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Large-scale computational content analysis on magazines targeting men and women: the case of Argentina 2008-2018

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ABSTRACT

Differences in magazines content aimed specifically at women or men are a means to create and reproduce gender stereotypes. Novel computational tools allow to study differences in magazines content taking into account all available articles. In this study, we analyse the case of two Argentinian magazines published by the same publishing house over a decade (2008–2018), advertised by the publishing house as targeting women and men respectively. Using computational tools, we are able to analyse more than 24,000 articles, which would have been an impossible task using manual content analysis methodologies. With Topic Modelling techniques we identify the main themes discussed in the magazines and quantify their different frequency between magazines over time. Then, we performed a word-frequency analysis to validate this methodology and extend the analysis to other subjects. Our results show that topics such as *Family*, *Business* and *Women as sex objects* present an initial bias that tends to disappear over time. Conversely, in *Fashion* and *Science* topics, the initial differences are maintained. Also, we identify a considerable increase in the use of words associated with feminism since 2015 and specifically the word *abortion* in 2018. Furthermore, we develop a website where everyone can perform additional analysis.

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Introduction

Representations of gender in any society cannot be understood without considering the political and cultural intersections that comprise the context in which they were produced and maintained (Butler 1998). Gender is a historical construction (Joan W. Scott 1986) deeply embedded in the use of discourse (Marisol Del-Teso-Craviotto 2006). The relevance of popular media for the production and reproduction of stereotypes in societies has been

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 Supplemental data for this article can be accessed [here](#)

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widely studied (Gaye Tuchman 1979; Janice Winship 1987). One of the most important theoretical frameworks on the role of the media as a stereotype reproductive agent is the Social Cognitive Theory (Bandura Albert, Ross Dorothea and Sheila A. Ross 1963). This theory states that behavioral patterns and attitudes can be acquired by observing symbolic models, both those observed in real life and those shown in popular media. Therefore, portrayal of women and men in stereotypical roles and frames in mass media serves as a source of generation and reproduction of gender stereotypes (Marisol Del-Teso-Craviotto 2006).

Over the years, several authors have reported the reproduction of stereotyping associations by mass media outlets such as magazines (Ervin Goffman 1979; Marín Murillo, et al. 2010), movies (Ramiro H Gálvez, Tiffenberg Valeria and Edgar Altszyler 2019; Katy Gilpatric 2010; Kimberly A. Neuendorf, et al. 2010), newspapers (M. Pilar Matud, Carmen Rodríguez and Inmaculada Espinosa 2011), radio (Martin Eisend 2010), music (Jacob S Turner 2011; Carolina Spataro 2013), and television (Martin Eisend 2010; Mallika Das 2011; Roger Desmond and Anna Danilewicz 2010; Heather J. Hether and Sheila T. Murphy 2010; Nathalie Koivula 1999). A revision on content analysis in mass media has been reported by Rebecca L. Collins 2011 and Rena M. Rudy, Lucy Popova and Daniel G. Linz 2010. The Global Media Monitoring project 2020 (Sarah Macharia 2020) shows that globally, news stories have not challenged gender stereotypes since 2005.

Another piece of evidence of stereotyping association is the existence of differential content in the media expected to be consumed by men or women specifically. This bias strengthens and perpetuates differences between the symbolic role models of genders (Marisol Del-Teso-Craviotto 2006).

The use of coding schemes for content analysis represents a standard approach for studying stereotyped roles (Kimberly A Neuendorf 2011), and for several decades, these schemes have been used to quantify elements of static categories. However, categories designed in the recent past might become outdated in the short-term, due to fast sweeping social changes (Yorgos C Zotos and Eirini Tsihla 2014). These changes require new categories to be built increasingly frequently. In addition, these categorizations need to be specifically adapted to each study, which poses a problem, as it may require careful manual labor on each specific research.

Between 2008 and 2018, relevant events around the expansion of women's rights and sexual diversity took place in Argentina. These series of events have been the focus of attention and debate in the mass media as well as in social media. The rise of the feminist agenda in Argentina developed between 2008 and 2018 on three levels: feminist activism, government representatives, and progressive legislation. As examples of the increased mobilization capacity of feminist grassroots organizations we can mention the "Slutwalk" march (2011), the *ni una menos* march protesting femicides, which gathered a million people in Buenos Aires in 2015; and the growing participation in the *Encuentro Nacional de Mujeres* (national women's meeting), which gathered 5000 women in 2008, and 200,000 in 2019. Changes in the government representatives were also experienced, with the election of Cristina Fernández de Kirchner (in 2008), the first woman to be elected president in Argentinian history; a change also seen in other countries in the region, like Chile (in 2006) and Brazil (in 2011). Several acts were passed by the congress as a reflection of these changes: the Human Trafficking Prevention and Punishment and Victims Assistance Act (N° 26,364) in 2008, and the Comprehensive Act on Protection to

Prevent, Punish and Eradicate Violence against Women in the Areas in which they Develop their Interpersonal Relationships (N° 26,485) in 2009. The Equal Marriage Act (2010) and the Gender Identity Act (2012) placed Argentina as an international legal role-model for LGBTQ+ rights. The Voluntary Pregnancy Termination Act deserves a special chapter in the history of women rights in Argentina. With the unprecedented debate that took place in 2018, both in the congress and the streets, although the act was not passed at that time, the massive debate laid the groundwork for its passing two years later. Our aim in this article is to explore the contents of two Argentinian magazines which target segmented audiences (BRANDO and OHLALÁ) within the context of the feminist movement rise in Argentina (2008–2018).

