The Impact of Gender on Conference Authorship in Audio Engineering: Analysis Using a New Data Collection Method

Kat Young, Michael Lovedee-Turner, Jude Brereton and Helena Daffern

***Abstract—Contribution:* This paper provides evidence of the lack of gender diversity at audio engineering conferences, using a novel and inclusive gender determination method to produce a new dataset of author gender.**

***Background:* Audio engineering has historically been male-dominated; while the number of non-male audio engineers has increased recently, the industry mindset has changed very little. Studies into the gender diversity of this field are required, to force a shift in mindset and create a more inclusive environment.**

***Research Questions:* To what extent is there an imbalance in the representation of different genders at audio engineering conferences? Do conference topic, presentation type, or author position have an impact on the gender balance?**

***Methodology:* A novel method was designed to obtain pronouns of authors where possible, avoiding removal of data or potential false positives. The main limitation of this methodology is the time required for gender determination. Gender composition was analyzed across 20 conferences, with gender balance further analyzed within four key categories: conference topic, presentation type, position in the author byline, and the number of authors.**

***Findings:* This study demonstrates a clear lack of gender diversity in conference authorship in audio engineering. The results show low overall representation of non-male authors at audio engineering conferences, with significant differences across conference topics, and a notable lack of gender diversity within invited presentations.**

***Index Terms*—audio engineering, bias, conferences, discrimination, engineering pipeline, gender, STEM, underrepresentation**

I. Introduction

MUCH literature exists on the subject of the gender gap within science, technology, engineering and math (STEM) [1], [2]. Although there has been a steady increase since 2000, still only 23.9% of UK professorial positions were held by women in 2015/16, and the percentage of female professors in STEM is smaller still. The Equality Challenge Unit (ECU) Report 2015/16 shows women held only 19.3% of UK STEM professor roles [3]. The numbers are a little better when looking at the student body; 45.7% of science graduates in the UK in 2013 were female, yet female students accounted for only 22.2% of engineering graduates in the same year [4].

Both the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Global Research Council (GRC) have stated goals to increase the participation of women in STEM [4], [5]. The disparity exists at every level within STEM: in student and researcher numbers, in scholarly output, and in salaries and advancement opportunities [4], [6].

Increasing diversity in the workforce has a positive effect on business and research outcomes. Companies that increased their percentage of women in leadership positions from 0% to 30% saw a 15% increase in profitability [7], whilst increasing gender diversity directly relates to higher earnings [8]. Research teams with greater diversity are more likely to produce more creative and innovative solutions to research problems [9] and are more effective [10]. However, these improved outcomes are not likely to arise if an increase in the diversity of people entering the different levels of academia is not achieved.

Researchers have proposed various reasons for the presence of the gender gap within STEM [1], [2], [11], [12]. Both explicit actions of all genders (whether conscious or unconscious) and societally-conditioned behaviors of minority genders play a role [11]. Women are cited less often, receive fewer prizes, have research that is perceived as being of lower value than their male counterparts and are rated as less competent, while men are more likely to self-promote and negotiate harder [11], [12]. Women have also been shown to be more risk averse, reject invitations to speak, publish less, and use more tentative language when describing their research, likely due to a lower level of self-belief or a sense of the impostor phenomenon [1], [2], [11], [12]. The impostor phenomenon refers to the experience in which a person believes they are not worthy of the place they currently occupy and are therefore 'an impostor', an experience commonly reported by high-achieving women [13], [14]. A barrier can also be produced by conscious or unconscious bias of management, particularly if positions of power are male dominated [15]. This can lead to female applicants being overlooked, or invited positions being passed on to other male researchers. Whilst various metrics indicate that progress is being made (the percentage of female STEM professors is up 11% from 15 years ago [16]), there is still a long way to go to reach gender parity (considered to be when the balance between women and men in a group is at least 40/60 [17]).

