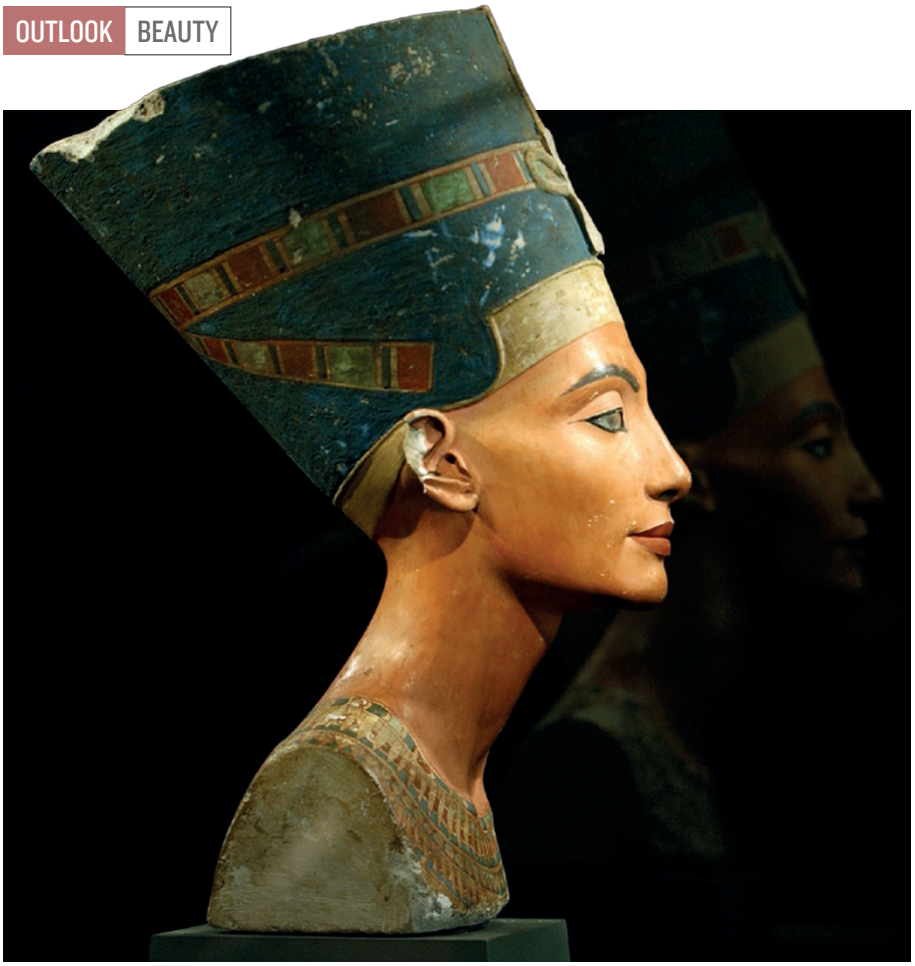

STEPHANIE PILICK/DPA/CORBIS

Portraying Nefertiti as a beauty may have been used as a way to depict the queen's moral qualities.

NEUROSCIENCE

The aesthetic brain

By studying how the brain responds to beauty, researchers hope to understand why we give some people an easier ride or appreciate certain artworks.

BY CHELSEA WALD

In the Neues Museum in Berlin, Queen Nefertiti's head perches, almost weightlessly, on a swan-like neck. The painted stucco and limestone bust is 3,300 years old, but its plump red lips, high cheekbones and almond-shaped eyes look as if they come straight out of a fashion magazine. Indeed, in the 103 years since German archaeologists unearthed the bust, it has achieved an iconic status that supermodels can only dream of. Although a vast chasm of history and culture separates the modern world from ancient Egypt, our continuing admiration of this portrayal lends credence to the idea that some beauty is timeless.

Science has also confirmed the adage, at least to a point. People broadly agree on what faces are attractive, both within and across cultures. Even babies prefer faces that adults judge to be attractive, suggesting that there is something hard-wired about these preferences. Our judgement of other people's attractiveness often happens subconsciously and influences us in ways we do not realize. Psychologists have observed that citizens vote for more attractive political candidates, judges give attractive defendants more lenient sentences and teachers grade better-looking students more favourably (see 'Snap judgement'). "The breadth of circumstances that seem to be affected by facial attractiveness is mind boggling," says psychologist Benedict Jones of the University of Glasgow, UK.