The emergence of the feminist movement transformed women and men's daily lives in Argentina in different spheres, such as family structure, child rearing, and the way of dressing and consuming. It also transformed values and cultural forms towards a more diverse and respectful society where women are not treated as objects, they can make decisions about their own bodies and participate in all professional spheres on equal terms with men. As the literature has shown, movements can influence the mass media agenda (Candi Carter Olson 2016). In this regard, we wonder if these social changes are reflected in the editorial lines of the media in Argentina. Has there been any improvement in the stereotypical representation of men and women in mass media? Have any stereotypes been preserved or reinforced during this period? These questions guide our research.

In the present study, we introduce a novel methodology for a semi-automatic analysis of gender bias in magazines content. Our corpus is based on the online articles from *OHLALÁ* and *Revista Brando*, two Argentinian magazines from the same publishing house that target women and men, respectively. The fact that they come from the same publishing house provides a unique opportunity for comparison. We apply computational techniques to identify the topics present in 24,000 articles between 2008 and 2018 from these magazines, and then, we analyse content evolution and differences between them over the years. As our methodology is able to capture a multiplicity of phenomena, in this article we focus only on those topics that we considered most relevant. Nevertheless, we created the website: <http://magbias.dc.uba.ar/> where the reader can complement the present analysis with their own research questions.

The main contributions of this article are the following:

- (1) Our case study context presents a unique time and place. The decade of 2008–2018 in Argentina is marked by the emergence of the feminist movement, and fast and strong changes in cultural patterns. Because of this, we expect to see changes in the content of magazines in such a short period (historically speaking).
- (1) We conducted a case study on two magazines from the same publishing house, which allows us to monitor the “editorial effect” of the content differences.
- (2) This methodological proposal allows us to be thorough in our case study. We are able to see the evolution of topics/words over time for each magazine. We illustrate this with a selection of results, but our tool allows for the study of a plethora of hypotheses. We created a website¹ where the readers can formulate their own research questions regarding the vocabulary changes of these magazines.

- (3) Our analysis corroborates previous studies, finding biases. It also accomplishes a level of detail that allows us to see which biases remain over time, and which changed.

Methods

In this section we describe the technical approaches of content analysis used to conduct this research. Firstly, we present the compiled dataset and its characteristics. Secondly, we describe a Topic Modelling technique employed for automatic detection of topics in the dataset. Thirdly, we outline a Word Frequency Analysis used to validate the automatic content detection. Finally, we describe the dataset preparation for these technical approaches. Given that the articles are originally in Spanish, the content analysis was performed in this language. A translation into English of the selected words and topics is provided.

Data collection

The corpus compiled for this paper consists of 6,060 articles downloaded from *Brando* magazine, and 18,082 articles from *OHLALÁ* magazine, published between 2008 and 2018 (Magazine links 2018). Figure 1 shows the distribution of articles over time for each magazine. All available articles online were gathered. According to the commercial information of each magazine (Comercial LA NACION [online] 2020), *Brando* magazine's target is men between 30 and 50 years old. It has a net sale of 10,000 copies, and 4,500 subscribers. *OHLALÁ*'s target are women between 25 and 45 years old. It has a net sale of 37,500 copies and 15,000 subscribers. Also, when launched, *OHLALÁ* was presented as

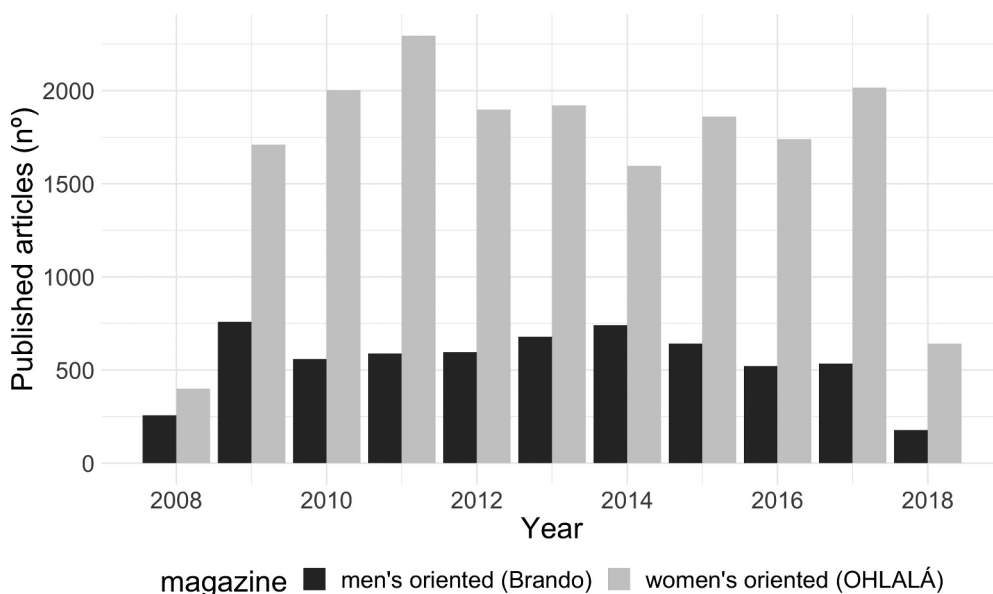


Figure 1. Articles published by year for men and women-oriented magazines, Brando and OHLALÁ.

a womens' magazine (La Nacion 2008). Nevertheless, it is important to highlight this is information provided by the publishing house, which is meant to convince potential advertisers. No public information is available regarding the actual readership of each magazine.