The home audio technology industry has been historically male, with its roots in the tinkering of hobbyists using skills learned during the World Wars [18]. Before World War II, the phonograph was not particularly associated with men, however, by the 1960s, home audio equipment had become a predominantly male hobby [19]. The ownership and usage of such equipment was strongly associated with 'the man of the

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house', and respite via audio equipment was a common trope found in advertisements of the time [18]. These associations were also present in academia: in one listening test comparing mono and stereo listening equipment undertaken in 1958, participants were asked what they would do if their wife disliked the idea of having additional loudspeakers in the living room [20]. Despite evidence of increasing numbers of women involved with high quality home audio systems [21], this mindset has not changed drastically, with similar beliefs still displayed about the role of women [22].

Professional associations are a useful indicator of the state of academia and industry, as both groups attend and contribute to published content. The Audio Engineering Society (AES) is one such leading professional association within the field of audio engineering. Formed in 1948, it currently has more than 12,000 members worldwide and organizes conferences, conventions, and the publication of a monthly journal across a wide range of audio-related topics [23]. The AES are making attempts to combat gender stereotyping of audio, with the recent formation of a Diversity and Inclusion Committee and the alignment of the British Section with the UNWomen 'HeForShe' campaign [24], [25]. However, fewer than 7% of AES members are female [16].

This paper investigates the gender diversity of authors at AES conferences in the last five years. By investigating whether a similar gender imbalance to that in membership is reflected at publishing level, a deeper insight into the gender diversity within the organization as a whole can be achieved. This paper will address the following research questions: 1) To what extent is there an imbalance in the representation of different genders at AES conferences? 2) Do conference topic, presentation type, or author position have an impact on the gender balance?

II. Related Work

Existing studies of this nature have looked predominantly at gender balance with a much wider scope than only audio engineering: West et al. looked at the JSTOR database [26], Allagnat et al. analyzed the Scopus database [6], and Eigenberg et al. looked at a number of journals within criminal law [27]. Whilst these studies are focused within academia, there has been very little work with regards to gender representation in audio engineering, and therefore direct comparison to related research is difficult. However, the methods employed in these previous studies are of use.

In [26], the JSTOR catalogue [28] was analyzed, looking at the overall gender composition across fields within the catalogue and the impact that authorship position had on gender composition. The entire corpus contained 8.3 million documents from 1545 to early 2011. However, since the authors were investigating citation relationships between publications, they analyzed only a subset of the whole corpus, limited to publications that cited others within the corpus. The method implemented to assign genders was based on gender coding of first names, using the US Social Security Administration [29] list of the 1000 most common male and female names in the US for each year from 1880–2010. If at least 95% of occurrences of a name belonged to single gender, the gender of the author was assigned as such. If the author was listed with an initial rather than a full first name, the name did not appear on the list, or the name had lower than 95% occurrence for a single gender, the author was removed from the analysis. This led to 26.7% of the 3.6 million authors analyzed being rejected from the study. The method is therefore biased towards US naming conventions and does not necessarily accurately represent non-US countries, or less common names.

In [6], the Scopus [30] database (62 million documents) was analyzed from 1996 to 2016 in five-year blocks. This study looked at the proportion of women within researchers and inventors, and gender-related patterns in a number of areas. As in [26], only researchers with a full first name were considered. To determine the gender of an author, three methods that combined gender coding of first name with geographical location were employed in succession. If the first method, Genderize.io [31], reported a probability of 85% of a name being either a male or female name and there were at least five instances of it in use, a gender was assigned. If that was unsuccessful, a gender was assigned if the second method, NamSor [32], predicted a probability of 0.7 for the name being either male or female (the reason for the difference in probability used is unclear). To resolve the gender of names of Japanese origin, the third method used a list of the most common male and female Japanese names. This three-step method was found to work well with Western countries and Latin or Anglophone names, but was not sufficiently robust for African, Asian or Arabic names, so these regions were excluded from analysis. Although not explicitly stated, it is assumed that where gender could not be assigned, the author was removed from analysis. The number removed is also not listed.

Although not related to STEM, [27] provides a variation on previous methods. Eigenberg et al. analyzed eight criminal law journals looking at gendered publication patterns. This dataset contained 998 articles with 2021 authors. The method used in this study assigned gender based on gender coding of the first name (source is not stated), however, in the case of a gender-neutral or ambiguous name, gender was extrapolated from author photos or pronouns used online. In this study there were two cases where a gender could not be assigned to an author (0.10%), and these cases were excluded from the analysis [27].

