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Does writing style affect gender differences in the research performance of articles?: An empirical study of BERT-based textual sentiment analysis

Yongchao Ma[1,2] · Ying Teng[2] · Zhongzhun Deng[3] · Li Liu[4] · Yi Zhang[4]

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Abstract
"Achieve gender equality and empower all women and girls" is essential to reduce gender disparity and improve the status of women. But it remains a challenge to narrow gender differences and improve gender equality in academic research. In this paper, we propose that the impact of articles is lower and writing style of articles is less positive when the article's first author is female relative to male first authors, and writing style mediates this relationship. Focusing on the positive writing style, we attempt to contribute and explain the research on gender differences in research performance. We use BERT-based textual sentiment analysis to analyse 87 years of 9820 articles published in the top four marketing journals and prove our hypotheses. We also consider a set of control variables and conduct a set of robustness checks to ensure the robustness of our findings. We discuss the theoretical and managerial implications of our findings for researchers.

Keywords Gender · Gender inequalities · Female · Research performance · Marketing · SDGs · Writing style

Introduction

As one of the Sustainable Development Goals (SDGs), the SDG 5 (Gender Equality): "achieve gender equality and empower all women and girls" is essential to reduce gender disparity and improve the status of women (UnitedNations, 2015). On International

✉ Zhongzhun Deng
danieldeng@scu.edu.cn

Yongchao Ma
martin@hust.edu.cn; martin.mar@my.cityu.edu.hk

1 School of Management, Huazhong University of Science & Technology, Wuhan, Hubei, People's Republic of China

2 Department of Marketing, City University of Hong Kong, Hong Kong, People's Republic of China

3 Business School, Sichuan University, Chengdu, Sichuan, People's Republic of China

4 College of Public Administration, Huazhong University of Science & Technology, Wuhan, Hubei, People's Republic of China

Women's Day in 2021, Elsevier, a renowned information services provider, and publisher, released a report titled "Researcher Journey Through a Gender Lens," which shows that there are gender differences in scientific research (Elsevier, 2020). On the one hand, gender differences exist across various subject areas, but the extent of these differences varies. On the other hand, the gender differences between men and women vary between countries. Japan, for example, has larger gender differences in research performance than the United States and China (Elsevier, 2020).

Researchers have made considerable efforts to promote gender equality (Badar et al., 2014; Kou et al., 2019; Lopez & Pereira, 2021; Myers et al., 2020; Restrepo et al., 2021). However, previous studies on gender equality in academia have three limitations. First, we observe that academic achievement studies have primarily focused on science, technology, engineering, and mathematics (STEM) disciplines, while business disciplines receive relatively little attention (Gruber et al., 2021). Second, there has been extensive prior research on gender differences, but limited effort has been made to explain the underlying mechanisms. As of now, some factors have been suggested as contributing to these differences, including such as age, country, institution, productivity (Lopez & Pereira, 2021; Myers et al., 2020; Restrepo et al., 2021), as well as differences in language use (Lerchenmueller et al., 2019; Newman et al., 2008; Urquhart-Cronish & Otto, 2019). Previous studies have also examined gender differences in research performance, but they tend to focus more on revealing the phenomenon than explaining its underlying mechanisms. Meanwhile, only a few of those studies have concentrated on writing style and have addressed the relationship between author gender and writing style. There are no studies that have examined the relationship between writing style and research performance. Based on those studies about gender differences in writing style (Lerchenmueller et al., 2019), we address two research questions in this study in an attempt to explain the gender differences in research performance through writing style. Here are the research questions:

Research Question 1: Are there gender differences in the research performance of male and female academics in business?
Research Question 2: What role does article's writing style play in explaining the gender differences in research performance?

The academic status of female authors in marketing is also inferior to that of their male counterparts (Elsevier, 2020). We propose that the articles with female first authors have a lower impact than the articles with male first authors. Academics of different genders exhibit different levels of confidence in their academic work (Heath et al., 2022; Hoops et al., 2019; Meyerson et al., 2017; Sawdon & Finn, 2014). According to (Ehrlinger & Dunning, 2003), women express significantly lower confidence than men, and we thus propose that writing style of articles with female first authors is less positive than that of articles with male first authors. Finally, female authors use fewer positive words in their academic writing, and their writing style is less positive. Combined with the "self-confidence effect", self-confidence predicts success in the future (Meisha & Al-dabbagh, 2021). An article with a positive writing style reflects the writer's confidence, and one with a more confident expression is more likely to be approved by the reader. Therefore, we propose that the writing style mediates the positive effect of gender differences on research performance.

Using BERT-based textual sentiment analysis, an analysis of 86 years' worth of 9,820 articles from the top four marketing journals addresses these research questions. The results prove our hypotheses. We control for factors related to the articles' writing style and research impact, including many factors at the author level, article level, journal level,

and affiliate level, and conduct a set of robustness checks, further ensuring the robustness of findings.

Literature review and hypotheses development

Gender inequalities in academia

Due to gender differences, men develop their careers more rapidly than women (van den Besselaar & Sandstrom, 2016). Access to valuable resources is differentially distributed among male and female scientists (Shauman & Xie, 2003). Additionally, the increased participation of women in STEM fields has also led to larger gender differences relating to productivity and impact (Elsevier, 2017; Huang et al., 2020; van Arensbergen et al., 2012). Literature on gender differences in research performance suggests that men outperform women (Abramo et al., 2015).

In recent decades, the gender context of academic science has substantially changed, with more female scientists entering the field (Elsevier, 2017; Huang et al., 2020; Lariviere et al., 2013) and occupying high-level academic positions (Diezmann & Grieshaber, 2019; Zippel, 2020). However, gender imbalances are still evident in the production of knowledge (Dinu, 2021; Koseoglu et al., 2019). According to Paswan and Singh (2020), women's representation varies by field, with biology (37%) having a relatively higher percentage of female authors compared with engineering (20%), information science (21%), and mathematics (22%). The degree of gender differences varies fundamentally by discipline. There is still a significant underrepresentation of women in academic medicine and life science (Ha et al., 2021; Lerchenmueller & Sorenson, 2018; Lerchenmueller et al., 2019). Gender differences also persist in other disciplines. Ghiasi et al. (2015) report men produce 80% of all scientific production in engineering. Women in the biomedical field have fewer publications on COVID-19 (Muric et al., 2021). In addition, female authors and reviewers are underrepresented in entomology journals (Walker, 2020).

Bibliometric studies have focused on gender differences in academic performance. Despite this, these studies are rarely able to explain these phenomena in terms of their underlying mechanisms, sticking instead to revealing the characteristics of these phenomena. Additionally, these studies are focused primarily on engineering and medicine, with little emphasis on the business sector. This article focuses on the discipline of marketing in the business. The academic status of female authors in marketing is also inferior to that of their male counterparts (Elsevier, 2020). We propose that articles with female first authors have a lower impact than the articles with male first authors. Here is the hypothesis.

H1 The impact of articles with female first authors is lower than that of articles with male first authors.

To eliminate these imbalances, we need first to explain the mechanism of this phenomenon. In this study, we focus on writing style and try to explain the research performance resulting from gender differences.

Gender differences and writing style

Multiple factors have been proposed as contributing to gender differences in research performance. The author's characteristics, such as age, country, institution, productivity, country of origin, the field of study, and position in the academic system, can affect gender differences in research performance (Abramo et al., 2021; Lopez & Pereira, 2021; Myers et al., 2020; Restrepo et al., 2021; van Arensbergen et al., 2012). For example, women who work in research and those who have young children have had a significant decline in time devoted to research (Myers et al., 2020) and are less effective at technology development activities (Kou et al., 2019). Lopez and Pereira (2021) contend that female researchers are even less capable of transferring knowledge profitably and efficiently from a business standpoint. Researchers of male researchers (collaborating primarily with same-sex scientists) adhere to the principle of gender homophily, but females do not (Abramo et al., 2019b; Jung et al., 2017; Kwiek & Roszka, 2021).

This paper focuses on the characteristics of the articles. Concerning the topic, Shang et al. (2022) explore gender balance and differences among first authors within the SDG 5-oriented research. Compared with the other 16 SDGs, the field of the SDG 5 produces relatively fewer scientific publications, with most of the first authors being female. Regarding the aim, Zhang et al., (2022a, 2022b) find that male researchers more often value and engage in research geared mainly toward scientific progress, which is more cited. However, female researchers more often value and engage in research mainly aimed at contributing to societal progress, which has more abstract views (usage). Regarding language use, some researchers give considerable attention to writing style (Lerchenmueller et al., 2019; Newman et al., 2008; Urquhart-Cronish & Otto, 2019). The writing style in academic articles is studied across a wide range of disciplines, including medical and life science (Cao et al., 2021; Lerchenmueller et al., 2019; Wen & Lei, 2022b), political science (Weidmann et al., 2018), and cross-cultural psychology (Holtz et al., 2017). For example, using sentiment analysis to examine the diachronic change in linguistic positivity, Yuan and Yao (2022) show that academic writing style in research articles in the journal science has become significantly more positive in the past 25 years.

Several earlier studies examine differences between the writing styles of male and female authors. According to some studies, gender differences exist in writing style, including levels of readability and concreteness (DeJesus et al., 2021; Joshi et al., 2020; Kolev et al., 2019), the extent of self-promotion (Cheng et al., 2017; Scharff, 2015), and the use of positive words (DeJesus et al., 2021; Lerchenmueller et al., 2019). By examining how gender differences affect the presentation of scientific research in positive ways, Lerchenmueller et al. (2019) discover that authors use more positive words to describe their research in scientific titles and abstracts, including "novel," "unique," "unprecedented," etc. Furthermore, Dehdarirad and Yaghtin (2022) report that women use fewer positive terms in citing research findings in papers. When citing papers, men were significantly more likely to use positive terms.