Topic modelling

We implemented a Topic Modelling technique, the Latent Dirichlet Allocation (LDA) (David M. Blei, Andrew Y. Ng and Michael I. Jordan 2003). The main function of LDA is to automatically identify the topics that best describe a dataset. This approach provides the opportunity of a semi-automatic analysis, as the words that describe each topic arise from the corpus itself and not from the choice of the researcher. In this sense, the researcher does not need to previously study the jargon used in the magazine in order to define the relevant topics, as the most repeated terms are automatically retrieved and thematically sorted by LDA. Since this model has been extensively explained by Blei et al. (2003), it will only be described briefly herein. Given a corpus of documents, LDA makes the assumption that there is a set of fixed topics that describe the content. LDA models each article as a distribution over topics, and each topic as a distribution over words. This can be thought of as the process of writing an article, in which the author first chooses the main topic, and then those themes condition the words that are more likely to appear in the manuscript. After processing the texts, LDA automatically computes the probability distribution for each topic on each article. Then, each topic obtained by the LDA can be represented by a list of its most probable words. Given that list, a researcher in the field needs to analyse the lists of words and assign a label to each emergent topic. For example, a list composed of ten words including *children*, *mother*, *mom* and *father*, among others, can be manually labelled as *family*.

In the present study, we fed the LDA with all the articles from both magazines and instructed the model to construct 100 topics. Given the table containing the 100 emerging topics and the 10 most probable words defining each of them, we selected and tagged the specific topics that we considered of interest regarding gender stereotypes, without prior knowledge of how they were distributed across magazines (Supplementary Table 1).

Then, for each magazine, we calculated the proportion in which each labelled topic is present for each year ($P_{M,Y}(T_i)$). As an example, this would be read as the proportion of the *family* topic in the *OHLALÁ* magazine in 2010.

This is accounted by

$$P_{M,Y}(T_i) = \frac{\sum_d P_{d,M,Y}(T_i)}{\#d_{M,Y}} \quad (1)$$

Where $P_{d,M,Y}(T_i)$ is the probability of the topic i (T_i) for document d in magazine M and year Y , and $\#d_{M,Y}$ is the number of documents for magazine M and year Y .

The main and novel contribution of Topic Modelling is the large-scale automatic identification of recurring topics in texts. In addition, it allows to quantify the presence of these topics among the magazines, thus revealing the differences present in magazines targeting women and men.

It is worth noting that not all inferred topics are interpretable (Jonathan Chang, et al. 2009). Therefore, an expert from the field is required to select the topics that she or he considers most coherent and most relevant for the hypothesis testing. Another relevant factor to consider is that the inferred topics can contain unexpected associations that arise from the discursive context of the corpus (John W Mohr and Petko Bogdanov 2013). To validate the LDA analysis in this study, we also performed a Words Frequency analysis as described below.

Words frequency analysis

We used the standard approach based on word counting. First, a list of unambiguously manually selected words was assembled to represent each topic. Second, the frequency of occurrence of these words for each year and each magazine was calculated. The frequency F of occurrences of the word-list l , in the year Y and magazine M was calculated as

$$F_{M,Y}(l) = \frac{\#W_{l,M,Y}}{\#W_{*,M,Y}} \quad (2)$$

Where $\#W_{l,M,Y}$ is the number of occurrences of words in the wordlist l in magazine M and year Y , while $\#W_{*,M,Y}$ is the total number of words in magazine M for that given year (Jean-Baptiste Michel, et al. 2011).

Finally, for each word list, we compared the time series of the $D_{M,Y}(l)$ frequencies of both journals, and used a fisher-exact test to assess whether differences are significant between both magazines. The words that have polysemy were excluded from the lists to avoid overlapping in word meanings. Given that the vocabulary used in the magazines is composed of thousands of words, and that we are building lists of words of undefined sizes, the possible combinations of words is enormous. Therefore, there are several thousands of potential tests. This generates a statistical problem known as “multiple comparison problem”, meaning that it is possible to find a combination of words that provide statistically significant differences where there are none, just by chance. This has to be avoided, otherwise it could become a source of misleading conclusions. Thus, the lists have to be carefully constructed and theoretically justified before experimentation. In this work, we construct word lists based on the Topic Modelling results, consequently avoiding this problem. We also build three lists of words that did not appear automatically in the Topic Modelling results, but we consider they pose relevant theoretical issues: the rise of the feminist movement in Argentina during the period of study, together with the abortion legalization debate in the Argentinian congress, and finally the increasing consumption of pseudoscience, represented in the use of zodiac signs terminology.