III. Method

A. List Generation

A list of authors was generated for AES conferences from January 2012 to December 2016. This five-year period is in alignment with other studies of this nature [6], [33], and resulted in a dataset including 39% of the available conference data, due to the distribution of AES conferences across years and data format limitations. From 1982 to 2011, there were 44 conferences, an average of 1.5 per year (the data is not available in a suitable format for 13 of these conferences); from 2012 to 2016, 20 conferences occurred (an average of four per year).

An author list was compiled from the online proceedings for each conference. A number of other points of interest were also noted: conference name and year, type of presentation[1], and the position of the author within the author list. For multi-authored papers, the author was assigned to one of three categories; first author, last author, or one of the other authors (labelled as 'middle'). No record was made of whether the author originated from industry or academia, of their position within their respective organization, or of the geographic location of the author, as these were outside the scope of this study. AES conferences are held in a variety of countries across Northern America, Europe and Asia, and authors submit from across the world.

The final list consisted of 1761 data points across 20 conferences with 702 presentations, giving an average of 88.05 authors per conference and 2.51 authors per presentation.

B. Gender Determination

A novel method has been designed to avoid the assumptions associated with determining gender from first name, and to allow gender identification outside the binary of male and female, as discussed in Section IV. This method was designed to use self-identified pronouns wherever possible, Fig. 1. By using direct data in the first instance, the impact of false positives generated from indirect data can be reduced, hence producing a more accurate list for gender diversity-based studies.

Pronoun was used as an analogy for gender, based on the current general understanding of the link between the pronoun a person uses and their self-identified gender. Asking for a pronoun was deemed to be less invasive than asking for gender identity, as it is more public; it also ensures consistency across data collected via emailed confirmation from author and pronoun extraction from written sources. Data collection was limited to English pronouns, avoiding translation issues such as in Finnish, where the pronoun 'Hän' translates to both 'He' and 'She'.

In cases where an investigator could confidently verify an author's pronoun due to personal acquaintance, the known pronoun was accepted as reliable and no further determination was required. For the remaining authors an email address was obtained through internet searching, and an email sent to every author asking for their pronoun. These two methods can be described as 'direct' data collection.

If no email address was available, no reply was received or the email failed, 'indirect' data collection was required. In the first instance, a pronoun was derived from a biography available online. This was deemed a valid source based on the assumption that the author would have, at some point, read or written the biographies available online. Biographies were limited to those from conference proceedings and publications, personal or a collaborator's professional website/LinkedIn/ResearchGate etc, press releases, or book biographies. Biographies were excluded if from social media

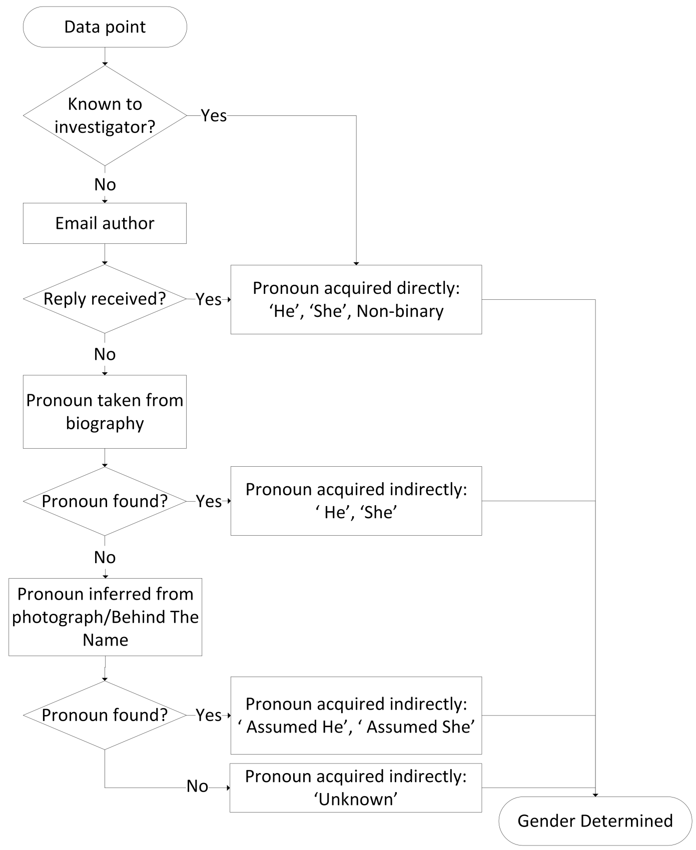

Fig. 1. Flowchart for gender determination using the novel method, including direct and indirect data collection methods.

or from non-professional websites, as these are not necessarily sources verified by the author.