We summarize research on gender differences in research performance and writing style. Previous studies have also examined gender differences in research performance, but they tend to focus more on revealing the phenomenon than explaining its underlying mechanisms. In addition, although many studies have concentrated on writing style, very few have addressed the relationship between author gender and writing style. Meanwhile, no studies have examined the relationship between writing style and research performance.

In this paper, we attempt to explain the gender differences in research performance through the writing style.

Confidence and gender differences

Academics of different genders exhibit varying degrees of confidence in their academic work. A gender-based "confidence gap" in medicine is characterized by differences between performance and self-concept (i.e., how an individual sees himself) (Heath et al., 2022). Despite similar performance metrics, women consistently self-assess themselves as lower than men (Hoops et al., 2019; Meyerson et al., 2017; Sawdon & Finn, 2014). Women in various fields, including science, engineering, economics, athletics, and academia, report low self-esteem and self-confidence regardless of their abilities or competencies (Hubble & Zhao, 2016; Lerchenmueller et al., 2019). Females tend to have lower levels of confidence (Dunn et al., 2021a, 2021b; Walker, 2020), and are also routinely less confident in their abilities and products than their male peers (Beyer & Bowden, 1997; Huang, 2013; Instone et al., 1983; Stankov & Lee, 2014) in math and science domains (Ehrlinger et al., 2018; Ellis et al., 2016; Else-Quest et al., 2010; Micari et al., 2007).

Across two preregistered studies with more than 900 active researchers in psychology, Dunn et al. (2021a, 2021b) show that more self-confident researchers select larger prior means, in part due to gender differences in researcher self-confidence. Furthermore, women express significantly lower confidence than men, which leads to lower confidence in their work quality than their male peers (despite performing equally well on the test) (Ehrlinger & Dunning, 2003). Therefore, we propose that the writing style of articles with female first authors is less positive than that of articles with male first authors. Here is the hypothesis.

H2 The writing style of articles with female first authors is less positive than that of articles with male first authors.

Writing style influences research impact (Morris et al., 2021; Parsons & Baglini, 2021). For example, using regression analysis and pairwise comparisons, Dehdarirad and Yaghtin (2022) show that male-authored papers receive a significantly higher positive sentiment compared with female-authored papers. Parsons and Baglini (2021) point out the importance of neutral language in peer review and provide examples of nonneutral linguistic and stylistic devices that emphasize a reviewer's personal response to the manuscript rather than their objective assessment. Back to writing style, female authors use fewer positive words in their academic writing, and their writing style is less positive. Referring to the "self-confidence effect", self-confidence predicts success in the future (Meisha & Al-dabbagh, 2021). An article with a positive writing style reflects the writer's confidence, and one with a more confident expression is more likely to be approved by the reader. We, therefore, propose that writing style mediates the positive effect of gender differences on research performance. Here is the hypothesis.

H3 The writing style of articles mediates the positive effect of gender differences on research performance.

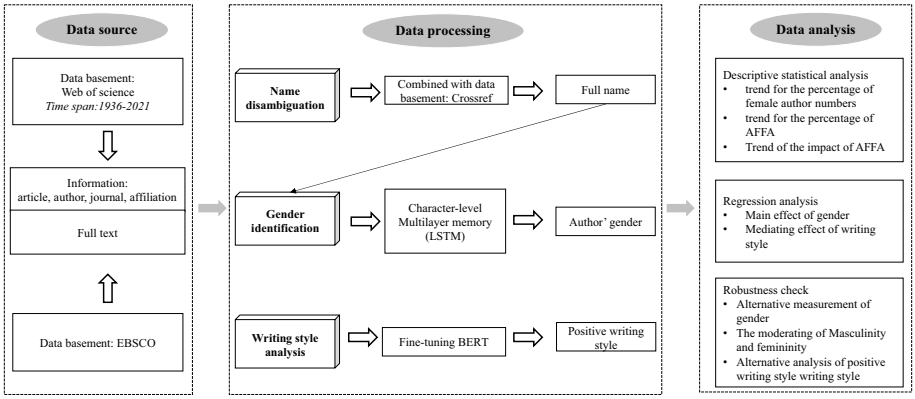

Fig. 1 Framework for data collection and processing

Research methodology

The procedures of data processing are presented in Fig. 1.

Data collection

Top journals are more influential and representative, which means a high position in the research system (Mauleon & Bordons, 2006; Mayer & Rathmann, 2018; Nielsen, 2017). For our study, we select the top four journals in the marketing field. There have been no previous studies on the research performance of female scholars in leading journals. Although there are many high-quality marketing journals, four journals have been selected for this study: Journal of Consumer Research (JCR), Journal of Marketing (JM), Journal of Marketing Research (JMR), and Marketing Science (MS). Among the leading marketing journals in the world, these four are widely recognized (Bauerly & Johnson, 2005; Stremersch & Verhoef, 2005; Tellis et al., 1999; Yoo, 2009).

Through the years, bibliometric studies have designed several methodologies to analyse scholarly output (Halevi, 2019). The article information data is obtained from the Web of Science (WoS), including the article, author, journal, and affiliation. We collected articles from the four journals[1] founded throughout 84 years, from 1936 to 2021.[2] To minimize the potential effect of a time interval on measuring the impact of publications, all the data were collected once on October 16, 2021. The corpus consists of 9,820 research articles (see supplementary materials for the descriptive statistics). We download full text from EBSCO.[3]

[1] These four journals were founded in 1936 (JM), 1964 (JMR), 1974 (JCR), 1982 (MS).

[2] The data of articles in 2021 were collected on October 16, 2021, when data collection was completed. This issue will not be repeated below.

[3] https://web.s.ebscohost.com.

Data processing

Determining the first author researcher's gender

Why the first author? According to Baerlocher et al. (2007), the order of the authors' names appearing in a paper generally indicates the extent to which each author contributed to the work (Larivière et al., 2016). It is not easy to quantify the contributions of each author. Current studies examining the relationship between authorship characteristics and article impact tend to focus on specific author positions, such as first authors, last authors, corresponding authors, senior authors, and so on (Skitka et al., 2021).

The first author is typically the one who leads the research and writing process. Most bibliometric studies focus on the first author in the current literature (Decullier & Maisonneuve, 2021; Jemielniak et al., 2022; Liu et al., 2022; Nguyen et al., 2021; Thelwall & Maflahi, 2022; Thelwall & Mas-Bleda, 2020; Thelwall et al., 2019; Thelwall, 2018, 2020a, 2020b). Shang et al. (2022) explore gender balance and differences among first authors within the SDG5-oriented research during the first five years after the implementation of the SDG5 in 2016. According to Zhang et al. (2021), there is an upward trend in the number of articles with a Chinese first author in international journals. Considering female and male first authors, Fox and Paine (2019) test whether gender predicts the outcomes of editorial and peer review for > 23,000 research manuscripts submitted to six journals in ecology and evolution from 2010 to 2015. Zeina et al. (2020) analyze the relationship between the first author's gender, ethnicity, and the chance of publication of rapid responses in the British Medical Journal (BMJ).

Besides, researchers have also considered authors in other positions when considering collaboration between genders. For example, the last author and the first author are often followed simultaneously (Sebo & Clair, 2023). Lerchenmueller et al., (2019) analyze whether men and women differ in how positively they frame their research findings and analyze whether the positive framing of research is associated with higher downstream citations. Specifically, they estimate the relative probability of positive framing as a function of the gender composition of the first and last authors. Andersen et al. (2020) report the results of an analysis that compares the gender distribution of authors in 1893 medical papers related to the pandemic with that papers published in the same journals in 2019, for papers with first authors and last authors from the United States. Research in pharmaceuticals and life sciences generally employs this approach.

In addition, some studies have also focused on other authors, such as corresponding authors (Edwards et al., 2018; Fox & Paine, 2019), senior authors (Polanco et al., 2020; Powell et al., 2022), solo authors (Nunkoo et al., 2020), middle authors, and mentee authors (Lopez-Padilla et al., 2021), co-first, senior, and co-senior authors (DeFilippis et al., 2021). While different types of other authors are taken into consideration, the first author is one that is emphasized by almost all authors. For example, Powell et al. (2022) investigated trends in female authorship in three journals over the past 25 years by using data for both first and senior authors. Lopez-Padilla et al. (2021) determine the changing patterns in gender differences and factors associated with the positioning of authors. They analyzed in four scenarios: first authors, last authors, middle authors, and mentee authors.

First authors play a significant role in bibliometric studies, and their importance cannot be overstated. In addition, since the sample articles in this study are mainly from marketing journals, the authors are not generally arranged alphabetically in the marketing field. In this study, we use the first authors to represent the gender attribute of a paper, considering those researchers make major contributions to scientific publications (Shang et al., 2022). We are concerned about articles with a female first author (AFFA).

Name disambiguation Considering part of the authors' names are abbreviated previously in WoS. To improve the quality of the authors' names used in our study, we further conduct author disambiguation procedures. We obtain the authors' full names from the Crossref[4] database using the DOI number of the article. After the name disambiguation, we get the first names of all authors. Code and a data demo are provided to demonstrate how we obtained this information at OSF: https://osf.io/bw8gx/.