Dataset preparation

Each article was labelled with its release year t , and the magazine of origin (*OHLALÁ* or *Brando*). The stop words, like *the*, *they*, *to*, etc, were removed using the Spanish stop words list in the NLTK Python package (Steven Bird, Ewan Klein and Edward Loper 2009). The list of the 500 most frequent words in Spanish was reviewed and a selection of 319 words

without semantic content related to our analysis (e.g. *friendship, love*) was also removed from the dataset. In addition, specific words that refer to one or another magazine (like their names and derived neologisms) were also removed.

For the Topic Modelling (LDA), each word was replaced with its stem form (a short version of the word with suffixes removed (Bird et al. 2009), and after the Topic Modelling step, a de-stemming was performed. Considering that in the present study the frequency analysis was implemented as a control, the stemming and de-stemming procedure was not performed for this case.

Summary

The proposed methodology is a combination of automatic Topic Modeling, together with a word frequency analysis. We consider that this provides the following advantages:

- (1) LDA automatically discovers recurrent themes that are present in the corpus, which is beneficial for the formulation of hypotheses.
- (2) LDA automatically represents each theme according to the probability of occurrence of each word in it. This is a major advantage, because it avoids the researchers' need to build lists of words for each topic to study. The manual construction of word-lists is time-consuming and can potentially introduce new biases. The LDA generated lists of terms is contextual to the used corpus, and therefore it captures the specific jargon within the magazine. This model avoids the problem presented by Zotos et al. (2014) of outdated categories and vocabulary.
- (3) When LDA assigns the distribution over topics for each article, it considers all words present in the document, and not only the salient terms that characterize a topic. It can also assign articles to multiple topics. Therefore, LDA is able to consider words in their context.
- (4) A complementary word frequency analysis allows to validate the results obtained by the LDA, and also, to study new content that could be omitted by the LDA due to its low frequency in the texts

In the following section, we will analyse the results of these techniques.

Results

Automatic topics detection

To evaluate the results from Topic Modelling, we run the LDA model over the full corpus, i.e., both women-oriented and men-oriented magazines, for 100 topics. We extracted the ten most relevant words for each topic (Supplementary Table 1). After careful analysis of the list of emergent topics, we selected and labelled six of them to perform the following experiments based on the relevance of these topics on gender stereotypes (Table 1).

Table 1. Selected topics extracted from LDA analysis, manually assigned tags and ten most probable words automatically detected in each topic. The words underlined appeared originally in English in the articles. In *italic*, a translation for the words originally in Spanish is provided.

id	Assigned Tag	Top 10 words
1	Women as sex object	natalia <u>hot</u> ana emma romina <u>versus</u> diez (<i>ten</i>) camilo morochas (<i>brunettes</i>) mega
4	Business	empresa (<i>company</i>) redes (<i>networks</i>) sistema (<i>system</i>) comprar (<i>to buy</i>) productos (<i>products</i>) mercado (<i>markets</i>) traves (<i>crossing</i>) tecnologia (<i>technology</i>) permite (<i>it allows</i>) desarrollo (<i>development</i>)
7	Children	niños (<i>kids</i>) adultos (<i>adult</i>) educativo (<i>educative</i>) colegio (<i>school</i>) chiquito (<i>tiny</i>) padre (<i>father</i>) secuestro (<i>kidnap</i>) <u>change</u> sauna pegote (<i>goop</i>)
21	Fashion	moda (<i>fashion</i>) diseño (<i>design</i>) estilo (<i>style</i>) marca (<i>brand</i>) colección (<i>collection</i>) ropa (<i>cloth</i>) tendencia (<i>trend</i>) prendas (<i>garments</i>) rosa (<i>pink</i>) zapatillas (<i>sneakers</i>)
50	Family	hijos (<i>children</i>) madre (<i>mother</i>) mama (<i>mom</i>) padre (<i>father</i>) bebe (<i>baby</i>) familia (<i>family</i>) papa (<i>dad</i>) embarazo (<i>pregnancy</i>) regalo (<i>gifts</i>) años (<i>years</i>)
82	Science	estudio (<i>study</i>) problema (<i>problem</i>) trabajo (<i>work</i>) explica (<i>explains</i>) ley (<i>law</i>) medico (<i>medic</i>) social (<i>social</i>) generar (<i>to generate</i>) desarrollo (<i>development</i>) investigar (<i>to research</i>)

Automatic content analysis

To evaluate whether the topics addressed in each magazine have a gender related content bias, we estimated the probability of each topic for each article. Then, we compared the evolution of the topic probability over time for each magazine, using GAM smoothing (Trebore J. Hastie and Robert J. Tibshirani 1990) in a percentage scale (Figure 2).

