender likelihood ratio is explained by nesting documents within the 31 topics. Hence, the document-topic association constitutes a significant component of the total variation. Compared to the Null model, adding level-1 characteristics in Model 1: Publication Year and Discipline, increases the predictive power of regression ($R^2 = 0.071$, with an

ICC decrease to 0.15). In Model 2, adding the within-topic percentage of papers associated with the Social Sciences significantly increases the explained variance ($R^2 = 0.177$, with a further ICC decrease to 0.10). Comparing Model 2 ICC to the Null, the Discipline and the standardized within-topic fraction of Social Sciences articles explain 50% of between-topic differences in the gender likelihood ratio.

Table 2

Multi-level regression results

Explanatory variables	Null model		Model 1		Model 2	
	OR	*SE*	*OR*	*SE*	*OR*	*SE*
Intercept	2.15***	0.355	1.76***	0.261	1.79***	0.224
Publication Year			1.00	0.003	1.00	0.003
Social Sciences [vs. Psych.]			3.26***	0.233	3.21***	0.230
Social Sciences and Psychology [vs. Psych.]			2.18***	0.153	2.17***	0.152
LS & Bio and Psychology [vs. Psych.]			0.77***	0.045	0.77***	0.045
LS & Bio and Social Sciences [vs. Psych.]			1.71***	0.152	1.69***	0.151
Social Sciences z-scored fraction within topics					1.05***	0.012
ICC	0.20		0.15		0.10	
N topics	31		31		31	
N documents	13036		13036		13036	
Marginal R^2 / Conditional R^2	0.000 / 0.202		0.071 / 0.210		0.177 / 0.261	
AIC	14634.257		14170.522		14159.568	

Note: *** $p < 0.001$.
Source: the authors' elaboration.

Concerning the impact of the document characteristics on the gender likelihood ratio, the results of Models 1 and 2 lead to convergent conclusions with only minor differences in regression parameters. We confirmed that Publication Year does not significantly impact the gender likelihood ratio. This result falls in line with our nonparametric analysis indicating the remarkable stability of gender fraction in the articles published in 1992–2021. Furthermore, regression results demonstrate that the likelihood of using the term 'gender differences' triples when the article is associated exclusively with the Social Sciences, doubles when the association is with the Social Sciences and Psychology, and almost doubles when the Social Sciences cooperate with the Life Sciences & Biomedicine (Psychology serves as the Discipline of reference). In turn, in papers where Psychology cooperates with the Life Sciences & Biomedicine, the odds of using 'gender differences' are significantly smaller. Ad-

ditionally, the Model 2 results demonstrate a positive impact of the within-topic percentage of papers associated with the Social Sciences on the gender likelihood ratio.

V. DISCUSSION

Our analysis suggests that the change in the popularity of 'gender differences' over 'sex differences' does not follow a uniform trend in the years 1971–2021. Regarding the global gender fraction for all WoS SSCI articles associated with the social sciences, the time series splits into two distinct periods. Until the early 1990s, a marked growth tendency in the gender fraction occurred, following the establishment of the distinction 'sex' vs 'gender' in the psychological literature[42] and feminist discourse, as well as the development of gender studies.[43] However, in the following years, the overall gender fraction holds steady. With a cut-off point set at 1992, the Publication Year does not significantly impact the likelihood of referring to 'sex differences' or 'gender differences'. This finding apparently contradicts some earlier research, which found evidence for continuing growth in the popularity of 'gender' over 'sex'. However, those earlier analyses[44] cut off their time series in the early 2000s, making the plateauing of the long trend challenging to diagnose. Furthermore, our analysis is not directly comparable to earlier studies due to the differences in search queries identifying publication records. Our empirical base was also restricted to article records associated with the Social Sciences. The overall stabilization of the gender fraction over time and the pronounced cross-disciplinary differences in usage patterns should be seen in the context of the ongoing efforts at standardizing discursive practices. Notably, when considering the temporal changes in terminological preferences, it is essential to account for the gradual incorporation of 'gender' as a category in stylesheets and publication guidelines.[45] For instance, focusing on the usage in the field of education research, Glasser and Smith[46] pointed out the impact of the manner of gender's introduction into the fourth edition of APA Guidelines from 1994, which promoted the broader use of gender in most contexts as the less ambiguous category. Regarding 'gender differences' specifically, Haig[47] pointed out that since the US Food and Drug Administration issued a guideline that studies must include 'gender differences' in all new drug applications (1993), the titles containing 'gender differences' would consistently outnumber those referring to 'sex differences' in the core WoS collection. However, despite disparate efforts at harmonizing editorial practices

[42] Basow (2010).
[43] Cranny-Francis et al. (2003).
[44] Haig (2004); Eagly et al. (2012).
[45] Torgrimson, Minson (2005).
[46] Glasser, Smith (2008).
[47] Haig (2004).

across academic publishing,[48] commonly accepted guidelines for using the terms 'sex' and 'gender' in research publications has yet to emerge. Explicit editorial policies remain rare at the journal level,[49] with notable exceptions of journals focusing on the study of sex- or gender-related issues.[50] Therefore, the lack of commonly accepted and well-defined guidelines means that the authors retain some leeway in their choice of terms.