Gender identification Gender identification is an enormous challenge, given that bibliographic data does not reveal it (Halevi, 2019). New bibliometric literature applying various gender-determination methods to authors and authorships (Elsevier, 2020; Halevi, 2019) provides new data-driven insights into gender disparities in science. Like other studies (Shang et al., 2022), the binary genders are considered and used in our analysis as well (Santamaría & Mihaljević, 2018). If no gender information could be inferred from an author, the gender was considered unknown (Shang et al., 2022).

A person's first name can be a strong signal of his/her gender (Liu & Ruths, 2013). Zeina et al. (2020) analyze the relationship between the first author's gender estimated from the first name and the chance of publication of rapid responses in the British Medical Journal. For each author in our sample, we use a new model architecture to identify the author's gender. The gender classifier is implemented using Character-level Multilayer long short-term memory (LSTM). It depends on NumPy, Scipy and, TensorFlow, Python packages for scientific computing. We use training data that a million names with gender annotation obtained from different countries. The architecture is as follows: Character Embedding Layer, 1st LSTM Layer, 2nd LSTM Layer, Pooling Layer, and Fully Connected Layer. The fully connected layer outputs the probability that a name is a male name. TensorFlow is used to build a character-level multi-layer LSTM neural network for machine learning, and a Python program is written for scholars' gender prediction. This model predicts gender by importing the names of scholars without surnames, returning the probability estimates of their genders, and classifying the genders. The recall and precision rates are 94.0/93.5% for men and 91.8/97.8% for women, resulting in an F1 score of 0.95 for men and 0.93 for women. Given the high F1 score, the threshold of ≥ 0.85 (equivalent to a Gender Probability Score ≥ 1.735) is used to infer gender (Elsevier, 2020).

In addition, the gender of these individuals is determined by associating each author's first name with the probability of the name being held by a man versus by a woman, using the Genderize database.[5] Researchers evaluate four gender assignment algorithms, using a control sample of gender-matched forenames from a U.S. government office, and find that the Genderize algorithm provided the most accurate gender assignment results. Applying a 90% probability threshold to the Genderize algorithm's gender designation yields the same

[4] https://www.crossref.org.

[5] Genderize database containing 216 286 distinct names across 79 countries and 89 languages.

determination with which gender can be predicted in our dataset for analysis (Lerchenmueller et al., 2019).

We conduct a random selection of 500 first authors to demonstrate the accuracy of our gender determination method. Using the authors' e-mail addresses, we manually collect the gender of these 500 authors by visiting their websites (we show the screenshot of these websites in the supplementary materials). The results of this analysis are then compared with the results of gender prediction calculated using machine learning. The results show that the coefficient of Cohen's Kappa is 0.881, indicating a good agreement (Zhu et al., 2020). This also confirms the reliability of the prediction approach.

Research performance

Productivity and impact are the two most important indicators of research performance across institutions (Larivière & Costas, 2016). Usually, citation counts and the number of publications published in scholarly journals are used to evaluate the research performance (Ghiasi et al., 2015; Zhang et al., 2020). Research performance is often determined by the number of citations that are cited as a result of the findings being read, used, applied, built upon, and cited by other researchers (Harnad et al., 2008). We regard the number of citations to be a measure of research performance (Jiang et al., 2018; Zhu et al., 2021).

Positive writing style

We quantify the positive writing style based on the words in titles, abstracts, and full papers. To ensure that all data are full and available, the corpus consists of 5,431 research articles dating with a total of 72,971,482 words (see the descriptive statistics in Table 1). Titles and abstracts represent some of the most important text in research papers, as readers often use these to screen articles to determine which ones deserve further attention (Lerchenmueller et al., 2019). We conduct the investigation on the full texts to gain a holistic understanding of academic writing, which yields more reliable and generalizable results than those studies analysing only abstracts (Yuan & Yao, 2022).

Considering the limitations of the small list of positive and negative words, many researchers adopt self-created dictionaries (Holtz et al., 2017), expand lists of positive and negative words (Bordignon et al., 2021), or use sentiment analysis with large lexicons in R (Wen & Lei, 2022a) to triangulate the results based on the small list of positive and negative words (Vinkers et al., 2015). Besides, it is extremely difficult to map the trajectory of discrete emotions using traditional survey methods due to their intensity and transience (Barsade & Gibson, 2007). Due to the advancement of automated text mining technology, some recent studies have begun to use advanced sentiment analysis techniques (Min et al., 2021). Due to BERT's exceptional understanding of the relationship between words and its ability to understand context, fine-tuning BERT is more accurate than traditional Linguistic Inquiry and Word Count based SVMs (EmoLex) (Min et al., 2021). To capture whether the articles' writing style is positive, we deploy fine-tuned BERT algorithms (Kumar et al., 2020; Min et al., 2021). BERT is an open-source deep learning model that is designed to perform well in a variety of natural language processing tasks (Devlin & Billings, 2018).

We use deep learning-based classification models to predict each paper's PWS. Formally, let x_i be text content of article i, and $f^e(x_i)$ represents a binary classifier for PWS. Then, the predicted label of x_i for the writing style e becomes:

Table 1 Descriptive statistics of the corpus used in the study

Year	Number of articles	Number of AFFA	Percentage of AFFA	Number of citations	Number of AFFA	Percentage of AFFA	Mean of title	Mean of abstract	Mean of pages	Mean of pages	Mean of full text length	Mean of reference	Mean of author size
1991	17	3	18	2229	200	9	72.24	849.82	4.88	14.24	11727.29	41.76	2.12
1992	127	24	19	30812	10,785	35	76.51	889.46	5.17	13.59	11737.49	41.36	2.06
1993	121	17	14	33389	2101	6	76.25	910.83	6.15	14.7	12702.77	43.39	2.2
1994	143	34	24	49553	7964	16	74.54	849.81	5.57	14.05	12173.59	43.31	2.17
1995	117	21	18	21485	5555	26	73.57	889.68	5.44	13.98	12016.13	39.41	2.21
1996	102	17	17	22581	6310	28	73.76	1574.57	6.16	14.53	12525.8	42.6	2.24
1997	109	17	16	25040	4933	20	76.72	1599.87	5.77	13.76	11881.82	38.88	2.41
1998	110	24	22	30469	6105	20	79.25	1594.13	6.99	14.05	12173.59	44.1	2.23
1999	130	33	25	30979	7614	25	76.12	1646.52	7.61	15.66	13435.84	48.06	2.35
2000	109	16	15	22091	3395	15	80.87	1642.59	6.68	14.84	12863.13	41.15	2.26
2001	124	31	25	27571	5919	21	79.99	1558.63	6.91	14.33	12380.52	43.19	2.15
2002	118	33	28	22948	5220	23	84.43	1579.55	7.02	15.31	13226.59	43.75	2.32
2003	128	44	34	23559	7929	34	78.5	1020.21	8.32	15.56	13410.52	49.5	2.3
2004	188	41	22	29788	6315	21	76.79	963.32	7.61	12.95	11109.59	40.06	2.4
2005	198	53	27	30932	7154	23	74.55	954.15	6.81	11.7	10047.43	35.85	2.28
2006	172	50	29	25632	8584	33	73.16	955.08	7.16	11.98	10355.94	37.83	2.3
2007	213	57	27	22843	7094	31	74.42	1031.24	7.96	13.37	11460.32	41.83	2.46
2008	246	73	30	23657	7860	33	75.73	1050.85	10.72	15.56	13410.52	46.59	2.5
2009	258	78	30	25365	7739	31	77.72	1081.16	11.32	14.41	12333.6	46.34	2.61
2010	273	101	37	29310	12223	42	79.26	1107.81	11.39	14.95	12887.34	47.52	2.64
2011	287	91	32	21416	7608	36	75.58	1100.57	11	12.95	11109.59	48.48	2.59
2012	252	97	38	18676	8032	43	78.51	1115.31	11.31	15.92	13740.6	54.04	2.63
2013	227	74	33	13668	4898	36	82.07	1134.78	11.23	16.7	14326.16	57.66	2.57
2014	236	94	40	11984	4578	38	80.4	1111.14	11.22	17.04	14667.86	60.17	2.71
2015	197	72	37	7833	2850	36	84.08	1174.43	12.57	16.7	14326.16	59.71	2.69

Table 1 (continued)

Year	Number of articles	Number of AFFA	Percentage of AFFA	Number of citations	Number of AFFA	Percentage of AFFA	Mean of title	Mean of abstract	Mean of pages	Mean of pages	Mean of full text length	Mean of reference	Mean of author size
2016	205	69	34	7109	2083	29	84.55	1224.17	13.23	17.44	15030.52	57.76	2.76
2017	229	89	39	6935	2854	41	80.72	1189.25	13.12	18.19	15679.84	61.34	2.86
2018	222	87	39	3679	1537	42	82.67	1233.57	13.23	18.55	15958.94	61.9	2.74
2019	217	83	38	2772	1113	40	82.28	1215.12	13.15	19.53	16830.65	63.22	2.83
2020	202	76	38	1078	463	43	79.02	1222.04	13.11	19.8	16997.34	62.14	2.83
2021	154	72	47	214	68	32	74.81	1253.79	11.94	20.34	17590.35	65.17	2.98
Total	5431	1671	29	625597	167083	29	78.03	1184.63	9.06	15.38	13229.61	48.65	2.46