If no biography was available and the author was not known to an investigator, two additional sources of information were recorded to enable assumption of gender based on name and gender presentation: a photograph gathered using the same method as biography pronoun, and a gender marker from the website Behind The Name [34]. Behind The Name uses a wide range of sources to determine the gender marker traditionally associated with a name. These 'Assumed He' and 'Assumed She' categories were grouped into 'He' and 'She' respectively for analysis. If no email, biography, photograph or gender marker was found (or the first name was gender-neutral), these authors were assigned to a final group labelled 'Unknown'.

This resulted in three pre-designed pronoun groups: 'He', 'She', and 'Unknown'. Other categories could be added as needed to accurately represent the gender diversity of authors to include non-binary[2] genders.

IV. Method Comparison

To assess the merits of the novel method for authors' gender determination, comparisons were made against the work presented by West et al. [26] and Allagnat et al. [6], labelled as Method 1 and 2 respectively. Comparison with the

[1] 'Type of Presentation' is used here to mean anything listed in conference proceedings, for example keynote, paper or panel.

[2] 'Non-binary' is used here as an umbrella term for gender identities that are not binary male or female.

work presented by Eigenberg et al. [27] was not possible due to the lack of information regarding the name database used.

Applying Methods 1 and 2 to the dataset produced in this study results in a larger section of the data labelled as 'Non-Assignable' or 'Unknown' than that produced with the novel method, Table I. It is of note that Method 1 results in 42.36% of the data being removed. Whilst removing the unknown data and recalculating the percentages, Table II, gives representation of male and female comparable to those produced with the novel method, the resulting dataset is much smaller, bringing into question the validity of any subsequent analysis. Some author genders have also been assigned differently between previous methods and the novel method in three different ways: case 1 where the gender was not assigned using Method 1 or 2 but was assigned using the novel method; case 2 where the gender was assigned in Method 1 or 2 but was not assigned using the novel method; or case 3 where the gender was assigned differently between Methods 1 or 2 and the novel method (Table III). Note that Methods 1 and 2 were compared not to each other but to the novel method used in this study.

TABLE I
COMPARISON OF METHODS USING THE DATASET GATHERED IN THIS STUDY

Method	Male	Female	Non-binary	Non-assignable
Method 1	52.07%	5.57%	N/A	42.36%
Method 2	82.57%	9.20%	N/A	8.23%
Novel Method	88.98%	9.09%	0.11%	1.82%

TABLE II
COMPARISON OF METHODS AFTER REMOVAL OF UNKNOWN DATA

Method	Male	Female	Non-binary
Method 1	90.34%	9.66%	N/A
Method 2	89.98%	10.02%	N/A
Novel Method	90.63%	9.25%	0.12%

TABLE III
COMPARISON OF DATA ASSIGNED DIFFERENTLY BETWEEN METHODS 1 AND 2 AND THE NOVEL METHOD

	Method 1	Method 2
Differently Assigned	744 (42.31%)	159 (9.09%)
Case 1	716 (40.66%)	128 (7.27%)
Case 2	2 (0.11%)	15 (0.85%)
Case 3	26 (1.59%)	16 (0.91%)

The main limitation of Method 1 is the use of US-based name lists, which does not account for gendered name differences between countries (for example, 'Andrea' is typically female in the US and typically male in Italy), or for names of non-Western origin. Although less country-specific than Method 1, Method 2 is still not robust to names of Asian origin or names of ambiguous gender. The success of name-based gender assignment is entirely based on the reliability of the sources drawn from, which do not necessarily provide a comprehensive list of names with accurate representation of all nationalities. Additionally, neither method allows for gender identification outside the binary male and female. Both limitations are addressed by the novel method employed here.