Our results show a significantly higher rate of appearance of the topic *business* in the men-oriented magazine compared to the women-oriented one, although this gap shrunk over time. The opposite occurred with the *children* topic, which at the beginning of the

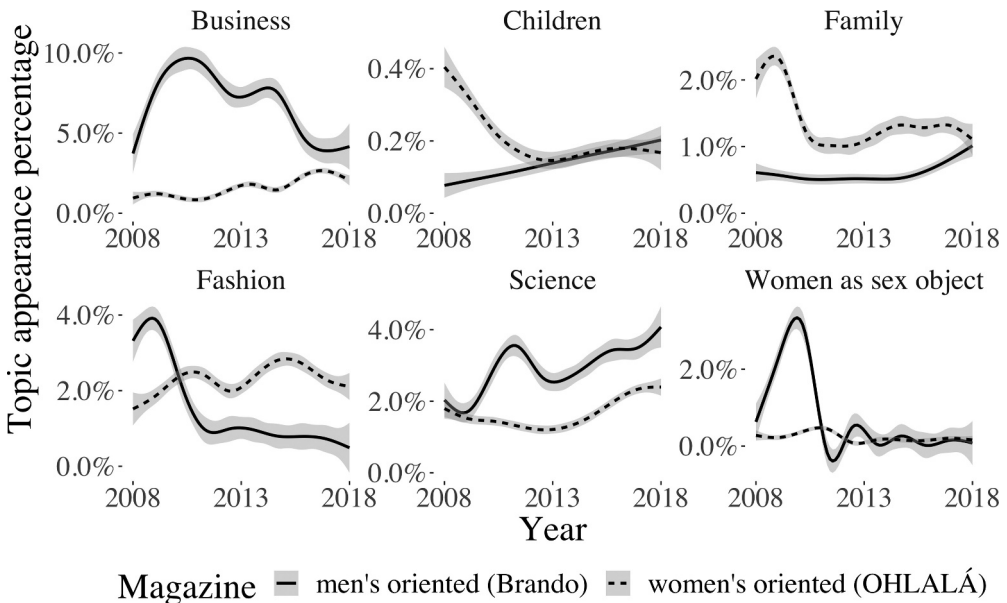


Figure 2. Topic appearance percentage over time. Each colour represents a magazine. GAM smoothing of the observations (Hastie et al. 1990) with 95% confidence intervals in grey.

analysed period presented much more frequent appearance in the women's magazine, but around 2013 this difference disappeared. The same trend was presented by the topic *family*, although the differences remained detectable until 2018.

The *fashion* topic had a particular behavior over the years. While it begins with greater representation in the men's magazine, a decreasing tendency was observed over time. In 2010 this topic was equally approached in both magazines, and then it continued to be overrepresented in the woman-oriented magazine without gap closure in 2018. One of the topics with more abrupt changes in the rate of appearance was *women as sex objects*, which had a very recurrent appearance in the early years of the men's magazine, but after peaking in 2011, an abrupt decrease is observed, and it practically disappeared. The topic *science* begins with equal presence in both magazines. However, its appearance in the men-oriented magazine increased around 2010, generating a difference between the magazines that was sustained over time.

Overall, this automatic analysis displayed several differences in the content of these magazines. It was observed that most of the evaluated topics changed over the years, in the women as much as in the men-oriented magazine. In addition, while some of the topics biases were reverted over time, some other topics remain associated with one of the two magazines.

Validation of automatic content analysis

Since the topics inferred by the LDA may contain unexpected associations that come from the discursive context of the corpus (Mohr et al. 2013), we supported these results performing a Word Frequency Analysis on the dataset.

To perform the frequency analysis, we manually selected non-ambiguous words that defined each of the six topics of interest (Table 2).

For each topic we considered the ten words resulting from the LDA analysis (Table 1) and excluded the ambiguous or non-representatives. For the *science* topic we use only the word *science* itself, because we consider that the words within this topic might be found in other contexts unrelated to science.

Figure 3 shows the evolution of the *relative word frequency* compared to the total words used in each magazine each year (Equation 2). In the majority of cases, the frequency of occurrence of the most representative words of each topic reproduced the trend observed in Figure 1.

Table 2. Words selected to represent each topic in the frequency analysis. The words underlined were used in English. In *italic*, a translation for the words used in Spanish.

Topic	Words
Family	<u>hijos</u> (<i>children</i>), <u>madre</u> (<i>mother</i>), <u>mamá</u> (<i>mom</i>), <u>padre</u> (<i>father</i>), <u>bebé</u> (<i>baby</i>), <u>familia</u> (<i>family</i>), <u>papá</u> (<i>dad</i>)
Children	<u>niños</u> (<i>kids</i>), <u>adulto</u> (<i>adult</i>), <u>colegio</u> (<i>school</i>)
Business	<u>empresa</u> (<i>company</i>)
Fashion	<u>ropa</u> (<i>cloth</i>), <u>diseño</u> (<i>design</i>), <u>estilo</u> (<i>style</i>)
Science	<u>ciencia</u> (<i>science</i>)
Women as sex objects	<u>hot</u> , <u>morocha</u> (<i>brunette</i>)

