- Imagination

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THE WORLD INSIDE YOUR HEAD



IMAGINATION allows us to detach ourselves from the here and now and sends us crashing into the past, the future or entirely fictional realms. Some have even argued it is our most distinctive human capacity, a key element of our extraordinary success — and our most poignant failures, too.

In the past few years, we have really got to grips with the nature of imagination, from the neural networks that conjure it to the fascinating variations in the way people experience it. Recent insights from neuroscience and psychology have transformed it from a mysterious and intangible concept to an observable, neurologically distinct process. Researchers have begun to uncover the brain architecture underlying imagination and see it at work in real time. They have discovered that some people have a hypersensitive imagination, while others have none whatsoever, and have revealed many ways of boosting our imaginations to better our lives.

Over the next 10 pages, find out how your brain conjures your imagination and how it changes as you age. Discover what your own imagination really looks like and how it differs from other people's. And learn how to harness your imagination to learn a new skill and achieve your goals. Used correctly, a bit of imagination might be all you need to be happier and healthier.

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WHERE DOES IMAGINATION COME FROM?

By Caroline Williams

Understanding what happens in your brain when it produces your inner world can help you boost your imagination

UNLIKE more specialised kinds of mental processing, there is no dedicated "imagination cortex" that shows up on brain scans. Instead, imagination is the result of inputs from all corners of the brain and throughout the body.

We know that imagination doesn't come in just one variety (see "Inside the different types of imagination", page 35) and isn't experienced the same by all of us (see "What our differing imaginations tell us about the brain", page 36). But in recent years, neuroscientists have begun to get a clearer understanding of how the components of imagination work in the brain.

Advances in scanning the active brain – specifically, functional magnetic resonance imaging (fMRI) – have revealed that it is organised into several key networks. Each shares information within its network while also keeping in touch with others. This allows the brain to switch between different "modes" of thinking by selecting the right network for the job at hand.

There are three key networks involved in our imaginations. The one most associated with such thought was discovered by accident in the late 1990s, when neuroscientists noticed a distinct pattern of brain activity when research participants were left waiting in fMRI scanners between tasks.

Regions of the brain associated with memory, mood and self-reflection became more active when the participants weren't occupied by a particular task, signalling an internally focused state of mind. This became known as the default mode network (DMN), and it is in play when we let our minds wander, mull over memories, think about the future or daydream.

However, the DMN isn't the only network now known to be involved in what we think of as imagination. If the DMN's musings are to reach conscious awareness, the brain also needs to loop in the salience network. This connects regions involved in emotion, attention and motivation, acting as a project manager, sifting through external stimuli and internal noise to determine what is significant. In terms of imagination, it is there to flag up ideas and memories that are too important, surprising or urgent to ignore.

The salience network is also where inputs from the body affect imagination. The network is anchored in the insula, a part of the brain that processes bodily sensations that can be related to emotional states. When these sensations are triggered by our imagination or a memory, for example, the recollection of a frightening experience causing your heart to race, it makes our musings feel more visceral.

Though the DMN and salience network can together create an experience of imagination – say, picturing the house you grew up in or the ideal combination of toppings on a pizza – as Evangelia Chrysikou, a creativity researcher at Drexel University in Pennsylvania, says: "Imagination doesn't equal creativity." For that, we need another network.

To get creative – in the neuroscientific sense of generating original ideas that serve a purpose in the real world – the brain needs to call on the central executive network. This links frontal areas to those further back in the parietal cortex, which help direct and sustain our attention so that we can hold a goal in mind while working through possible solutions.

Brain imaging studies by Chrysikou and others demonstrate that people who score better on tests of creativity have stronger connections between all three key imagination networks. This might allow them to rapidly switch back and forth between generating, noticing and evaluating ideas.

So how can we encourage these systems to work together and improve our imagination? For a start, we can encourage activity in the DMN by taking time to let our mind wander. We can also physically go for a wander: a study by researchers at Stanford University in California found that a short walk increased creative idea generation by 60 per cent in the moment and for a short time afterwards.

And once you are moving and imagining, try focusing your imagination on something that matters to you. The salience network makes sure that you notice changes related to the excitement of a sudden breakthrough.

This means that the more you care about coming up with a solution, the more likely you are to feel it when inspiration strikes and to find the motivation to act on it.