These observations have been difficult to explain, Jones says. But now, using technologies that range from digital face morphing to brain imaging, psychologists and neuroscientists are starting to identify the diverse qualities that humans find attractive in faces, as well as the complex networks in the brain that respond to beautiful features. Their work is not only uncovering neural links between evaluations of attractiveness and those of social attributes such as trustworthiness, but is also giving an insight into our appreciation of artworks such as the Nefertiti bust. "This isn't a trivial quirk of our facial structure," says neuroscientist Peter Mende-Siedlecki at New York University. Beauty may be difficult to define, he says, but it is real and its influence is vast.

WHY BEAUTY?

Thinkers and artists throughout history believed that facial beauty was intrinsically linked to certain ideal proportions — to Plato, for example, the width of a face should be two-thirds of its height. In fact, it is much more complicated than that. Starting in the 1990s, psychologists began to adapt special-effects techniques such as digital morphing to construct faces that people found more attractive. They identified three key qualities — symmetry, sexual dimorphism (femininity and masculinity) and 'averageness' — that correlate with attractiveness, says Jones.

Why these traits? In the case of symmetry and highly feminine traits, scientists posit that we may have evolved a preference for them. "These are things that are thought to be quite important for mate choice and mate preference in many non-human animals," Jones says. A symmetrical face may indicate a healthy development, free of genetic disorders or infectious diseases. A feminine face — think of Nefertiti's lips, cheekbones and eyes — could indicate fertility. And in fact, data suggest that feminine features are linked with higher oestrogen levels and hence with fertility. For masculine traits, however, psychologists speculate that a hyper-masculine face may be a 'costly signal' — a sign that a man has energy to spare. Many studies have shown that women prefer more masculine characteristics around the time of ovulation.

The story behind averageness is less straightforward. In the late 1800s, Victorian polymath Francis Galton invented a way to make composite portraits by superimposing photographs of different people. He hoped that this would help to identify the common physical characteristics of criminals, of those with a disease or of other 'biological types' such as a person's ethnicity. But in the process he noticed that the composites were generally better looking than the individuals who made them up. "The special villainous irregularities" had been removed, he wrote. A century later, psychologists followed up on Galton's observation[1], using digital techniques to show that people do indeed find these averaged faces to be more attractive than the originals.

Averageness, like symmetry, may be a signal of health — in particular, a lack of potentially harmful genetic irregularities. But this aspect of beauty might instead be a by-product of how the brain works, says Marcos Nadal, a psychologist at the University of Vienna who

studies aesthetic experiences. Processing faces is an exceedingly complex task. The brain might just prefer faces that resemble the average face of a population because they are easier to identify than less typical faces. "There are studies that show that averageness plays a role in the attractiveness of many other objects," like an average-looking watch face for example, says Nadal. "The brain works by extracting regularities."

For now, these explanations for our preferences are conjectures. And as scientists gather further evidence, the picture of why we find others attractive grows more complicated. In one study, for example, researchers found that some non-industrialized societies do not consider highly feminine or masculine faces to be especially attractive[2]. The authors speculate that a preference for sexual dimorphism could arise from processing lots of diverse faces in a densely populated environment. Skin quality, fat distribution and expression can also contribute to attractiveness, supporting the idea that beauty is linked to many markers of fitness, as well as a potential mate's receptiveness. "Even making what may seem like a simple judgement — is this face attractive or not? — is dependent on a very complex system involving many different inputs," Mende-Siedlecki says.

THE ROOT OF ATTRACTION

This beauty-recognition system is part of the neural network that processes faces, which is shared between various brain regions. The occipital lobe, at the back of the brain, receives the signals from the eyes. Here, specialized areas extract basic information about the face being observed, such as features, expression, eye gaze and lip movement. These data are then bounced forward to the parts of the system that process higher-level information such as emotional state.