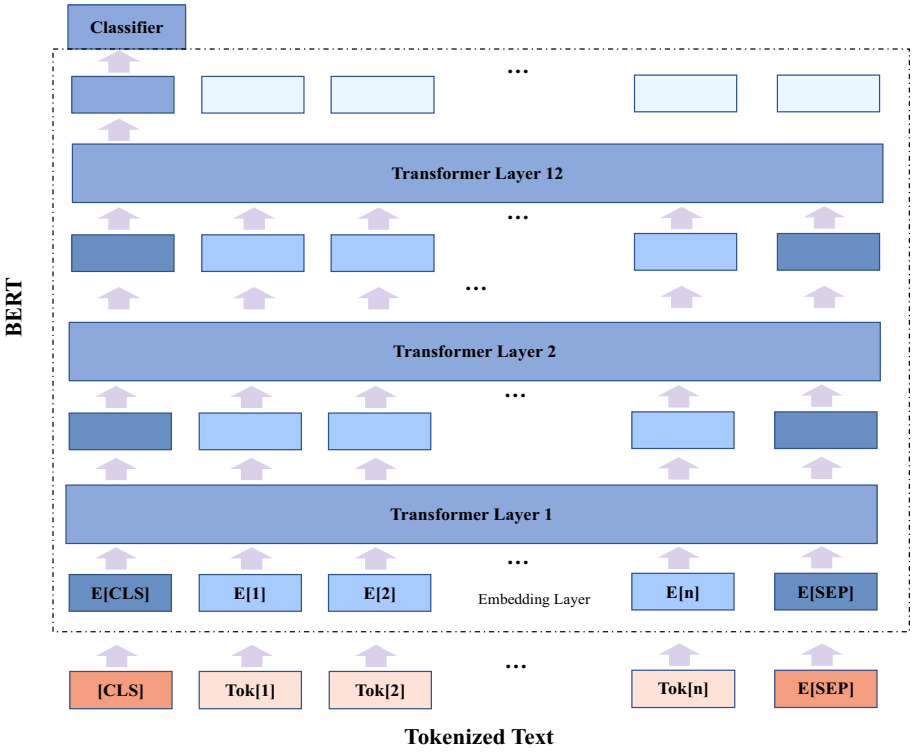

Fig. 2 Framework for data collection and processing

$$\widehat{y_i^e} = f^e(x_i)$$

The binary classifiers, $f^e(x_i)$ are constructed by training the fine-tuned BERT models. The BERT base model has 12 layers of transformer blocks (see Fig. 2).

We train the fine-tuned BERT models with the open-sourced TensorFlow implementation for BERT[6] and the pre-trained weights from the PyTorch port built by Hugging Face.[7] We also open the complete code used in our study's data collection and processing framework at OSF: https://osf.io/bw8gx/. The main components include code for training/inferencing the fine-tuned BERT models.

Control variables

In addition, to eliminate other factors that may affect the author's writing style and authorial impact of the essay, we control for factors related to the articles' writing style and research impact, including many factors at the author level, article level, journal level, and affiliate level, that may influence articles' research performance. Specifically, on the author

[6] https://www.tensorflow.org/official_models/fine_tuning_bert.
[7] https://huggingface.co/transformers.

level, publication productivity is a primary criterion for tenure and promotion in academia (Rigg et al., 2012). A more published author will be less pressured to create new articles and be more confident in their writing abilities. We control the author's preview publications in these top journals. The collaboration influences the research impact (Abramo et al., 2019a; Liu et al., 2022), and writing style of a manuscript is not only dependent on or determined by its first author, but also most likely by other authors. We, therefore, control the presence of men in the author team due to the influence of male authors.

On the article level, the length of the text influences the research impact (Arkin et al., 2019; Huang et al., 2020). Furthermore, the length of the text may dilute its stylistic features (dilution effect). We control the length of the abstract as well as the full article was controlled (Zeina et al., 2020). Compared to male authors, women tend to use fewer positive terms when citing research findings from papers composed of the same gender (Dehdarirad & Yaghtin, 2022). In general, the more references that are used, the greater the impact on the overall writing style. So, we also control the number of references used.

We also control variables on the journal level (Fernández et al., 2020; Lerchenmueller et al., 2019; Zeina et al., 2020). An examination of the relationship between the impact of a journal and the citation of an article, with the impact of a journal varying from year to year. Accordingly, we use the journal's impact factor for the corresponding year as a control variable. Moreover, different journals are positioned differently, and their articles are written differently. For example, Marketing Science focuses primarily on articles that answer important research questions in marketing using mathematical modeling.[8] The Journal of Consumer Research publishes scholarly research that describes and explains consumer behavior.[9] Finally, since journal style is difficult to quantify, as well as other characteristics of journals that may be overlooked, we add a journal fixed effect to the model.

We also control variables on the affiliate level (Fernández et al., 2020; Jiang et al., 2018; Liu et al., 2022). Research quality is affected by English language proficiency (Zhang et al., 2022a, 2022b). In non-English-speaking countries, editorial services are becoming increasingly popular, which means that non-English-speaking authors are using these services more frequently. Editorial services obviously affect the language proficiency of the article, so we control the affiliate language.

Finally, since the dataset of this study covered a long period of time, and there has been a significant improvement in academic writing in the past 25 years (Yuan & Yao, 2022), it is necessary to add the year fixed effect. We summarize all variables used in Table 2. Table 3 and Table 4 describe our samples with descriptive statistics and the correlation. It should be noted that because of the discrete lognormal distribution of data, we use the natural logarithms of some measurements as variables, including citations, publications, and so on.

Descriptive statistical analysis

This study examines gender inequalities in marketing between males and females. Referring to previous studies (Powell et al., 2022; Shang et al., 2022), we regard the number of female authors, the number of articles with female first authors, and the research performance of articles with female first authors.

[8] https://pubsonline.informs.org/page/mksc/submission-guidelines.
[9] https://academic.oup.com/jcr.

Table 2 Descriptive statistics of the corpus used in the study

Variable	Definition and measurement	Source
Dependent variables		
Impact	Citations of articles	Web of science
Independent variable		
Gender	Gender of first author	Web of science/crossref
Mediate		
Writing style (WS)	Positive/negative writing style	Web of science
Author		
Authors publications	The total number of Top4 published before this article for the author	Web of science
Male authors	Whether male author present	Web of science
Article		
Year	Publishing year	Web of science
Abstract	The number of abstract words	Web of science
Full text length	The number of paper pages	Web of science
Reference	The number of references	Web of science
Journal		
Journal impact factors yearly (JIFY)	The yearly impact of the journal	Web of science
Affiliate		
Affiliate language	Whether the official language of the country in which the institution is located is English	Web of science/Wikipedia

Table 3 Descriptive statistics

Variable	Mean	Std. dev	Min	Max
Dependent variables				
Impact	7.056	13.608	0	115
Independent variable				
Gender	1.388	0.488	1	2
Mediate variable				
WS	2.010	1.802	0	12
Author				
Authors publications	2.866	2.809	1	21
Male authors	0.992	0.089	0	1
Article				
Abstract	125.324	27.288	321	2372
Full text	13478.29	3775.57	866	31176
Reference	63.264	29.810	2	327
Journal				
JIFY	6.677	3.295	2.794	15.36
Affiliate				
Affiliate language	0.776	0.417	0	1

The annual trend for the percentage of female author numbers

Firstly, we calculate the percentage of female authors in all articles published in the top four journals for each year. In the period 1936–2021, there was a rise in the number of authors publishing papers in the top four journals. The percentage of women authors is just 0.10 in 1936, and there is only one female for every nine authors. The percentage of women in 2021 is 0.40, and four women out of every ten authors are women. Figure 3 reveals that female researchers are increasingly publishing articles in leading marketing journals. By comparing the trend of female authors in the top four marketing journals between 1936 and 2021, we find that the proportion of female authors has grown. But in general, the number of female authors published in the top four marketing journals each year is still less than that of male authors. Consistent with previous studies, our study proves that gender differences between men and women still exist in marketing.

The annual trend for the percentage of AFFA

We look at the trend in the percentage of AFFA. As a result, for each year, we calculate the percentage of AFFA among all authors who published articles in the top four journals. There is an increase in the annual trend for the percentage of the article with a female first author (AFFA) in the top four journals between 1936 and 2021. There was only one AFFA in every 20 articles in 1936, and the percentage of AFFA was 0.10. By 2021, the percentage of AFFA increased to 0.50, and there were 92 AFFA in 184 articles. Results show that, in marketing, more and more AFFA are published in top journals, as illustrated in Fig. 4. The number of articles published in the top four marketing journals per year is lower for AFFA than for male first authors. Our study confirms the existence of gender differences in marketing, consistent with previous research. While our results show an increase in the annual trend for the percentage of AFFA in top marketing journals, these results are only

Table 4 Intercorrelations

	1	2	3	4	5	6	7	8	9	10
Impact	1									
WS	0.081*	1								
Gender	− 0.017	− 0.034	1							
Authors publications	− 0.012	− 0.02	− 0.057	1						
Male authors	− 0.016	0.075*	0.025	0.001	1					
Abstract	− 0.062	0.108**	0.014	0.076*	0.045	1				
Full text length	0.032	0.02	− 0.019	0.024	− 0.002	0.136***	1			
Reference	0.265***	0.058	0.123***	− 0.039	− 0.044	0.012	0.416***	1		
JIFY	− 0.164***	0.02	0.136***	0.067	− 0.006	0.066	0.156***	0.430***	1	
Affiliate language	0.009	− 0.021	− 0.111**	0.133***	− 0.037	− 0.021	0.017	0.001	− 0.065	1