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THE EVOLUTION OF OUR MIND'S EYE

The human imagination is a remarkable thing. It has given us the novels of Jane Austen, the songs of R.E.M. – and atom bombs. We can imagine alternative histories in which the second world war didn't happen, or daydream about a long-lost teenage crush. "All of these things emerge from this human capacity to think beyond the material, or the immediate sensory realm," says Agustín Fuentes, a biological anthropologist at Princeton University and author of *The Creative Spark: How imagination made humans exceptional*. "Where did this come from? Well, clearly, it evolved."

Non-human animals have some degree of imagination. Many can plan ahead: Portia jumping spiders can devise complex attacks on prey, for example. Our imagination is an elaborated version of this.

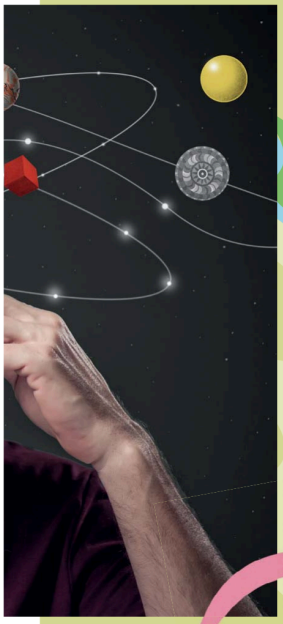
We can see the emergence of imagination in the fossil record of our hominin ancestors – especially in the stone tools they made. "To change the shape of a rock into a new form that's usable requires a kind of imagining that we just don't see evidence of in other organisms," says Fuentes.

The oldest known stone tools are 3.3 million years old, from Lomekwi in Kenya. That's before our species, or even our genus, *Homo*, evolved. Clearly, earlier hominins had enough imagination to make and use stone tools. Later, hominins started creating meaning, for instance by painting themselves and cave walls with red ochre, or engraving symbols.

The development of language was a "phase shift" that greatly enabled our imaginations, says Fuentes. "The way in which we have to convey, store and retrieve information opens the door to a lot of other things," he says. In particular, we can easily convey our ideas to each other – something even our closest relatives, chimpanzees, struggle to do.

The importance of language in imagination speaks to a wider point: "Imagining is actually incredibly social," says Fuentes. "We [often] talk about other people's imaginations, especially when we talk about artists or geniuses... Our imaginations are not our independent creations, but rather the amalgamations of all of our lived experiences and [the] experiences of so many other people."

Michael Marshall



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HOW YOUR IMAGINATION CHANGES AS YOU AGE

By Michael Marshall

It is natural to associate wild flights of fantasy with children and a more mundane internal world with adult life. But that isn't the whole picture

AS CHILDREN grow into adulthood and then continue ageing, what happens to their imagination? Do all of us gradually lose our innate capacity to conjure up novelty amid the drudgery of life, or does experience teach us to fine-tune it? Paul Harris, a developmental psychologist at Harvard University, has argued that imagination gets better with age, stating in a 2021 review that young children's pretend play generally sticks to "everyday regularities"; only later do they start imagining dramatic counterfactuals. In particular, Harris points to an apparent shift around the age of 4, when children start to be able to imagine two mutually incompatible possible outcomes for an event.

This is supported by studies showing that children often fail creative tasks that adults pass. In one such test, participants are asked to retrieve a handled bucket. To do this, they are given a straight pipe cleaner. The solution is to bend it into a hook, but children younger than 5 rarely figure this out.

Angela Nyhout, a developmental psychologist at the University of Kent, UK, has been working on understanding how our imagination might shift with age. In as-yet-unpublished work, commissioned ›

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by English Heritage, Nyhout and her colleagues asked visitors at Dover Castle, UK, how they might use various historical objects, including a mould in the shape of a warrior god and a dress fastener. "Older adults came up with more creative possibilities than younger adults," she says.

That tracks with the work of Andrew Shtulman, a cognitive developmental psychologist at Occidental College in Los Angeles, who argued in his 2023 book *Learning to Imagine* that imagination is a skill that we develop with practice.