Studies consistently show that attractive faces light up the brain's dopamine-driven reward network. For example, researchers have found people would press a key to see an attractive face for longer, in much the same way as a mouse will press a lever to get food or drugs, Jones says. Those faces stimulate areas such as the nucleus accumbens, which Nadal calls "a generator of pleasurable sensations".

A key module of this system is the orbitofrontal cortex, which sits just above the eyeballs. Neuroscientists think that the middle part of this region is where the brain judges the value of a potential reward. In a study in which people could win money, this area showed more activity when the winnings were bigger[3]. "It's focused on attractiveness with a positive bent: this is something of great social value," says Mende-Siedlecki. Researchers have also shown that a different part of the orbitofrontal cortex — an area that is associated with punishment — responds to unattractive faces. So just as seeing an attractive face may feel like winning money, seeing an unattractive face may feel a little like losing it.

SNAP JUDGEMENT

We infer social traits just by looking at a person's face — attractive features are associated with being trustworthy.

Attractiveness activates these reward areas even if we are not consciously thinking about the beauty of a face. Outside of the reward network, this is also true for some core parts of the face-processing system in the visual cortex. Neurologist Anjan Chatterjee of the University of Pennsylvania in Philadelphia and his colleagues showed participants 100 different images of faces, asking them to evaluate either the faces' attractiveness or their identities. Using functional magnetic resonance imaging, the researchers found that brain areas specializing in face recognition showed more activity when participants looked at faces that they had previously rated as attractive than when they looked at less appealing faces[4]. Such enhanced activity occurred even if participants were thinking only about the face's identity and not about its attractiveness. This shows that the brain responds rapidly and automatically to beauty, Chatterjee says — even when beauty is not on our mind.

FEAR FACTOR

Research on facial attractiveness is also leading neuroscientists to re-evaluate an almond-shaped emotion centre deep in the brain, called the amygdala. "For so long, we thought the amygdala is all about threat, all about snakes and spiders," says Mende-Siedlecki. Indeed, early studies focused on the role of the amygdala in processing fearful faces. But it is now clear that the amygdala reacts to all kinds of faces. A few studies have also indicated that, unlike other regions such as the orbitofrontal cortex, the amygdala may respond to attractiveness in a non-linear way — the reaction gets stronger the more beautiful or ugly a face is, and weaker for more neutral-looking visages. "The signal is saying, there's something here that's kind of weird, kind of unexpected, not what I'm used to," Mende-Siedlecki says.

The amygdala also contributes to judgements of trustworthiness, says Mende-Siedlecki. This overlap might be efficient for the brain, but as a side effect it could play a part in what psychologists call the attractiveness halo effect — a reflexive presumption that external beauty indicates overall goodness. Such a neural short cut can lead to all sorts of social benefits for attractive people, from better grades to more lenient punishments. Jones and his team have found that people presented with hiring scenarios are more likely to award higher salaries to more attractive people[5]. He contends that society should address this bias as much as it does for other prejudices. "Hopefully, you will start to see things like people taking into consideration how you can minimize the effects of facial appearance on court decisions and hiring decisions," he says.

The study of facial attractiveness is also helping neuroscientists to start to understand a completely different aspect of society: aesthetics. "In so far as we understand something about the neural response to beauty, we can begin to generate hypotheses about neural responses to other objects, including art objects," says Chatterjee, who is also the author of *The Aesthetic Brain* (Oxford Univ. Press, 2013). Take Nefertiti's bust, for example. Academics agree that it probably does not resemble the real queen. Among other things, the sculptor Thutmose rendered it remarkably symmetrical.

Why would he do that? "People have used the metaphor of artists as intuitive neuroscientists, in the sense that they have been able to engage the brain mechanisms that make people become interested or shocked or enamoured," says Nadal. He speculates that Thutmose was not after realism or even physical attractiveness when he made his masterpiece. Instead, he was taking advantage of the halo effect, accessing the deep link that the brain makes between beauty and other virtues. "Beauty would convey Nefertiti's moral qualities, like goodness or justice or rectitude," Nadal says. And as we know from historical accounts of her peaceful and prosperous reign, this queen was much more than just a pretty face. ■

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