The propensity to refer to 'sex differences' or 'gender differences' proves strongly associated with the disciplinary fields within which a journal article is published. Our analysis strongly indicates that the global time trend comprises different trends within disciplinary clusters. For articles exclusively associated with the Social Sciences, the rise in the gender fraction continues even after the early 1990s. For exclusively psychological articles and those that combine Psychology with the Social Sciences, the trend remains flat. On the other hand, the trend for articles involving research areas from the Life Sciences & Biomedicine has sloped down in their collaborations with Psychology or the Social Sciences since the early 2000s. This descriptive finding finds support in the results of multi-level regression modelling. Our reliance on a broad disciplinary classification with five possibilities (the tripartite option of articles registering Research Areas from the Social Sciences, Psychology and the Life Sciences & Biomedicine was excluded from modelling due to very low incidence) supported the conclusion that association with the Social Sciences significantly increases the likelihood of referring to 'gender differences'. The association between the Life Sciences & Biomedicine has an inverse effect. This finding is not surprising, as the differences the Social Sciences focus on tend to involve socio-cultural patterns and their reproduction. The use of broad disciplinary classification rather than the available information on specific research areas within disciplines constitutes an explicit limitation of our analysis. However, given the amount of data at our disposal, including research-area level information in modelling was impractical. For instance, in the Social Sciences, a substantial fraction of the declared research areas are infrequent or classified as 'other topics' in the WoS records. Therefore, the analysis would have to be restricted to the most frequent research areas, as the 'other' category would be heterogenous concerning terminological practices.

The likelihood of using 'gender differences' is strongly differentiated by the content clusters determined by topic modelling. At the descriptive level, this conclusion is supported by the results summarized in Table 1, where major differences in the gender fractions exist between topics. The lowest gender fractions occur in topics with a high association with the Life Sciences & Biomedicine: 'Animal testing and experimentation' (16.8%), 'Cognitive functions' (29.6%) and 'Stress in neuropsychological contexts' (33.6%). On the other hand, the highest gender ratios occur in topics highly associated with

[48] Heidari et al. (2016); Schiebinger, Leopold, Miller (2016).
[49] Fox et al. (2022).
[50] Frieze, Chrisler (2011).

the Social Sciences: 'Student attitudes and behaviour' (89.9%), 'Internet usage and social networks' (87.3%), and 'Race and ethnicity on the labour market' (87.1%). The regression model also suggests a strong link between content clusters and disciplines. In the null model, including only information on the document-topic association, a large amount of variation (ICC 0.20) is explained by this information only. However, the incorporation of information regarding disciplinary classification demonstrates strong discipline-topic correlations. In Model 1, a robust document-discipline association is attested; further, Model 2 proves the impact of the topic-discipline association. Including document-discipline and topic-discipline information decreases the variation explained by topic alone by half (ICC 0.10).

VI. CONCLUSION

The propensity to refer to 'gender differences' rather than 'sex differences' in articles published by journals associated with the Social Sciences proves to be strongly differentiated by their disciplinary associations. Regarding the fraction of articles using 'gender differences' over time, the trend splits into two distinct periods. The first encompasses the gender ratio rise from zero in 1970 to approximately two-thirds of articles in the early 1990s. In the second stage, however, the gender fraction holds steady over the next three decades. Underlying the overall stabilization in the usage, a marked differentiation of trends persists across academic disciplines. For articles with Research Areas classified exclusively as Social Sciences, a steady upward trend in the fraction of papers using 'gender differences' occurs even in the period 1992–2021; this trend is counterbalanced by a significant decline in the gender ratio for articles associated with the Life Sciences & Biomedicine and Psychology starting in the early 2000s. Psychology constitutes the most prominent Research Area focusing on 'sex differences' and 'gender differences', as more articles are associated with Psychology than all the other Social Sciences. Furthermore, its usage patterns sit between those of the Social Sciences and the Life Sciences & Biomedicine, which is also visible in its high rates of interdisciplinary collaborations. It also boasts the highest diversity of research interests, as evidenced by the many distinct topics. The overall dominance of Psychology may be an artefact of the composition of WoS SSCI, due to its sparse representation of journals geared towards the humanities. Nevertheless, our findings suggest that regarding the discussions of 'sex differences' and 'gender differences', Psychology should be treated as distinct from the other Social Sciences.

Using 'sex differences' or 'gender differences' proves strongly associated with the subject matter of journal articles. Topic modelling identified 31 distinct content clusters with markedly different gender ratios (ranging from the minimum of 16.8% to the maximum of 89.9%). These differences seem to reflect the likelihood that the articles belonging to a given topic would touch

upon biological rather than socio-cultural traits. For instance, low gender ratios occur in such topics as 'Animal testing and experimentation' or 'Mating preferences and practices' and, conversely, topics such as 'Race and ethnicity on the labour market' or 'Student attitudes and behaviour' have very high gender ratios. Given that the topical and disciplinary classifications remain closely associated, reflecting the diversity of research interests regarding 'sex differences' or 'gender differences', some degree of usage stabilization seems in evidence despite the absence of definitive editorial guidelines. The mainstream distinction between 'sex' and 'gender' appears to hold sway, with the post-1992 changes in usage patterns more likely attributable to the fluctuations in research interests than terminological choices.

Appendix and Replication files

To facilitate research openness, transparency and reproducibility, replication materials for analysis are available in this repository https://osf.io/vw49a/?view_only=3914f9473a394cc7adeab2cc9b371e19.

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