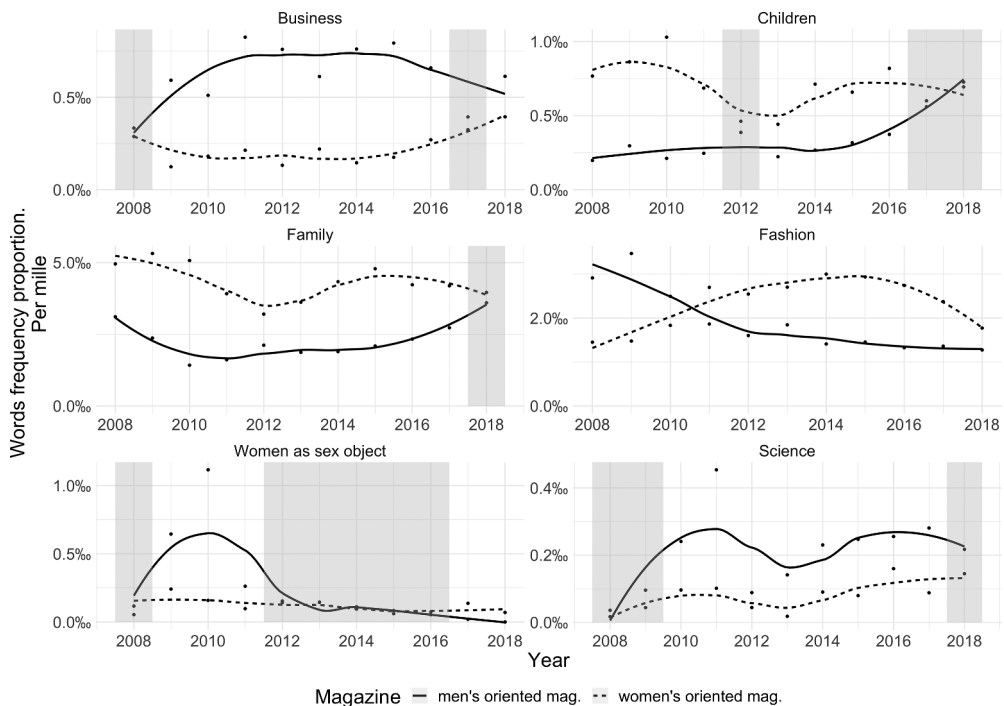


Figure 3. Frequency evolution of the words in the word-lists. Solid lines are a LOESS smoothing of observations. The years with non-significant differences between the magazines are shaded in grey.

The exception to this is the frequency analysis of words associated with *children* topic, whose behavior is more similar to the *family* topic than to its own topic. This result can be interpreted as either that this topic is not coherent enough or that we labelled the topic erroneously. This is an example of how this verification step is important when using Topic Modelling.

Figure 4 shows the frequency evolution of the word-list containing the word horoscope (*horóscopo*) and non-polysemic zodiac signs [*horoscope (horóscopo)*, Taurus (*Tauro*), Aries, Gemini (*Géminis*), Scorpio (*Escorpio*), Sagittarius (*Sagitario*), Capricorn (*Capricornio*), Aquarius (*Acuario*), Pisces (*Piscis*) and Virgo]. We also show the frequency evolution of the word abortion (*aborto*), and the frequency evolution of words associated with feminism [*feminist (feminista)*, *feminists (feministas)* and *feminism (feminismo)*].

The frequency of words associated with *horoscope* is very high and keeps increasing over the years in women-oriented magazine. On the contrary, it remains at low values in the men-oriented magazine (Figure 4a). The word *abortion* appears very infrequently in both magazines, with the exception of 2018, when the frequency of this word is significantly higher in the women-oriented magazine than in the men-oriented magazine (Figure 4b). Finally, regarding the words associated with *feminism*, an increase is observed in the appearance of them in both magazines since 2015. However, these words were more represented in the magazine oriented to women than in the one oriented to men (Figure 4c).

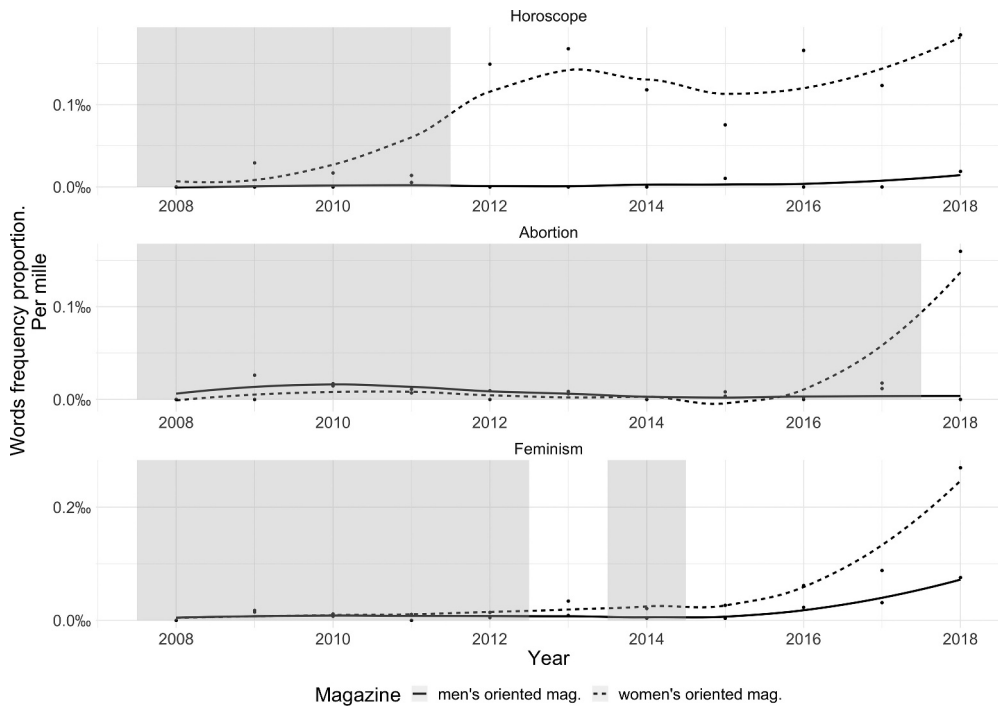


Figure 4. Frequency evolution of words for a: Horoscope, b: Abortion and c: Feminism. Solid lines are a LOESS smoothing of observations. The years with non-significant differences between the magazines are shaded in grey.

