Gendered Sounds in Household Devices: Results from an Online Search Case Study

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ABSTRACT
Multiple household devices are now using human-like voices. We investigate whether there are gender differences in the voices used by different kinds of specialized smart devices (e.g., microwaves vs. toy trucks) as provided by Google's search engine. These gender differences could fuel gender stereotypes in the household environment, or they could help challenge them. Early results suggest a preponderance of male-sounding voices among household devices in the search results but also multiple instances of counterstereotypical media presentation.

KEYWORDS
Gender bias; algorithmic bias; search bias, audio bias.

INTRODUCTION
Media platforms and technological systems serve as gatekeepers for the spread of information. These systems then influence and reflect stereotypes, including those in the household and gender domains (Herdağdelen, 2011; Noble 2018, 2013). There is well documented evidence of marginalization based on gender in print and electronic media as well as digitally mediated platforms (Singh, Chayko, Inamdar, & Floegel, 2020; Arslan & Koca, 2007; Bligh, Schlehofer, Casad, & Gaffney, 2011; Sink & Mastro 2017). These media reinforce "traditional" stereotypes but can also serve as useful examples for counter-stereotypical imagery in certain situations (Singh et al., 2020).

Specialized smart devices with computerized voices, which are becoming ubiquitous in households, are currently understudied with respect to potential gender bias (Anderson & Rainie, 2018). The household is a highly gendered institution (Richardson, 2009), and gender stereotypes are often associated with digital voices (Reeves & Nass, 1996). Understanding how gender is portrayed and reflected in these devices allows for stereotypes to be identified and challenged before they become (advertently or inadvertently) baked into emerging platforms and diffused throughout the household environment and society at large (Silverstone & Hirsch, 1992).

This study does not include voice-enabled personal assistants, like Alexa, Siri, and Google Assistant, as there is an established body of research on these devices (Abrahams, 2018; Broussard, 2018; Shulevitz, 2018). This project instead focuses on speech that originates from specialized devices in household environments targeted to specific tasks and roles, whose impact has not been studied widely. Specifically, this study looks at search engine (Google) results on a selection of "talking" household devices. The devices selected are consistent with similar literature (England, 2017) on gendered labor in the home, and include traditionally female-associated devices viz. microwaves, vacuum cleaners, and soft toys, and traditionally male-associated devices, viz. security alarms, fire alarms, and toy trucks. Considering the above, the Research Questions for this study are:

- RQ1: For which types of household devices are male-sounding voices more commonly used? For which are female-sounding voices more commonly used?
- RQ2: Do stereotypical gender expectations play a significant role in the gender of the device voice?

METHODOLOGY
For each of the six device types, the first 100 video results (or as many as retrieved, if fewer) were downloaded from a Google video search. The format for the search was "talking X", where X is the device (e.g., "talking microwave"). A human annotator listened through each video. Speech in this case refers to audio content that is (a) human-sounding and (b) coherent words or language. The various types of audio content listened for included:

- Male-sounding speech
- Female-sounding speech
- Gendered but not "speech" - device makes a human-sounding noise

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- Gender-indistinct human speech - cannot be distinguished as male or female
- Robotic voice - voice is not human sounding but does include speech

In case of multiple voices in the video, the scores were distributed proportionally in the different categories.

RESULTS

To answer RQ1, we look at the data summarized in Table 1. Of the 600 videos, 297 contained content that fit into one of the considered audio categories. The remaining videos did not include a voice of any kind emanating from a device and are not included in Table 1. The male- and female-sounding categories contained most of the instances.

Device	Male-sounding	Female-sounding	Gendered, not speech	Gender-indistinct human speech	Robotic	Total
Microwave	25	12	0	0	0	37
Vacuum cleaner	15.8	14.2	12	0	0	42
Soft toy	38.73	12.27	0	28	10	89
Fire alarm	8	31	0	0	0	39
Security alarm	15.5	18.5	0	0	0	34
Toy truck	52.66	2.34	1	0	0	56
Totals	155.69	90.31	13	28	10	297

Table 1. Overall Data Collection

For four of the six devices (microwave, vacuum cleaner, soft toy, toy truck), male-sounding speech is more prevalent than female-sounding speech. For two devices (fire alarm and security alarm), female-sounding speech is more commonly found. Overall, there were more male-sounding devices (155) than female-sounding devices (90). The overrepresentation of male-associated search results on the internet is consistent with past studies (Singh et al., 2020). However, the results did **not** match the gender stereotype expected in five of the six categories. For instance, while we expected more female-sounding speech for talking microwaves, we found more male-sounding speech. This could be interpreted as a challenge to traditional stereotypes or as an artifact of male overrepresentation in media and on the internet in general. Irrespective, knowing these search results' preponderances is important as they could impact household device adoption.

To answer RQ2, we undertook regression analysis. The dependent variable is the observed speech gender (male-sounding speech = 0, female-sounding speech = 1), the independent variable is the stereotypically expected gender, and the control variables are the six device types. The gender stereotype was found to play a significant role (p-value = 0.0117, i.e., $p<0.05$) in impacting the observed sound. At the same time, the specific device type was found to be significant in multiple device categories.

DISCUSSION

For RQ1, of the six device types, only one (toy trucks) falls into the stereotypically expected gender group. There are a variety of reasons this may be the case. The first potential source of bias includes the search engine, where the ratio of search engine results may be biased. There is an overrepresentation of maleness on the internet (Singh et al., 2020). Next, the dataset is relatively small, and the labels were assigned manually by a single human annotator. This limitation will be mitigated with other annotators examining the same data (research is in progress). Another limitation of the study includes the use of gender as a binary construct. While the majority of the results appear to fall into the dichotomy, the authors acknowledge gender to include non-binary variants. The significance of the gender stereotype variable as observed in RQ2 aligns with past research. While there is a relationship, the dataset does not perfectly coincide with past research. Multiple devices showed counter stereotypical results, which demonstrates the potential for internet search results to challenge stereotypes.

This is one of the early studies to consider gender bias in the search for household devices. The study looked at Google search results for six devices falling into traditional household gender divisions. While the study suggests a statistically significant relationship between gender expectation and the apparent gender of speech, there are nuances of male overrepresentation and counter-stereotypical media presentation. With further refinement and analysis, these results could render explicit the biases in audio devices, and suggest potential ways to counter stereotypes.

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