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 choices1. 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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which convert energy from light into an electric current. More than a decade ago, a silicon-based photoelectrochemical device was proposed as a prosthesis for people with damaged retinas. Members of the same research group as Li et al. then came up with a set of design principles for interfacing such devices with various biological targets.

In the present work, Li et al. produced a proof-of-concept device that uses laser light to generate an electric current in a silicon device that is designed to be implanted at the surface of the heart muscle. The authors tested the device on isolated heart cells, as well as on an intact heart that had been removed from a rat. They then showed that they could use the device to stimulate a mouse's heart in vivo. Finally, Li et al. demonstrated that their device could reliably pace a pig's heart, either during open-heart surgery or after an endoscopic operation.

As part of the characterization of their device, Li et al. mapped the 3D distribution of the electric current that was generated below the surface of the heart muscle. The current's effect on the heart can be understood by calculating an 'activating function' that stimulates the heart muscle through a set of virtual electrodes. The authors' 3D map enables calculation of this activating function, which can then be used to optimize the energy and waveform characteristics of the light required for clinical application.

One of the key challenges of implantable pacemakers is that they can cause the different parts of the heart to contract out of sync. Unlike a healthy heart, which is stimulated by the body's conduction system, a heart that is controlled by a pacemaker is stimulated by electrodes that are usually implanted in the right atrium or ventricles (Fig. 1a). Although the electrical signal travels rapidly through the whole organ, this localized stimulation can result in asynchronous excitation, leading to out-of-sync contractions. Various resynchronization devices add a left ventricular electrode, preventing and mitigating heart failure in such cases. However, these devices either target only a few sites in the heart or they require precise implantation of one electrode at a specific point in the conduction system.

Li et al. say that this problem can be overcome by stimulating the heart at several sites using a network of their silicon devices (Fig. 1b). However, it is unclear how these devices will be joined together, and how they might be implanted in a beating heart.

“Implantable pacemakers can cause the different parts of the heart to contract out of sync.”

There are other engineering challenges to be surmounted. First, the heart is surrounded by a layer of fat. Will implantation involve penetrating this fat and anchoring the device to the muscle? Or will the device and its light source be delivered through a vein to the heart's interior?

Second, the implantation of a foreign body might induce a physiological response, which could lead to Li and colleagues’ devices being encapsulated with fibrous tissue, as was the case for early implantable electric pacemakers. Third, and perhaps most importantly, it is not yet clear how the authors plan to deliver light to the heart, to which access is complicated by the rib cage and lungs.

In the authors’ proof-of-concept experiments, the hearts were exposed, providing easy optical access to the heart surface. This makes it possible to stimulate several silicon devices with light. But a heart is usually covered with many layers of tissue, which scatter light. For this reason, the light used in Li and colleagues’ strategy would either have to be generated by light-emitting diodes in the devices themselves or be directed to the heart from a remote source through light guides. Both approaches have the same problem as conventional electric pacemakers: the devices can be rejected by the body, or otherwise fail. Ideally, if there is a way of stimulating Li and colleagues’ devices through the rib cage, external light sources could be incorporated into a wearable device. However, the device’s sensitivity might prove insufficient for this solution.

With all of these hurdles still to be cleared, it is difficult to predict when or whether photoelectric stimulators, such as the one designed by Li and colleagues, will prove to be more robust than conventional electric pacemakers. However, the authors’ exciting proof of concept shows the enormous potential that the technology holds, and suggests that photoelectric devices could eventually transform a range of therapies, including those requiring neural, muscular and cardiac stimulation.

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