Correlations ≥ .076 are significant at $p = .50$

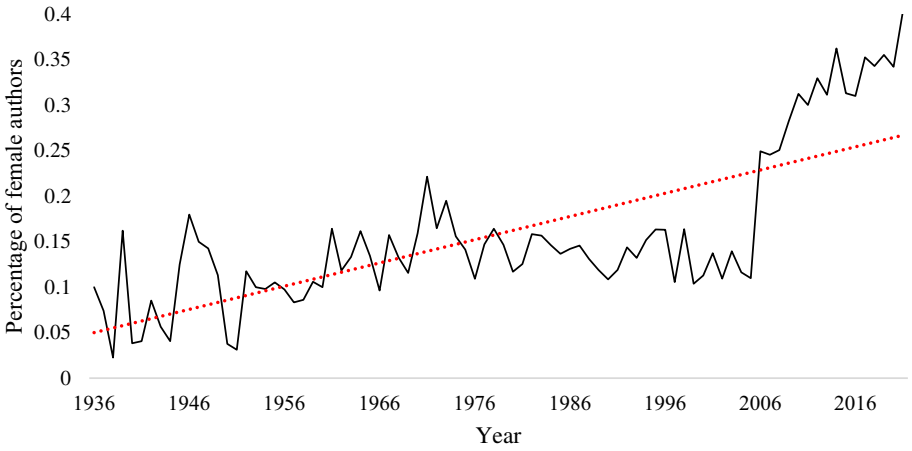

Fig. 3 Percentage of female authors

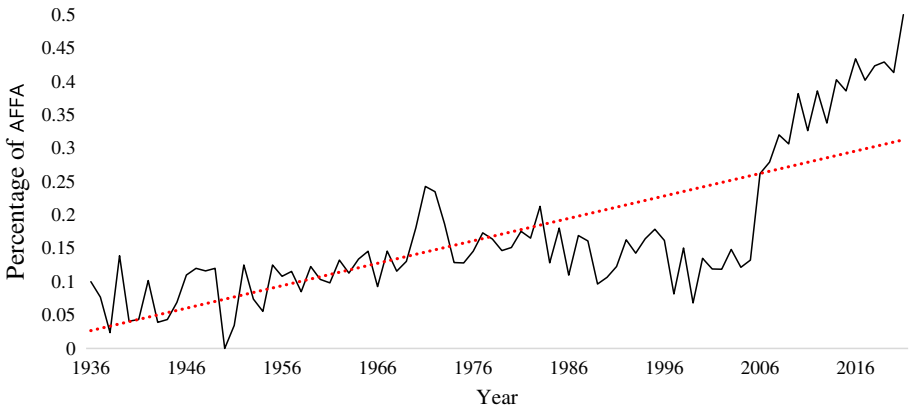

Fig. 4 Percentage of AFFA

indicative of the increase in female researchers' research performance. It is interesting to compare the quality of the articles written by female researchers and the contribution made by female researchers. We further compare the research performances of AFFA.

Annual trend of the impact of AFFA

From 1936 to 2021, we compare the impact of AFFA in the four top marketing journals. We calculate the percentage of the citations of AFFA among the citations of all articles in the top four journals yearly. There has been an increase in the impact of AFFA papers published in the four top journals between 1936 and 2021. In 1936, there was a 0.00 percent of AFFA among the sum citations of all articles. Accordingly, the impact of AFFA in the sum citations of all articles increase to 0.32 in 2021. According to the results, the impact of AFFA published in top journals in marketing is increasing, see Fig. 5. Qualitatively, this result indicates that the quality of the impact

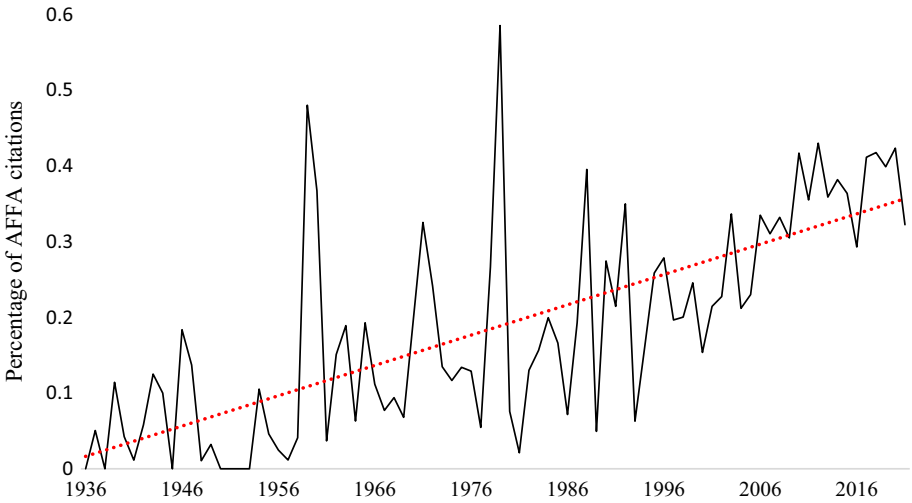

Fig. 5 Percentage of AFFA citations

of AFFA is improving. This indicates that female researchers are performing better in their research. In the four top marketing journals, AFFAs receive fewer citations than articles with male first authors each year. Our study again demonstrates that gender differences still exist in marketing, consistent with previous research.

Regression analysis

It is necessary to disambiguate the authors according to their names, affiliations, publications, etc. To better understand the observed gender differences in the research performance of AFFA, we use Ordinary Least Squares (OLS) regressions in STATA 17 to detect the differences in research performance after other variables are added to the models.

Regression models

To explore the relationship between the articles' impact and the author's gender, we estimate the following baseline model:

$$\begin{aligned} Impact_{it} = {} & \alpha + \beta_1\, Gender_{it} + \beta_2\, Author\ publications_{it} + \beta_3\, Male_{it} \\ & + \beta_4 Abstract_{it} + \beta_5 Full\ text\ length_{it} + \beta_6 Reference_{it} \\ & + \beta_7 JIFY_{it} + \beta_8 Affiliate\ language_{it} + Year\ dumimes \\ & + Journal\ dummies + \epsilon_{it} \end{aligned} \tag{1}$$

where i represents the article, and t represents the year. $Impact_{it}$ represents the research of article (i) in the year (t). $Gender_{it}$ is a dummy variable coded 1 for the female author and 0 for the male author. Our control variables are based on the variables we analyzed above.

As the dependent variable in our data is compressed at 0 for some observations, we employ the Tobit model (Zhu et al., 2022).

To examine the mechanism for the articles' impact, we use a modified version of Baron & Kenny's (1986) three-step mediation test proposed by Zhao et al. (2010), in which the Sobel test is replaced by bootstrap (Zhu et al., 2022). To enhance the diversity of analytical methods, we also use the Monte Carlo method (Li et al., 2021; Selig & Preacher, 2008) with 50,000 bootstrapping samples. The mediation effect model consists of the following components:

$$\begin{aligned} Impact_{it} = {} & \alpha + \beta_1\, Gender_{it} + \beta_2\, Author\ publications_{it} + \beta_3\, Male_{it} \\ & + \beta_4 Abstract_{it} + \beta_5 Full\ text\ length_{it} + \beta_6 Reference_{it} \\ & + \beta_7 JIFY_{it} + \beta_8 Affiliate\ language_{it} + \beta_9 Affiliate\ score_{it} \\ & + Year\ dumimes + Journal\ dummies + \epsilon_{it} \end{aligned} \tag{2}$$

$$\begin{aligned} WS_{it} = {} & \alpha + \beta_1\, Gender_{it} + \beta_2\, Author\ publications_{it} + \beta_3\, Male_{it} \\ & + \beta_4 Abstract_{it} + \beta_5 Full\ text\ length_{it} + \beta_6 Reference_{it} \\ & + \beta_7 JIFY_{it} + \beta_8 Affiliate\ language_{it} + \beta_9 Affiliate\ score_{it} \\ & + Year\ dumimes + Journal\ dummies + \epsilon_{it} \end{aligned} \tag{3}$$

$$\begin{aligned} Impact_{it} = {} & \alpha + \beta_1\, Gender_{it} + \beta_2\, Author\ publications_{it} + \beta_3\, Male_{it} \\ & + \beta_4 Abstract_{it} + \beta_5 Full\ text\ length_{it} + \beta_6 Reference_{it} \\ & + \beta_7 JIFY_{it} + \beta_8 Affiliate\ language_{it} + Year\ dumimes \\ & + Journal\ dummies + \epsilon_{it} \end{aligned} \tag{4}$$

where WS_{it} is the writing style of the article of article (i) in the year (t).

Baseline results

Model 1, Model 2, and Model 3 in Table 4 report regression results where the dependent variable is impact. Model 1 includes only gender. Model 2 adds control variables at the author level, article level, journal level, and affiliate level. Model 3 adds all control variables and includes the year, journal publisher, and country fixed effects.

In Table 5, the coefficient on gender is negative and significant across all three models, suggesting that gender is negatively associated with impact. For example, the coefficient on gender in Model 3 equals -0.0583 ($p = -0.035$). There is a significant negative correlation between full-text length, reference, and impact. However, there is no significant correlation between other control variables and impact. Baseline results supported H1.

In the next step, we analyse writing style of the articles in order to explain the reasons for the differences in impact between male and female authors.

