

Sociology

Online images are more gender-biased than text

Bas Hofstra & Anne Maaïke Mulders

A big-data analysis shows that men are starkly over-represented in online images, and that gender bias is stronger in images compared with text. Such images could influence enduring gender biases in our offline lives. **See p.1049**

Images are an increasingly important vehicle for circulating information online and for grabbing and keeping people's attention¹. On page 1049, Guilbeault and colleagues² detail how online images reflect and exaggerate existing gender bias found in the offline world.

The authors googled a wide variety of social categories (such as 'lawyer', 'doctor', 'neighbour', 'friend' and 'cousin') and documented that, across these social categories, the number of images representing men was larger than the number representing women compared with similar social categories in other media. Furthermore, the association of these categories with a particular gender (for example, women and 'art teacher' versus men and 'carpenter') is much stronger in online images compared with online texts, and exposure to these online images can affect individuals' measures of unconscious (implicit) bias for several days. The findings support the idea that production of online content, in combination with the dynamics of people's online behaviours, might reproduce and even exacerbate offline patterns related to inequity and a lack of diversity. Because people spend a significant portion of their lives online, these dynamics seem striking.

Guilbeault and colleagues compiled a large data set of 349,500 images – 100 images extracted for each of the 3,495 social categories they studied – and employed thousands of human coders to capture whether those images leaned towards male or female representation (excluding images found of non-binary people). Men seemed to be starkly over-represented in images compared with their representation in a range of other sources (such as in texts, in public opinion and in a census describing employment statistics). What makes the results compelling is that they were not affected by the country from which the images were searched for, suggesting that male over-representation is not unique to Google searches performed in specific countries. Furthermore, the authors replicated their results using images extracted from

different sources, such as Wikipedia and the Internet Movie Database (IMDb). This suggests that the observed male over-representation and gender bias in images are consistent and generalizable across other widely popular online platforms.

The authors also compared the magnitude of gender bias in images and text by assessing to what extent 2,986 social categories co-occur with references to women or men in various online texts. Using several models to analyse text from a range of sources, they observed a similar association between gender and social categories in text as in images. The gender associations – that is, how each gender is represented in each social category – correlate strongly across both types of media. This suggests that gender associations for the social

category 'art teacher', for example, are comparable in both images and texts. Yet, the authors found that gender associations with certain categories are much more extreme in images than in text (Fig. 1). For example, observing female 'art teachers' in online images was more likely than reading about female 'art teachers'. Perhaps this finding is not wholly unexpected because, as the authors note, images portraying people naturally signal some demographic information, whereas text can be written in a way that minimizes information on specific demographics.

So why does all of this matter? Guilbeault *et al.* argue that people process images more quickly and images are more memorable than text. Therefore, if online images convey such strong gender associations, they could influence people's beliefs about gender. To test this conjecture, Guilbeault and colleagues conducted a preregistered experiment in which 450 participants from the United States were organized randomly into three groups: participants searched for specific occupations using either Google News or Google Images, or for phrases that do not describe occupations (such as 'guitar') using Google (the control group). Afterwards, the participants completed tasks designed to measure unconscious bias in relation to gender (an 'implicit association test'). The authors found that the participants who searched for images exhibited stronger gender bias compared with those who searched text or who were in the control group. Most strikingly, gender bias seemed to endure for up to three days after the experiment, but only in those

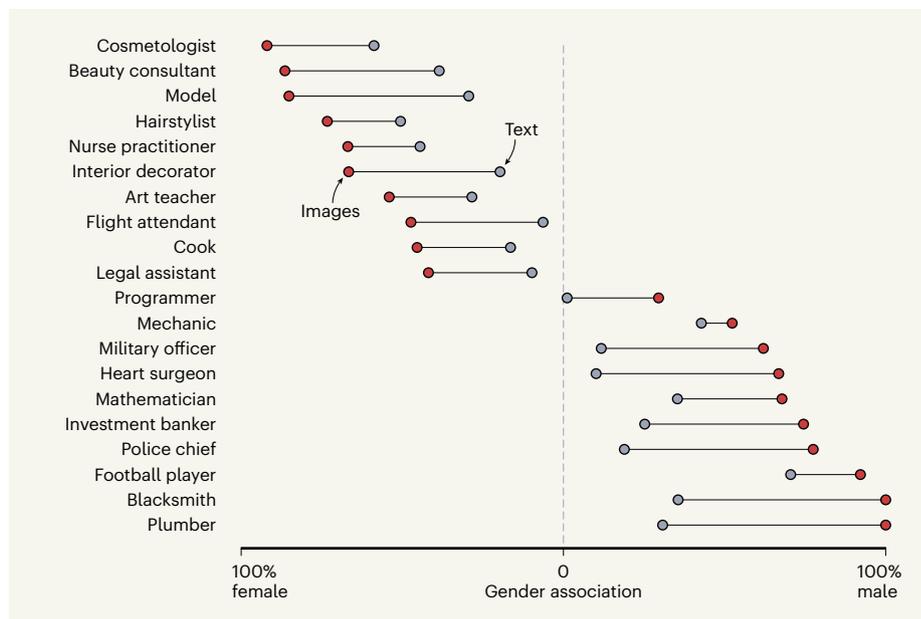


Figure 1 | Gender associations with social categories in online images compared with online text. Guilbeault *et al.*² searched for 2,986 social categories, such as occupations, using Google Images (for images) or Google News (for text) and measured the frequency with which each social category was associated with one or another gender in the search results. They found that gender association was more extreme for online images than for online texts. The graph shows a selection of occupations across the range of gender association scores. (Figure adapted from Fig. 1a of ref. 2.)

who searched for images.