Discussion

The concept of gender identity is an operational term that intends -in a political process- to enlarge visibility and legitimacy (Butler 1998). Gender, says Butler, “is not always constituted coherently or consistently in different historical contexts, because gender intersects with racial, class, ethnic, sexual and regional modalities of discursively constituted identities” (Butler 1998).

Several studies have analysed differential content in gender-oriented magazines. One of the first texts that made a comparison of female and male press is Alice E. Courtney and Sarah W. Lockeretz 1971, which analysed seven magazines that targeted both male and female readers. Over the years, these analyses were performed mainly by manual content quantification, presenting a limitation on the number of articles that were included.

Using a Topic Modelling technique, we were able to successfully analyse 24,000 articles from two magazines, one targeting men and the other targeting women, in a period of 10 years. By complementing this model with Word Frequency Analysis, we were able to automatically identify five relevant topics (*business, family, women as sex objects, fashion and science*). This method allows to discover themes that are present in the corpus and it represents each theme according to the occurrence probability of each word in it. Unlike the classic method based on static word lists, the words that represent the topics are specific to the historical moment and the environment, thus solving concerns raised by Zotos et al. (2014) about the effects of strong cultural changes.

Our analysis shows that there are differences in the appearance frequency of topics between both journals, and that these differences were consistent with well-studied gender stereotypes that reinforce traditional social roles (Murillo et al. 2010).

Our findings are aligned with the literature regarding oversexualization of women (Edward Downs and Stacy. L. Smith 2010), portrayal of women as responsible for family matters (Mallika Das 2011; Scott Coltrane and Michelle Adams 1997), association of science and business to men and not to women (Matud et al. 2011; Courtney et al. 1971) and association of fashion with women (Murillo et al. 2010; Deana B. Davalos, Ruth A. Davalos and Heidi S. Layton 2007; José I Baile, María Gabino-Campos and Ana Laura Pérez-Lugoa 2020).

Despite the fact that there are studies which characterize horoscopes content in magazines targeting women and girls (Edson C. Tandoc and Patrick Ferrucci 2014), little research has been carried out to address the difference between media targeting men and women regarding content associated to horoscope and astrology.

From a static point of view, our analysis confirms the presence of content bias, already described in the literature. However, especially in such a hectic period for Argentinian society, the longitudinal approach revealed that the content bias does change over time. The ultimate reasons that motivate these changes in the studied magazines are only fully comprehensible when knowing the inner context of the newsroom, which is beyond the scope of this article. Nevertheless, a possible hypothesis is that in the heat of the events mentioned above, women and men-oriented magazines modified their contents in an attempt to reach the readership that have new ideas, values and forms of consumption.

Our results showed that there was a strong tendency to close the content distribution gap between the magazines on topics such as *business*, *family*, and *women as sex objects*. The latter topic fell abruptly between 2011 and 2012. The timing of this change coincides with the rise of the feminist movement in the Argentinian political arena, starting with the first “Slutwalk” in 2011 (G. F. Díaz and C. Pastor 2012). These results are in line with the hypothesis that the feminist movement and the struggle for women rights in Argentina has, at least partially, succeeded in condemning the objectification of women and, therefore, the media has made decisions that respond to these new rules.

Since 2015 the presence of feminism in magazines targeting women has increased sharply. Such phenomenon coexists with the rise of the #NiUnaMenos movement and its presence in the media. This movement protests against gender violence and femicides (Muireann O’Dwyer 2016; María C. Davies 2017; C. Garibotti María and M. Hopp Cecilia 2019). In 2018, a jump is observed in the use of the word *abortion* in the magazine aimed at women, reflecting the uprising debate on abortion legalization in Argentina that was discussed in Congress that year (Mirna Lucaccini, Luca Zaidán and Mario Pecheny 2019).

Regarding the *family* topic, our finding is aligned with the signs observed by Marshall David, et al. (2014) of a change in the representation of fatherhood in magazine advertisements. On the other hand, the *fashion* and *science* gap shows no signs of narrowing. In addition, the gap in the content associated with the *horoscope* shows an increase when compared to the beginning of the analysed period. The persistence of the *science* and *horoscope* gap is in line with the ongoing debates in local feminisms. Androcentric bias in science has been debated by the Argentinian feminist movement before our period of analysis (Diana Maffia 2007; Diego Kozlowski, et al. 2022). These problems in scientific production have split waters within the local feminist movement. Feminist researchers

and university students have begun to discuss gender bias in science, in order to promote diversity in research. But, at the same time, other local activists have started to question the role of science itself, and instead they have proposed to recover *ancestral knowledge*, traditionally excluded from science, such as the horoscope (Agostina Mileo 2020). As we can see, pseudo-sciences are not unanimously criticised by the feminist movement, and therefore mass-media magazines are unlikely to modify their content related with these topics in the foreseeable future.