Table 5 Results of main effect

D.V. Impact	Model 1		Model 2		Model 3	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Gender	− 0.0250	0.842	− 0.0424	0.032	− 0.0583	0.035
	− 0.1260		− 0.1240		− 0.0938	
Author publications			− 0.0037	0.964	− 0.0785	0.201
			− 0.0805		− 0.0613	
Male authors			− 1.1590	0.178	− 0.5880	0.361
			− 0.8590		− 0.6430	
Abstract			− 0.2120	0.485	− 0.0375	0.872
			− 0.3030		− 0.2330	
Full text length			− 0.914**	0.003	− 0.0422**	0.004
			− 0.3080		− 0.2460	
Reference			1.440***	0.000	0.8250***	0.000
			− 0.1620		− 0.1300	
JIF			− 1.053***	0.000	0.6920	0.084
			− 0.1560		− 0.4000	
Affiliate language			− 0.0848	0.558	− 0.0198	0.857
			− 0.1450		− 0.1090	
_cons	1.284***	0.000	8.893**	0.000	− 0.0318	0.991
	− 0.1850		− 3.2580		− 2.7000	
Year fixed effects	NO		NO		Yes	
Journal fixed effects	NO		NO		Yes	
N	5431		5431		5431	
pseudo R^2	0.0001		0.0660		0.2395	

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

The mediating effect of the writing style

The dependent t-test indicated that articles with a male first author had a more positive writing style than those with a female first author ($M_{female} = 0.52$, SD = 0.63 vs. $M_{male} = 0.89$, SD = 0.66, t (5430) = 3.693, p = 0.000). H2 is supported.

The next step will be directly verifying the mediating role of WS. The estimation results for anxiety are reported in Table 6. Column (1) shows that the coefficient on gender is negative and significant across all three models, suggesting that gender is negatively associated with impact (β = -0.0583, $p = 0.035$). H1 is supported again. Columns (2) indicate that the coefficient on gender is negative and significant across all three models, suggesting that gender is negatively associated with WS ($\beta = -0.0294$, $p = 0.079$), and H2 is supported again. In column (3), gender also has a significantly negative relationship with impact with less coefficient ($\beta = -0.0313$, $p = 0.051$), and WS has a positive effect ($\beta = 0.0787$, $p = 0.0016$) on impact. The mediation effect of WS is significant for the articles' impact. H3 is supported.

We used the Monte Carlo method (Li et al., 2021; Selig & Preacher, 2008) with 50,000 bootstrapping samples, and results supported the mediating effect of WS on the relationship between author gender and research impact (estimate = − 0.75, 95% CI [− 0.0280, − 0.0082]). Results supported the mediating effect of WS. H3 is supported again.

Robustness check

As a means of further enhancing the stability of this paper's findings, we conduct a set of robustness checks.

Alternative measurement of gender

Based on our hypothetical derivation, the percentage of female authors (0–100%) was used as a proxy measure of gender, taking into account the role of authors on other positions. We predicate that the lower the gender ratio (0–100%) in the author team, the greater the impact of the article.

We determine the percentage of female authors based on the count of all authors in each article, and the female percentage is calculated as follows:

$$Female\ percentage = 100\% * \frac{\sum Female\ authors_i}{\sum Total\ authors_i}$$

where *Female percentage* is the index of the article *i*'s female authors percentage, and *Female authors* is the count of female authors in the article *i*. *Total authors* is the total number of authors in the article *i*.

Results To explore the relationship between the articles' impact and the author's gender, we use the same models (1), but we use the female percentage as the independent variable.

Model 1, Model 2, and Model 3 in Table 7 report regression results where the dependent variable is impact. Model 1 includes only the female percentage. Model 2 adds control variables at the author level, article level, journal level, and affiliate level. Model 3 adds all control variables and includes the year, journal publisher, and country fixed effects.

Table 6 Results of mediating effect

D.V	(1) Impact		(2) WS		(3) Impact	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Gender	− 0.0583**	0.035	− 0.0294*	0.079	− 0.0313*	0.051
	− 0.0938		− 0.0710		− 0.0938	
WS					0.0787***	0.016
					− 0.0783	
Author publications	− 0.0785	0.201	− 0.0269	0.558	− 0.0758	0.217
	− 0.0613		− 0.0459		− 0.0613	
Male authors	− 0.5880	0.361	0.8700	0.100	− 0.6440	0.318
	− 0.6430		− 0.5280		− 0.6450	
Abstract	− 0.0375	0.872	0.4430*	0.013	0.0682	0.771
	− 0.2330		− 0.1780		− 0.2340	
Full text length	− 0.0422**	0.004	0.0535	0.769	− 0.0460	0.851
	− 0.2460		− 0.1820		− 0.2460	
Reference	0.8250***	0.000	0.0811	0.400	0.8220***	0.000
	− 0.1300		− 0.0961		− 0.1300	
JIF	0.6920*	0.084	0.3930	0.198	0.6660	0.097
	− 0.4000		− 0.3050		− 0.4001	
Affiliate language	− 0.0198	0.857	− 0.0414	0.616	− 0.0179	0.870
	− 0.1090		− 0.0825		− 0.1091	
_cons	− 0.0318	0.991	− 4.354*	0.033	− 0.2391	0.930
	− 2.7000		− 2.0360		− 2.7121	
Year fixed effects	Yes		Yes		Yes	
Journal fixed effects	Yes		Yes		Yes	
N	5431		5431		5431	
pseudo *R*2	0.2395		0.0236		0.2402	

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 7 Results of main effect

D.V. impact	Model 1		Model 2		Model 3	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Female percentage	− 1.4690***	0.000	− 1.324***	0.001	− 0.802***	0.008
	− 0.3890		− 0.3890		− 0.3020	
Author publications			− 0.0061	0.939	− 0.0755	0.215
			− 0.0793		− 0.0607	
Male authors			− 0.8070	0.343	− 0.3990	0.532
			− 0.8510		− 0.6390	
Abstract			− 0.1040	0.730	0.0250	0.914
			− 0.3000		− 0.2310	
Full text length			− 0.964**	0.002	− 0.0796**	0.045
			− 0.3050		− 0.2440	
Reference			1.363***	0.000	0.780***	0.000
			− 0.1610		− 0.1300	
JIF			− 1.063***	0.000	0.6550	0.100
			− 0.1530		− 0.3970	
Affiliate language			− 0.0807	0.571	− 0.0213	0.844
			− 0.1420		− 0.1080	
_cons	1.284***	0.000	8.8930**	0.000	− 0.0318	0.991
	− 0.1850		− 3.2580		− 2.7000	
Year fixed effects	NO		NO			Yes
Journal fixed effects	NO		NO			Yes
N	5431		5431			5431
pseudo R^2	0.0091		0.0743			0.2444

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 8 Results of mediating effect

D.V	(1) Impact		(2) WS		(3) Impact	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Female percentage	− 0.802***	0.008	− 0.494**	0.027	− 0.579**	0.011
	− 0.3020		− 0.2230		− 0.3040	
WS					0.0546	0.485
					− 0.0781	
Author publications	− 0.0755	0.215	− 0.0252	0.580	− 0.0738	0.225
	− 0.0607		− 0.0456		− 0.0608	
Male authors	− 0.3990	0.532	0.9560	0.069	− 0.4420	0.491
	− 0.6390		− 0.5250		− 0.6420	
Abstract	0.0250	0.914	0.486**	0.006	0.0022	0.993
	− 0.2310		− 0.1780		− 0.2340	
Full text length	− 0.0796**	0.045	0.0239	0.896	-0.0813	0.740
	− 0.2440		− 0.1820		− 0.2440	
Reference	0.780***	0.000	0.0500	0.605	0.780***	0.000
	− 0.1300		− 0.0966		− 0.1300	
JIF	0.6550	0.100	0.3660	0.229	0.6370	0.110
	− 0.3970		− 0.3040		− 0.3970	
Affiliate language	− 0.0213	0.844	− 0.0369	0.651	− 0.0204	0.850
	− 0.1080		− 0.0816		− 0.1080	
_cons	− 0.0318	0.991	− 4.667*	0.022	− 0.3090	0.909
	− 2.7000		− 2.0240		− 2.7020	
Year fixed effects	Yes		Yes		Yes	
Journal fixed effects	Yes		Yes		Yes	
N	5431		5431		5431	
pseudo R^2	0.2444		0.0286		0.2447	

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

In Table 7, the coefficient on the female percentage is negative and significant across all three models, suggesting that the female percentage is negatively associated with the impact. For example, the coefficient on gender in Model 3 equals − 0.802 (p = 0.008). There is a significant negative correlation between the full-text length, the reference, and the impact. However, there is no significant correlation between other control variables and the impact. Baseline results support H1 again.

In the next step, we analyse the writing style of the articles in order to explain the reasons for the differences in impact between male and female authors.

The mediating effect of the writing style The next step will be directly verifying the mediating role of WS. The estimation results for anxiety are reported in Table 8. Column (1) shows that the coefficient on gender is negative and significant across all three models, suggesting that gender is negatively associated with impact ($\beta = -0.802$, $p = 0.008$). H1 is supported again. Columns (2) indicate that the coefficient on gender is negative and significant across all three models, suggesting that gender is negatively associated with WS ($\beta = -0.494$, $p = 0.027$), and H2 is supported again. In column (3), gender also has

a significantly negative relationship with impact with less coefficient ($\beta = -0.579$, $p = 0.011$), and WS has a negative effect ($\beta = -0.494$, $p = 0.027$) on impact. The mediation effect of WS is significant for the articles' impact. H3 is supported.

We used the Monte Carlo method (Li et al., 2021; Selig & Preacher, 2008) with 50,000 bootstrapping samples, and results supported the mediating effect of WS on the relationship between author gender and research impact (estimate = − 0.11, 95% CI [− 0.1201, − 0.0562]). Results supported the mediating effect of WS. H3 is supported again.