These results suggest that online images, and hence the online realm, are not only highly gendered, but that this gendered nature might also influence further gender bias in everyday life. Previous work shows that exposure to stereotype-confirming images negatively affects women's self-esteem and hampers their leadership aspirations, suggesting that gender-biased images can establish and reinforce gendered career choices³. Repeating the current study's measurements of unconscious bias using social categories other than occupations (for example, 'cousin') would enable a further exploration of the consequences of strong gender associations in online images. The authors' conclusions might also be strengthened by conducting the implicit association test with more participants and in different countries, or by further examining conscious (explicit) gender bias.

There are several lingering questions that are essential for future studies to address. What are the exact mechanisms that cause the Internet to become such a gendered environment with respect to online images? Could it be related to particular populations of Internet

users, certain design choices or the transfer of existing offline imagery to websites? Once the exact mechanisms are known, what interventions could be put in place to ameliorate those dynamics? Answering these questions is imperative in an age in which images generated by artificial intelligence (AI) will probably become highly prevalent and widespread on the Internet. If these AI-generated images are based on online images that are already gendered, imagery found on the Internet might spiral into becoming increasingly gender-biased.

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2. Guilbeault, D. et al. *Nature* **626**, 1049–1055 (2024).
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Biomedical engineering

Light can restore a heart's rhythm

Igor R. Efimov

Implantable electric pacemakers save millions of lives worldwide, but they aren't perfect. A proof-of-concept study shows that using light to regulate a heartbeat might be a better option than existing strategies. **See p.990**

Life starts with a heartbeat and ends without it. This regular rhythm is set by the body's natural pacemaker: a collection of cells known as the sinus node¹. When this node fails, cardiologists can implant an electric pacemaker to stimulate a person's heart back to a normal rate². But standard pacemakers are powered by electrochemical batteries that have a limited life, and the devices are prone to electrode failure and interference from external electromagnetic fields³. On page 990, Li *et al.*⁴ present a technique that uses the energy from light to stimulate the heart, which could offer a solution to these problems.

Heart muscle consists of cells that interact through chemical, mechanical and electrical signalling systems. The electrical coupling allows the entire muscle to be excited by enabling an electrical signal to spread rapidly from a single stimulation point. The other types of

coupling have offered inspiration for alternatives to the standard electric pacemaker. Researchers have investigated the possibility of targeting specific proteins that can transmit the required signal mechanically or through changes in temperature or light. These sensors could be triggered non-invasively by light or ultrasound^{5,6}.

However, despite considerable efforts, these approaches are yet to yield clinically viable therapies. One obstacle is that both natural and genetically engineered molecular sensors are not sufficiently sensitive. Another problem is that existing devices are not sophisticated enough to interface well with human tissue. It has also proved difficult to achieve targeted and stable delivery of the genetically engineered molecular sensors to the heart.

An alternative tactic involves implanting biocompatible photoelectrochemical devices,

From the archive

Stephen Hawking proposes that black holes can explode, and William H. Bragg reflects on the perseverance of scientists.

50 years ago

Quantum gravitational effects are usually ignored in calculations of the formation and evolution of black holes... Even though quantum effects may be small locally, they may still... add up to produce a significant effect over the lifetime of the Universe... [I]t seems that any black hole will create and emit particles such as neutrinos or photons... As a black hole emits this thermal radiation one would expect it to lose mass. This in turn would increase the surface gravity and so increase the rate of emission. The black hole would therefore have a finite life... For a black hole of solar mass this is much longer than the age of the Universe. There might, however, be much smaller black holes which were formed by fluctuations in the early Universe. Any such black hole... would have evaporated by now. Near the end of its life the rate of emission would be very high and about 10^{30} erg would be released in the last 0.1 s. This is a fairly small explosion by astronomical standards but it is equivalent to about 1 million 1 Mton hydrogen bombs.

From *Nature* **1** March 1974

100 years ago

In what way do we hope to benefit by research?... There is so much... work to be done before the good observations come; it may be that weeks are spent in preparation and five minutes in making the actual measurement. It is all very humiliating; and the blunders one makes are very foolish... [O]ne redeeming feature is that... there is always the hope... every student... who strives to understand the workings of Nature by experiment... is paid by... discovery of a richer world. There is a fellowship between all who have tried to understand... [W]e must research, and with all our energy... [T]he spirit of research is like the movement of running water, and the absence of it like the stagnation of a pool. Scientific research, in its widest sense, ... is an act of faith in the immensity of things.

From *Nature* **1** March 1924