However, some limitations remain. It is time intensive due to the pronoun collection procedure which makes it less feasible for larger datasets; to develop a method based on self-identified pronoun that is sustainable for larger datasets, pronoun or gender collection would need to be fully integrated into the conference submission system; along with other author details such as honorific, affiliation and contact details.

Also, the use of online biographies to find author pronouns may result in incorrect pronouns, where the author may be reluctant to provide their chosen pronoun if it deviates from societal norms, or their chosen pronoun may have changed since writing the biography. Despite these limitations, the method used has allowed for inclusion of a larger proportion of the data than when compared with previous studies with similar objectives. It is believed that the discrepancies in gender assignment between previous methods and that outlined here are in favor of the novel method, with the use of 'direct' data collection procedures resulting in a more accurate reflection of the gender composition of the database. From the pronouns assigned using the proposed novel methodology (excluding cases where a pronoun could not be assigned), 35.63% came from 'direct' data collection (personal knowledge or email confirmation), 43.15% from biographies available online (assumed to be more accurate than gender marker), and only 21.23% inferred from gender markers of names and photographs.

V. RESULTS AND DISCUSSION

A. Pre-Processing

To account for variation in the format of conference proceedings, presentation types deemed to be of similar delivery intent were grouped. 'Demo' and 'Sponsor Seminar' were grouped into 'Demo', 'Workshop' and 'Tutorial' grouped into 'Workshop', and 'Invited Speaker', 'Invited Talk', 'Talk' and 'Lecture' grouped into 'Invited Speaker'.

Data points tagged as 'Assumed He' (18.63% of overall dataset) were combined into 'He' (20.93% of 'He' once grouped). Data points tagged as 'Assumed She' (2.21% of overall dataset) were combined into 'She' (24.38% of 'She' once grouped). Due to the small number of direct confirmations of non-binary pronouns, these were grouped into one category: 'Non-binary'. This results in four categories: 'Male' ('He'), 'Female' ('She'), 'Non-binary', and 'Unknown'.

Statistical analysis of categorical data indicates the use of a Pearson's chi-squared (χ^2) test to evaluate the likelihood of any observed difference arising by chance. However, with the data gathered in this study, some pronoun entries in the contingency table contained fewer than five occurrences. This required that pronouns be grouped to enable valid statistical analysis using this test. The four variables ('Male', 'Female', 'Non-binary', and 'Unknown') were reduced into 'He' and 'Not He', with the 'Unknown' category removed (32 data points), reducing the contingency table to a 2 x N table where N is the number of variables in the non-pronoun category.

B. Overall Gender Composition

Table IV shows the large disparity between the representation of male- and non-male-identifying[3] authors at AES conferences over the past 5 years. Women and non-binary people occupy only 9.09% and 0.11% of the author positions respectively, with 1.82% of the dataset being 'Unknown'. This is comparable to the findings of Mathew et al. with regards to AES membership: 7% of registered AES members were female [16].

TABLE IV
OVERALL GENDER COMPOSITION ACROSS DATASET.

Gender:	Male	Female	Non-binary	Unknown
Percentage:	89.04%	9.09%	0.11%	1.76%

These values are lower than those found by West et al. in the JSTOR database (21.9% of identifiable authors as female) but this included many topics outside of STEM, and not engineering [26]. Allagnat et al. [6] found that, when conducting analysis independent of field in the Scopus database, many regions were roughly 40% female, but when looking at engineering the percentage was much lower: in the period 2011–2015, the United States had 21% women, UK 20% and the EU 24%, and no comparator region had female representation greater than 35%. The results found in this study indicate that audio engineering therefore has lower non-male representation than engineering as a whole, a trend also seen by Allagnat et al. across umbrella and sub-fields [6].

There has been very little change in the gender composition of authors at AES conferences over the five years analyzed. 2016 has the lowest representation of non-male authors, with only 6.03% of authors being female, and 0.43% of the 464 authors using a pronoun other than 'He' or 'She'. The two highest years for female representation were 2012 and 2015 with 12.43% and 12.20% respectively. During this five-year window, 2016 was the only year to have any non-binary representation. With only a five-year analysis window, no immediate trend can be observed within this data, Fig. 2.