The idea that imagination increases in line with the number of candles on your birthday cake isn't uniformly accepted, however. Alison Gopnik, a psychologist at the University of California, Berkeley, has conducted research indicating that children are more open-minded than adults. This is because they know less about the world, says Nyhout: "They don't really have a very strong expectation [of what might happen], so they're more likely to explore a number of different spaces."

What does seem to be true is that our imagination evolves. Nyhout's team has experimented by asking children in different age brackets how problems from stories could be resolved. In one, a child sits on his front porch drawing, then goes inside to get some juice – only for the wind to blow his drawings away. While older children often say the boy should have brought his drawings inside, preschoolers sometimes come up with out-of-left-field – and more imaginative – ideas like "the wind shouldn't have blown".

What's more, in her study at Dover Castle, she found that "young adults and adolescents seem to be a bit more flexible in their thinking", says Nyhout. While older adults envisioned more ways that an object could be used, they generally stuck to the same domain, such as "kitchen", whereas younger adults roamed more widely.

Nothing exemplifies these contradictions more than studies of people's mental imagery. There is evidence that our visual imagery becomes less vivid as we get older. However, this seems to reflect changes in what we prioritise when we imagine things. "Typical older adults are less likely to zoom in and remember the very specific details that make up a past event," says Jessica Andrews-Hanna, a cognitive scientist at the University of Arizona. Instead, they focus on "the overall gist of the memories", she says, especially their meaning and significance.

Viewed negatively, "our memories, our ability to remember the details, fade as we get older", says Andrews-Hanna. However, "maybe that's not a bad thing". Instead of fixating on details, "we may want to access our experiences at the level of meaning", she says.

"I think it's clear that our imaginations have different features at different ages," says Nyhout – but that doesn't mean it gets better or worse. "The child's imagination might be optimal in some settings and inadequate in others, and vice versa," she says. "Because of these differences, collaboration across ages might help us to come up with solutions to pressing problems, like reducing inequality or sustainable development."

"THE CHILD'S IMAGINATION MIGHT BE OPTIMAL IN SOME SETTINGS AND INADEQUATE IN OTHERS"

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INSIDE THE DIFFERENT TYPES OF IMAGINATION

By Adam Zeman

Imagination isn't just one thing – it turns out there are at least four forms



LIDYA NADA/UNSPLASH

1. REPRODUCTIVE IMAGINATION

Conjure up the image of an apple in your mind's eye. Is it green or red? Does its skin shine? Does it have a stalk? Can you get a sense of its weight as you gently twirl it? Does it have a scent? If these questions make sense to you, you have created a "sensory image" of an apple. This kind of imagination is known as reproductive. You know an apple's properties, so you can reproduce apple-like sensations in the absence of the real thing. (Those who are born blind don't have the visual element of this sort of imagination, but can, of course, imagine movement, a sense of space, smells, sounds and so on).

Research suggests that when you do so, the brain regions that activate strongly when you look at an apple activate weakly, giving your imagery its visual feel. We know this because brain imaging has shown directly that visual cortices fire up when we visualise things. Plus, forming an image can have similar physiological effects to looking at the real thing. For example, if you imagine looking into the sun, your pupils will constrict.

2. CREATIVE IMAGINATION

Once we can create images of things in their absence, there is plenty of scope for tinkering with them. When we do this, we nudge our reproductive imagination into the productive, also called the creative, kind. We harness this style of imagination in both humdrum contexts ("How will my friend feel if I touch on that difficult subject?") and innovative ones, such as when a playwright creates a startling denouement or a physicist posits a new fundamental particle.

Imagery seems to be a frequent ingredient in the process of creation – but not an essential one. If someone with aphantasia, who lacks a visual mind's eye, is asked to imagine an apple behind their eyelids, nothing appears (read more on this in "What our differing imaginations tell us about the brain", page 36). Yet such individuals can also be creative, producing things that are new and useful, from the latest tech to pieces of music.

3. PERCEPTIVE IMAGINATION

The two kinds of imagination mentioned previously are arguably the offspring of a more fundamental form, which allows us to experience the world around us. We don't usually consider our day-to-day perception of everything we see – the books on our bedside table, our toothbrushes in the bathroom, the sky as we step out of our front door – as "imaginative", but the latest research indicates there are strong reasons for deeming it so.