Performing a word frequency analysis as a control turned out to be a good complement to Topic Modelling. The Word Frequency Analysis of the topic *children* did not show similar behavior to that of Topic Modelling, so we can disregard this topic from the analysis.

Overall, our work presents a novel application of methods that proves to be useful in analysing large amounts of articles with computational tools and that contribute to the field of gender bias analysis in magazine content.

Limitations

The methodological framework proposed in this study focuses on the textual evidence of gender stereotypes in magazines. This approach does not consider the non-textual evidence, such as images and other formats. The visual content on magazines plays a vital role in gender stereotypes reproduction, especially in advertising (Susan G. Kahlenberg and Michelle M. Hein 2010; Mager John and James G. Helgeson 2011; Kyoungtae Nam, Guiohk Lee and Jang-Sun Hwang 2011). An approach that considers both the textual and non-textual dimensions could be enriching in this sense. The methodology developed in this article should be complemented with a method that can automatically analyse images (Kelvin Xu, et al. 2015; Andrej Karpathy and Li. Fei-Fei 2015). Nevertheless, such endeavor is beyond the scope of the present article.

Regarding Topic Modelling, it automatically captures the most frequent topics, and it is worth considering that some of these might be difficult to contextualize and comprehend. Therefore, results interpretation and topic curation by an expert from the field is required, making the method not fully automatic. Furthermore, relevant issues or the hypothesis to be tested may not be well represented in the automatically generated topics when they are not recurrent subjects in the articles (e.g. horoscope, abortion and feminism), and thus, the analysis of word frequency would be a useful complement.

On the word frequency approach, it is important to note that conducting many tests might point to misleading conclusions due to the problem of multiple comparisons. Therefore, the lists need to be carefully constructed and theoretically justified before experimentation, highlighting once again the relevance of interdisciplinary work among computer and social scientists in the experimental design and interpretation.

Future research directions

In the present research, our data sources were two magazines from the same publishing house. In order to have a complete understanding of gender roles in magazines, it would be interesting to extend data sources to a more general corpus. Also, the analysis focuses on Argentinian magazines. Replicating these methods on magazines from different

countries would allow international comparison of gender stereotypes. Our study covers the years 2008 to 2018. In future work, we hope to expand this range to the present. As mentioned above, our analysis could be enriched with analogous methods for describing the visual elements of articles.

Practical implications

In the last few years, gender bias awareness has increased in Argentinian society and media. This increase is portrayed in the results of our work for some of the analysed topics, such as *women as sex objects*, *family*, and *business*. However, certain differences between the magazines targeting men or women persist and have not shown evolution on topics such as *fashion*, *science*, and *horoscope* during the analysed period. Therefore, not only do our results show the topics that are currently under discussion in Argentinian society, but they also might highlight those that have not yet emerged in public debate. Both the proposed methodology and the results themselves contribute to the open discussion. Furthermore, as the methodological framework proposes a semi-automatic way to track the evolution of gender stereotypes in magazines, providing quantitative evidence on this problem might be an interesting and useful tool for the local feminist movement. We created the website: <http://magbias.dc.uba.ar/> where everyone can complement the present analysis with their own unique research questions. Another putative application of this method could be to analyse and compare different sections within a newspaper or to evaluate biases resulting from journalists' gender.

Conclusion

The goal of this study was to use Data Science and Natural Language Processing techniques to compare the content of a women-oriented magazine with that of a men-oriented magazine produced by the same publishing house over a decade (2008–2018). Both magazines contained more than 24,000 articles in total, and, although there are several studies that use traditional methods to quantify the content of women and men-oriented magazines, as far as we know, ours is the first study that compares magazines in such a large dataset.

Our approach was to use Topic Modelling to identify the main topics discussed in the magazines, and then, quantify the different presence of these topics differs between magazines over time. This method allowed us to discover content present in the articles and to represent the topics according to the words that are most associated with them. Also, a validation step was carried out by performing a Word Frequency Analysis. This test validated five of the six topics: *business*, *family*, *women as sex objects*, *fashion* and *science*. We created a website (<http://magbias.dc.uba.ar/>) where everyone can formulate their own research questions regarding the vocabulary changes of these magazines.

Overall, our work contributes to the longstanding field of gender content analysis in mass media (Kuipers Giseline, Elise Van Der Laan and Elisa A.G. Arfini 2017; Rebecca L. Collins 2011; Rudy et al. 2010; Murillo et al. 2010; Martin Eisend 2010; Rosalind Gill 2009; Gunther Kress and Theo van Leeuwen 2006; Nathalie Koivula 1999) but with a novel methodology that highlights the relevance of interdisciplinary work and shows how computational tools are useful resources to analyse large amounts of content among platforms.

New advances from computer science have proven to be a powerful tool to increase the research scope in social sciences. Large-scale data analysis allows researchers to cover the vast sources of information generated by our society nowadays more thoroughly, providing new insights and bringing new answers to longstanding research questions. They can show general tendencies that help us guide our research. In the case of Natural Language Processing, this type of analysis can help us create broad descriptions of our corpus and formulate hypotheses. These new methods do not replace human work, but they do provide further tools to analyse reality.

Note

1. <http://magbias.dc.uba.ar/>

Declarations

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