Previous studies have found an improvement in gender ratio over time [6], [16], [26], [35]. West et al. found that female authorship had increased substantially since the 1960s, but this may be partly due to the increase of female authors using names rather than initials (a condition for being removed from the study), as well as looking at more subject areas than just STEM alone [26].

Studies specifically investigating gender composition in the field of audio engineering have shown an increase in percentage of female representation e.g. female membership of the AES increased from 5% to 7% between 2006-2016; female membership of the International Computer Music Association from 15% to 18% in the same time period [16]. It may be the case that the five-year window used in this study is not large enough to show a trend in gender composition over time, or show evidence of any knock-on effect of this increase in membership.

[3]'Non-male' is used here as a grouping of 'She', and 'Non-binary'.

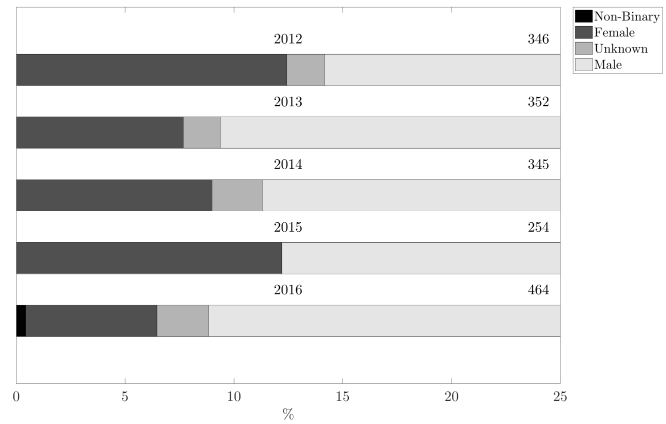

Fig. 2. Gender composition of AES conference by year, where the number on the right is the population size for each year. For clarity, x-axis is limited to 25%.

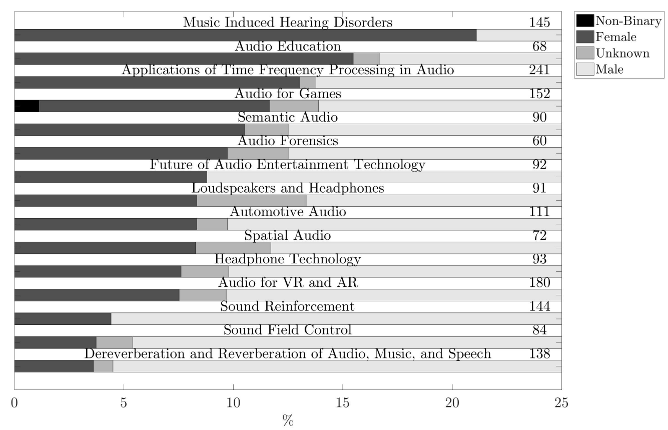

Fig. 3. Gender composition by conference topic, where the number on the right is the population size for each topic. For clarity, x-axis is limited to 25%.

C. Gender Composition by Conference Topic

Disaggregating the data by conference type, Fig. 3, shows that the percentages of female and non-binary authors vary between conference topics. Music Induced Hearing Disorders had the highest percentage of female authors (21.11%) followed by Audio Education (15.48%). The lowest representation of female authors was found in Dereverberation and Reverberation of Audio, Music, and Speech (3.60%), followed by Sound Field Control (3.73%). Only a third of the conference topics had representation of female authors above 10.00%; only one topic had non-binary representation. These differences between male and non-male are significant, $\chi^2(14, N = 1729) = 38.14, p < 0.01$, indicating a link between topic and non-male representation.

It is suggested that the more 'theoretical' conference topics have lower representation of non-male authors, as opposed to the more 'applied' topics. The higher percentage of female representation in conferences relating to audio education and audio medicine, for example, parallels the increase in female representation in those fields more generally, in both authorship and academic positions [6], [26], [35]–[37].