The moderating of masculinity and femininity

A lesser-known form of cultural bias called masculine defaults must be recognized to understand and remedy women's underrepresentation in majority-male fields and occupations (Cheryan & Markus, 2020).

Masculinity and femininity oppose ego goals with social goals. While masculinity is characterized by competition, achievement, assertiveness, and success, femininity relates to cooperation, helping others, sharing, empathy, and solidarity. A feminist culture emphasizes modesty and subtlety, while a masculine culture emphasizes selfishness and competition (Hofstede, 2001). Regarded masculinity and femininity (Hofstede, 2001), we propose that masculinity and femininity influence the article's impact. According to our conclusions, we predict that there is a significant difference between the impact of articles with different gender authors in the context of feminist culture and that of masculinist culture. The impact of articles with first authors from a feminine country is lower than that of articles with first authors from a masculine country.

Using a common approach to verification mediation through manipulation of conditioning in psychology and management (Fishbach et al., 2006; Huang et al., 2017; Salerno et al., 2019; Woolley & Risen, 2021; Yani-de-Soriano et al., 2019), people's attitudes or behaviours are observed to change accordingly by affecting conditions related to psychological mechanisms using natural or experimental stimuli. A psychological mechanism is then indirectly validated. If our proposed psychological mechanism for writing style holds, then our prediction will be true. H1, H2, and H3 are supported.

Determining a researcher's affiliation's country Using the author's e-mail address, we acquired each researcher's affiliation list and extracted corresponding country information. To determine the researcher's affiliation country of origin where the institution is located, we adopt the method used by (Boekhout et al., 2021; Shang et al., 2022). Three steps were taken: (1) For researchers with affiliations from only one country, the country is marked as the researcher's country of origin. (2) For a researcher with affiliations from more than one country, if the country most often associated with the researcher in their publications coincided with the country associated with the researcher in their first publication, then this country is considered the researcher's country of origin. Otherwise, we regard the evidence as insufficient to determine a single country of origin (Shang et al., 2022). (3) Referring to Hofstede Insight,[10] we calculate the masculinity score for each country.

[10] https://www.hofstede-insights.com/country-comparison/greece.

Regression models To explore the relationship between articles' impact and masculinity scores for affiliates, we use the same models (1), but we use the masculinity scores (masculinity scores for the country of the author's masculinity) as the independent variable.

Baseline results Model 1, Model 2, and Model 3 in Table 10 report regression results where the dependent variable is impact. Model 1 includes only masculinity scores. Model 2 adds control variables at the author level, article level, journal level, and affiliate level. Model 3 adds all control variables and includes the year, journal publisher, and country fixed effects.

In Table 9, the coefficient on the masculinity score is positive and significant across all three models, suggesting that the masculinity score is positively associated with impact. For example, the coefficient on gender in Model 3 equals 0.101 ($p = 0.031$). There is a significant negative correlation between abstract, full-text length, reference, and impact. However, there is no significant correlation between other control variables and impact. Baseline results support H1.

In the next step, we analyse the writing style of the articles in order to explain this effect.

The mediating effect of the writing style The dependent t-test indicated that articles with a first author from high masculinity country (masculinity scores > 50) had a more impact than those with a first author from low masculinity country (masculinity scores < 50) ($M_{\text{low masculinity scores}} = 0.82$, SD = 0.63 vs. $M_{\text{high masculinity scores}} = 0.89$, SD = 0.66, t (5430) = 3.693, $p = 0.000$). H1 is supported. The dependent t-test indicated that articles with a first author from high masculinity country have a more positive writing style than those with first author from low masculinity country ($M_{\text{low masculinity scores}} = 1.42$, SD = 0.63 vs. $M_{\text{high masculinity scores}} = 2.76$, SD = 0.66, t (5430) = 5.693, $p = 0.000$). H2 is supported.

The next step will be directly verifying the mediating role of WS. The estimation results for anxiety are reported in Table 10. Column (1) shows that the coefficient on masculinity scores is positive and significant across all three models, suggesting that masculinity scores are positively associated with impact ($\beta = 0.101$, $p = 0.031$). H1 is supported again. Column (2) indicates that the coefficient on masculinity scores is negative and significant across all three models, suggesting that the masculinity score is positively associated with WS ($\beta = 0.117$, $p = 0.048$), and H2 is supported again. In column (3), the masculinity score also has a significantly positive relationship with impact ($\beta = -0.0831$, $p = 0.063$), and WS has a positive effect ($\beta = 0.0747$, $p = 0.003$) on impact. The mediation effect of WS is significant. H3 is supported.

We use the Monte Carlo method (Li et al., 2021; Selig & Preacher, 2008) with 50,000 bootstrapping samples, and results support the mediating effect of WS on the relationship between author masculinity scores and research impact (estimate = 0.14, 95% CI [1.0280, 1.7102]). Results support the mediating effect of WS. H3 is supported again.

Alternative analysis of the positive writing style

Several studies use a small list of predefined positive/negative words to examine the linguistic positivity bias (Lerchenmueller et al., 2019; Vinkers et al., 2015; Weidmann et al., 2018). Following Lerchenmueller et al., (2019), we explore gender differences in the use of

Table 9 Results of main effect

D.V. Impact	Model 1		Model 2		Model 3	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Masculinity	0.208**	0.032	0.132***	0.009	0.101**	0.031
	− 0.2140		− 0.2150		− 0.1610	
Author publications			− 0.0015	0.985	− 0.0836	0.174
			− 0.0806		− 0.0613	
Male authors			− 1.1440	0.183	− 0.5610	0.382
			− 0.8580		− 0.6410	
Abstract			− 0.2170	0.475	− 0.0296	0.899
			− 0.3030		− 0.2320	
Full text length			− 0.910**	0.003	− 0.052**	0.833
			− 0.3080		− 0.2460	
Reference			1.431***	0.000	0.833***	0.000
			− 0.1630		− 0.1300	
JIF			− 1.056***	0.000	0.6980	0.081
			− 0.1560		− 0.4000	
Affiliate language			− 0.0478	0.764	− 0.0583	0.626
			− 0.1590		− 0.1200	
_cons	2.110*	0.015	9.481**	0.005	− 0.3550	0.898
	− 0.8680		− 3.3690		− 2.7740	
Year fixed effects	NO		NO		Yes	
Journal fixed effects	NO		NO		Yes	
N	5431		5431		5431	
pseudo R^2	0.0007		0.0661		0.2395	

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 10 Results of mediating effect

D.V	(1) Impact		(2) WS		(3) Impact	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Masculinity	0.101**	0.031	0.1170	0.048	0.0831*	0.063
	− 0.1610		− 0.1240		− 0.1610	
WS					0.0747**	0.053
					− 0.0783	
Author publications	− 0.0836	0.174	− 0.0290	0.528	− 0.0808	0.189
	− 0.0613		− 0.0459		− 0.0614	
Male authors	− 0.5610	0.382	0.8630	0.102	− 0.6140	0.341
	− 0.6410		− 0.5270		− 0.6430	
Abstract	− 0.0296	0.899	0.447*	0.012	− 0.0589	0.802
	− 0.2320		− 0.1780		− 0.2340	
Full text length	− 0.052**	0.833	0.0510	0.779	− 0.0552	0.822
	− 0.2460		− 0.1820		− 0.2460	
Reference	0.833***	0.000	0.0882	0.361	0.830***	0.000
	− 0.1300		− 0.0964		− 0.1300	
JIF	0.6980	0.081	0.4060	0.184	0.6720	0.094
	− 0.4000		− 0.3050	0.072	− 0.4010	
Affiliate language	− 0.0583	0.626	− 0.0722	0.422	− 0.0546	0.648
	− 0.1200		− 0.0898		− 0.1200	
_cons	− 0.3550	0.898	− 4.667*	0.022	− 0.3090	0.909
	− 2.7740		− 2.0240		− 2.7020	
Year fixed effects	Yes		Yes		Yes	
Journal fixed effects	Yes		Yes		Yes	
N	5431		5431		5431	
pseudo R^2	0.2395		0.0243		0.2401	

Standard errors in parentheses, *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

each of these 25 positive words that are used in life science (we show this all 25 positive words in the supplementary materials).

Percentage calculation of these 25 positive words There is no doubt that titles and abstracts are among the most important text in research papers since readers often use this information to determine which articles deserve further investigation (Lerchenmueller et al., 2019). We focus on the frequency of these 25 positive words that are used in all papers' abstracts or titles. To ensure that all data are full and available, the corpus consists of 5,431 research articles (see Table 5 for the descriptive statistics).