D. Gender Composition by Presentation Type

Investigating the gender composition by presentation type, Fig. 4, shows that few female and non-binary authors are represented on 'Invited Papers' (2.08%), 'Keynote' (6.57%), and 'Workshop' (6.28%). Conversely, higher female and non-binary representation was observed for 'Demos' (13.04%), 'Panels' (11.69%) and 'Poster' (11.49%). Presentation types which could be described as 'invited' (invited paper, invited speaker, keynote, panels) are those with the lowest representation, with a 50% or more reduction in the representation of female and non-binary authors in some of these presentation types.

Invited positions are likely to be occupied by industry experts and senior academics rather than students or early researchers. Increasing the number and diversity of visible role models is often proposed as a way to encourage greater diversity of applicants in industry and education [38]–[40]. If the visibility of non-males remains low, this will, in turn, have a knock-on effect for future conferences, where the environment is perceived as non-inclusive and the lack of incoming non-male students will stagnate the gender diversity of these invited positions [40].

The reduction in non-male representation could also be representative of unconscious bias in the selection process of invited speakers by the selection committee [11], [15], or due to women being more likely to turn down invitations to present than men [11]. Comparing 'invited' types against the overall dataset (where the types classified as invited are denoted with an asterisk in Fig. 4) shows that there is no statistically significant difference, $\chi^2(1, N = 1940) = 0.72, p > 0.05$, in the representation of non-males in invited positions verses the overall dataset. Although there is no significant difference in the representation of non-males in the 'invited' types when compared to overall, the general low percentage of female and non-binary authors in these positions highlight that there is likely unconscious bias in the selection process for invited positions at conferences.

Whilst the relationship between the gender diversity of the selection committee and the gender diversity of conference authors, as well as the relationship between an invitation to speak and acceptance of that invitation, are interesting avenues for research, for example in [41], they are not possible with the dataset acquired during this study. The lack of female and non-binary representation across other non-invited presentation types could also be indicative of a knock-on effect caused by a lack of female and non-binary authors in the keynote and invited positions.

E. Gender Composition by Author Position

Various systems exist for defining the positions of authors in papers, including declining order of contribution, alphabetical sequence and first-last-author-emphasis [42]. Within scientific writing, typically the first author has contributed most, as is often the case with student-led research, and the last author is the supervisor or project lead [26], [42]. Therefore, these positions tend to receive higher credit for the paper's impact [42]. However, due to the lack of a known standard for author order at AES conferences it cannot be definitively stated that this is the case for all publications in this dataset.

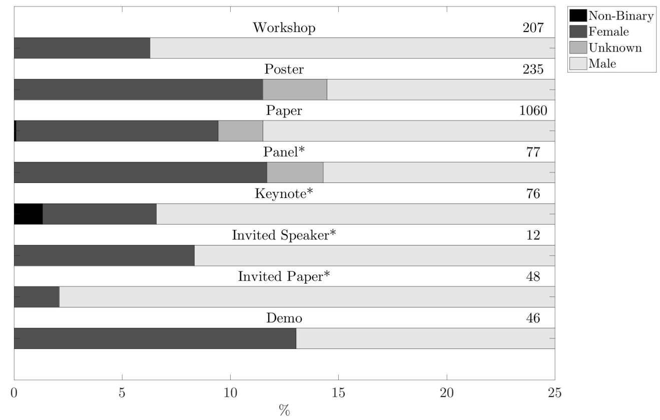

Fig. 4. Gender composition by the different presentation types, where the asterisk indicates an 'invited' paper and number on the right is the population size for each presentation type. For clarity, x-axis is limited to 25%.

A number of presentation types were excluded from the analysis as they did not easily fit an understanding of author order: for example, the author order listed on a panel follows no discernable system other than perhaps the order in which the panelists were confirmed.

Analysis of the relative author position for papers, invited papers and posters, Fig. 5, reveals that there are fewer female and non-binary authors in the first author position (7.65%), compared to the middle and last author positions (9.94% and 11.08% respectively). These findings are comparable to those shown by West et al. [26], where female authors were less represented in the first and last author positions, however, analysis of each combination of positions indicated there was no significant difference between them: $\chi^2(1, N = 743) = 2.59, p > 0.05$ for First against Last; $\chi^2(1, N = 839) = 1.45, p > 0.05$ for First against Middle; $\chi^2(1, N = 840) = 0.23, p > 0.05$ for Last against Middle. This indicates that while non-male representation overall is low, it is equally represented across the author positions, in contradiction with Allagnat et al [6], who showed that women were relatively over-represented in first or corresponding author position, i.e., the share of female lead authors was greater than the share of female researchers in the field. This contradiction may likely be due to the lack of an established system of author positions within the AES.

F. Gender Composition of Single-Author Versus Multi-Authored Presentations

Single-authored papers, posters and invited papers made up 14.53% (102) of the presentations; it is assumed that these presentations are more likely to have been authored by established researchers rather than students. Disaggregating the data, Table V, to investigate the gender composition by single authorship shows 8.82% female authors, and no non-binary authors represented. This percentage of female single authors is lower than the wider view of single-authored publication patterns across more fields, with West et al. finding 17% of single-authored papers within JSTOR authored by women

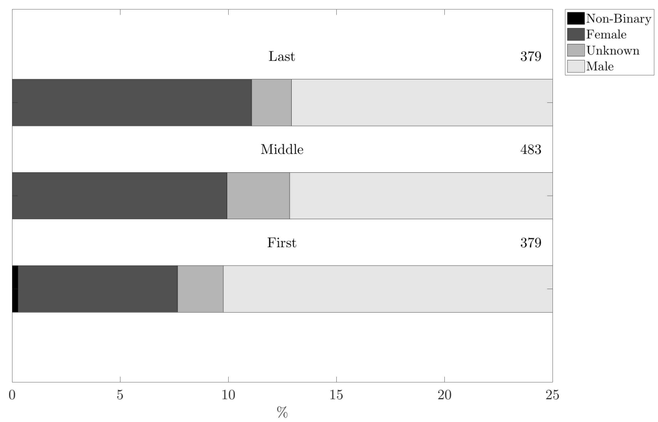

Fig. 5. Gender composition by relative author position in presentation, where the number on the right is the population size for each author position. For clarity, x-axis is limited to 25%.

[26]. They also found an increase in the number of female single-authored papers post-1990, with this being a possible side effect of historic female authors using initials over first names.

Comparing the non-male representation in multi-authored and single authored papers, there was a percentage difference of 0.77% (single authored: 8.82% non-male, multi-authored: 9.59% non-male (9.51% female, 0.08% non-binary)). This was found not to be a significant difference, $\chi^2(1, N = 1313) = 0.11, p > 0.05$, which contradicts findings by Eigenberg et al. that women are more likely to participate in multi-authored publications [27]. This may be an artifact of differing behavior across different sectors, but perhaps indicates a positive result within the AES with regards to single- versus multi-author authorship trends.

TABLE V
GENDER COMPOSITION OF SINGLE AUTHORS VS MULTI-AUTHORED PRESENTATIONS ACROSS DATASET.

Authorship Type	Male	Female	Non-binary	Unknown
Single authored	91.18%	8.82%	0%	0%
Multi-authored	87.99%	9.51%	0.08%	2.42%

VI. CONCLUSION

This study provides numerical data, collected using a novel gender determination method, representing the gender composition of authors at Audio Engineering Society conferences from 2012–2016, with analysis of specific categories within that dataset. The method employed in this study was shown to be more robust when compared to two existing techniques. The results clearly substantiate the anecdotal lack of gender diversity in audio engineering, with a large disparity between male and non-male representation in authorship overall and within all categories analyzed. Results showed a significant difference in the representation of non-male authors by conference topic. However, no significant differences were found in representation of non-males by 1) presentation type, 2) author position, and 3) between single- and multi-author publications, despite very low representation in some invited presentation types. It is of note that gender parity is not displayed in any aspect of the dataset. Overall, female participation in AES conferences is low; more must be done to ensure that gender inequality is addressed, creating an environment where future students can thrive regardless of gender.

DATA ACCESS

Data used is available at: doi.org/10.5281/zenodo.889045. Visualization of the data, incorporating additional conference data gathered since this study, is available at: http://tibbakoi.github.io/aesgender.

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