To determine whether men and women differ in the positive presentation of their research, we use the percentage of these 25 positive words (*Positive words*) based on the count of words in each article. Due to the right-skewed nature of the data, this research transforms the data by taking the logarithm. The *Positive words* are calculated as follows:

TABLE 11 Results of mediating effect

D.V	(1) Impact		(2) PW		(3) Impact	
	β (SE)	*p*	*β (SE)*	*p*	*β (SE)*	*p*
Gender	− 0.0583**	0.035	− 0.0798*	0.076	− 0.0598*	0.815
	− 0.0938		− 0.5110		− 0.0925	
PW					0.186***	0.000
					− 0.0519	
Author publications	− 0.0785	0.201	0.2540	0.428	− 0.0877	0.149
	− 0.0613		− 0.3200		− 0.0606	
Male authors	− 0.5880	0.361	− 4.0220	0.150	− 0.3440	0.589
	− 0.6430		− 2.7920		− 0.6370	
Abstract	− 0.0375	0.872	0.3890	0.751	− 0.0268	0.907
	− 0.2330		− 1.2220		− 0.2300	
Full text length	− 0.0422**	0.004	− 0.1790	0.886	− 0.0414	0.864
	− 0.2460		− 1.2500		− 0.2420	
Reference	0.825***	0.000	− 1.3490	0.053	0.862***	0.000
	− 0.1300		− 0.6960		− 0.1280	
JIF	0.6920	0.084	− 4.200*	0.047	0.830*	0.037
	− 0.4000		− 2.1120		− 0.3970	
Affiliate language	− 0.0198	0.857	− 0.2480	0.673	− 0.0174	0.872
	− 0.1090		− 0.5880		− 0.1080	
_cons	− 0.0318	0.991	13.6600	0.309	− 0.8430	0.752
	− 2.7000		− 13.4200		− 2.6660	
Year fixed effects	Yes		Yes		Yes	
Journal fixed effects	Yes		Yes		Yes	
N	5431		5431		5431	
pseudo R^2	0.2395		0.0243		0.2401	

Standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

$$Positive\ words_i = \log\left(\frac{\sum Positive\ Words_i}{\sum Total\ Words_i} * 10000 + 1\right)$$

where *Positive words* is the index of the article *i*'s percentage of these 25 positive words, and *Positive words* is the count of these 25 positive keywords in the abstract or title of the article *i*. *Total Words* is the total number of words in the abstract or the title of the article *i*.

Results

The mediating effect of positive words

To explore the relationship between the articles' impact and the author's gender, we use the same models (2–4), but we use positive words as the mediator.

The dependent t-test indicated that articles with a male first author had a greater impact than those with a female first author ($M_{female} = 0.78$, SD = 0.45 vs. $M_{male} = 0.91$, SD =

0.71, t (5430) = 4.527, p = 0.000). H1 is supported. The dependent t-test indicated that articles with a male first author use more positive words than those with a female first author (M_{female} = 1.26, SD = 0.69 vs. M_{male} = 1.38, SD = 0.45, t (5430) = 3.693, p = 0.000). H2 is supported.

The next step will be directly verifying the mediating role of *Positive words*. The estimation results for anxiety are reported in Table 11. Column (1) shows that the coefficient of gender is negative and significant across all three models, suggesting that gender is negatively associated with the impact ($\beta = -0.0583$, $p = 0.035$). H1 is supported again. Columns (2) indicate that the coefficient on gender is negative and significant across all three models, suggesting that gender is negatively associated with Positive words ($\beta = -0.0798$, $p = 0.076$), and H2 is supported again. In column (3), gender also has a significantly negative relationship with impact with less coefficient ($\beta = -0.0598$, $p = 0.018$), and *Positive words* has a positive effect ($\beta = 0.186$, $p = 0.000$) on impact. The mediation effect of *Positive words* is significant for the articles' impact. H3 is supported.

We used the Monte Carlo method (Li et al., 2021; Selig & Preacher, 2008) with 50,000 bootstrapping samples, and results supported the mediating effect of *Positive words* on the relationship between author gender and research impact (estimate = − 0.88, 95% CI [− 0.0280, − 0.0102]). Results supported the mediating effect of *Positive words*. H3 is supported again.

Discussion

In order to address gender disparities and improve women's status, the UN proposes promoting "gender equality" as one of the SDGs. This study is piqued by an aim to underpin current global efforts to promote gender diversity in studies, which matters for the achievement of gender equality in research and society.

An analysis of the 86 year 9820 articles from the top four leading journals in marketing from 1936 to 2021 is presented in this study. Our conclusions are as follows. We draw four main conclusions from our analysis. Firstly, we find that female authors have an increasing academic status in marketing, as evidenced by their number, publications, and influence. However, there are still gender differences between men and women, which is in line with previous research (Elsevier, 2017; Huang et al., 2020; Lariviere et al., 2013). Secondly, by combining the study of writing style and assertiveness, we find that articles with female first authors have a more negative language style than those with male first authors. In addition, the positive writing style of the articles explains the gender differences in research performance. Thirdly, in the robustness check, we find that masculinist and feminist cultural traits moderate the effect. Compared to the articles whose first authors originate from feminist culture emphasizing modesty, the articles whose first authors originate from masculinist culture emphasizing competition have a greater impact.

Theoretical contributions

We make three contributions to the literature in this paper. Firstly, focusing on the top four marketing journals, we find that although female scholars are becoming more academically prominent, gender differences between men and women still exist. Previous studies have focused on STEM and medicine (Elsevier, 2017; Huang et al., 2020; van Arensbergen

et al., 2012), and we complement the study of gender differences in research performance in marketing.

Furthermore, we explain the differences between male and female scholars on research performance by combining studies on confidence and writing style. On the one hand, these studies typically consider only descriptive variables such as age, country, institution, productivity, etc. (Lopez & Pereira, 2021; Myers et al., 2020; Restrepo et al., 2021). In this paper, we discuss the writing style and promote research in this area. On the other hand, previous studies have failed to investigate the underlying mechanisms of gender differences in research performance (Fox & Paine, 2019; Horbach et al., 2022), and we accounted for gender differences by examining the writing style.

Additionally, previous research on research performance differences has rarely focused on cultural differences (Cheryan & Markus, 2020; Khosrowjerdi & Bornmann, 2021). In a robustness check, we find the effects are moderated by the culture of masculinism and feminism. The authors' articles have a greater impact in a masculinist culture than in a feminist culture. However, we find a correlation between Hofstede's masculinity and femininity cultural dimension and research performance. We contribute to the study of research performance and cultural differences, but it needs to be further investigated.

Finally, we contribute to the method of analyzing writing style. The latest studies resort to larger dictionaries and lexicons to tackle the limitation of the small list of positive and negative words (Bordignon et al., 2021; Holtz et al., 2017; Vinkers et al., 2015; Wen & Lei, 2022a). We use advanced sentiment analysis techniques (Min et al., 2021). Consistent with Min et al. (2021) in organizational behavior, we also find that fine-tuning BERT enhanced the extraordinary understanding of the relationship between words and BERT's ability to understand the context of the original sentence in marketing. We share the data, code, and stimuli at OSF: https://osf.io/bw8gx/. This article uses the latest deep learning algorithm to promote the research of big data analysis methods in marketing research and provides method guidelines and references for future research on the writing style of the article.

Managerial implications

The findings of this study are practical in nature. To achieve gender equality, academics must put forth a concerted effort. We find that, despite the persisting gaps in performance between men and women, the academic status of women has significantly improved. Based on these results, we offer theoretical insights to reduce gender differences. Despite the gender differences that have been identified by studies, we propose a method to boost the research performance of women researchers. Women can be more confident and active in writing articles, which helps increase the article's impact.

But it should be more cautious about the managerial implications (Cao et al., 2021; Millar et al., 2019; Yuan & Yao, 2022). Research is based on scientific evidence and rigorous logic to seek truth and facts. The best way to publish a paper with high impact is to improve the quality of this research. Our findings encourage authors to collaborate and express more actively while maintaining scientific rigor and accuracy.

Limitations and future research

In spite of the fact that all of our research hypotheses are confirmed, there are still some limitations to our study with robustness. First, we use the gender of the first author to represent the gender attribute of a paper (Decullier & Maisonneuve, 2021; Jemielniak et al.,

2022; Liu et al., 2022; Nguyen et al., 2021; Thelwall & Maflahi, 2022; Thelwall & Mas-Bleda, 2020; Thelwall et al., 2019; Thelwall, 2018, 2020a, 2020b), a set of robustness check improve the robustness of findings. But it should be noted that a manuscript has also been edited/revised by other authors before it is submitted and published. That is, the writing style of a manuscript is not only dependent on or determined by its first author, but also most likely by other authors. There is also a need to consider the contribution and the impact of the authors in other positions in the article, such as the last authors (Andersen et al., 2020; Lerchenmueller et al., 2019; Sebo & Clair, 2022), corresponding authors (Edwards et al., 2018; Fox & Paine, 2019), senior authors (Polanco et al., 2020; Powell et al., 2022), solo authors (Nunkoo et al., 2020), middle authors, and mentee authors (Lopez-Padilla et al., 2021), co-first, senior, and co-senior authors (DeFilippis et al., 2021). Based on the foregoing point, we suggest more research needs to pay attention to this point in future research.

Moreover, although our research demonstrates that a positive writing style can have a positive impact on an article's impact, we ignore its negative "backfire". It is detrimental to incorporate language associated with self-promotion and aggrandization into scientific writing (Morris et al., 2021). Our study aims to explain gender differences in academic performance from the perspective of the writing style, and we do not examine this negative "backfire". Future research should, however, explore the limits and possible inflection points of the effects of the positive writing style. This might help to rectify the problem.

Besides, the correlation between positive words and research performance may be affected by other factors, such as an individual's race (Palomo et al., 2017). The article's unstructured data, in addition to the positive words, gives us additional information, such as the topic, the methodology, the subject, etc. This study is not able to investigate these factors due to the length of the article and the scope of our research. We intend to combine our findings with other databases to investigate these factors in the future.

Finally, we focus exclusively on marketing. To generalize our findings to other scientific fields, future studies should examine more journals in different fields of study. Meanwhile, please note that the articles used for this study are those published in leading journals with high scientific quality. Further research can determine whether this effect applies to general journals.

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Declarations

Conflicts of Interest The authors declare no conflict of interest.

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