Our waking experience depends on our hard-won knowledge of the sensory world – from painstakingly learning to hear, see, smell and experience touch – in collaboration with our brain's ceaseless activity.

Take colour, for instance. We experience leaves as being green, but "green-ness" isn't an objective property of a leaf, the way that, say, its mass is. Instead, the way the leaf reflects the light that hits our eyes when we look at it produces what we collectively call "green". As such, the stance taken by leading neuroscientists, including Anil Seth at the University of Sussex, UK, is that our experience is a controlled hallucination. "We perceive the world not as it is, but as it is useful to us," Seth writes in his book *Being You: A new science of consciousness*. This, too, is a type of imagination in action.

4. CULTURAL IMAGINATION

We now come to concealed, or cultural, imagination. We are deeply cultural creatures, shaped by our heritage during our individual lives and adapted to culture by our evolutionary history. Our cultural heritage, from the style of clothes we wear to the tools we use to prepare food and the sort of homes we live in, is the cumulative creative product of human imagination, but its imaginative origins are often invisible to us.

As you might intuit, cultural imagination is often culturally specific. A British person's cultural imagination is likely to be different from a Japanese person's. Deep-seated beliefs, like faith in a particular deity or that a specific way of running society is optimal, are the products of imagination.

So, too, are deeply damaging ideas, such as that one race is superior to others. Such cultural beliefs are sometimes mistaken for objective facts.

The science of imagination can surely contribute something here to social good. As cultural creatures, we should respect traditions – they make us who we are – while acknowledging that they are human creations, sometimes wonderful, but still fallible and malleable, with the capacity to result in both extraordinary good and tremendous harm.

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WHAT OUR DIFFERING IMAGINATIONS TELL US ABOUT THE BRAIN

By Adam Zeman

One mind can create a very different reality to another. What does this tell us about how we make sense of the world?

BECAUSE we live our lives entirely in our own heads, understanding the contents of someone else's – and how radically their experience might differ from our own – is hard. New research, though, is revealing just how diverse the human imagination can be.

Take the concept of a "mind's eye". You might take being able to conjure up mental images in your imagination as a given. But research from myself and others has shown that 1 to 4 per cent of the population have aphantasia, meaning they lack wakeful visual imagery – ask them to "see" a hippo floating down a river on a pink lilo, and nothing happens. (Most people with aphantasia experience visual imagery in their dreams, however.)

Aphantasia is often associated with a "thinner" than usual memory for personal past or autobiographical events, and sometimes with autism and difficulties with face recognition. People with aphantasia are more likely than those with exceptionally vivid imagery to work in STEM areas. They often report that close relatives are also aphantasic, hinting at a genetic basis. Aphantasia may be protective in some ways, possibly offering some defence against medical conditions involving imagery, like post-traumatic stress disorder (PTSD).

Fully understanding the brain signatures of aphantasia is a work in progress, but five papers published this year and last have begun to help us untangle what is going on. One brain-imaging study, for example, has shown how the regions associated with visual imagery do fire in those with aphantasia, but slightly differently, with less connectivity between the parts that deal with thought and vision.

Hyperphantasia, the converse of aphantasia, is estimated to affect 10 per cent of people. Here, imagined imagery is "as vivid as real seeing", with those affected often reporting a rich autobiographical memory. The mind's eye is so intense in people with hyperphantasia that they can confuse real events with imagined ones. Such vivid imagery seems to nudge them in the direction of traditionally "creative" careers, such as designing and film-making, and may place them at greater risk of conditions fuelled by imagery, like PTSD.

Research also shows that they may be more likely to experience maladaptive daydreaming, spending countless hours lost in fantasy, with dire consequences for their real-world lives, though further studies are needed to clarify these links. Brain-imaging studies demonstrate that, when they imagine, people with such detailed imaginations have enhanced connectivity between the regions associated with thought and vision.

Imaginations can also be affected by neurological and psychiatric conditions. Epilepsy, in which abnormally synchronised neuronal discharges march around the brain, can trigger sensory hallucinations, for example – such as the sensation of an overpowering smell – and experiences of reliving, from déjà vu to full-blown recollection. Parkinson's disease, which affects both early visual processes in the brain and their subsequent interpretation, is associated with visual disturbances including pareidolia – the tendency to spot familiar objects where we know none exists – and hallucinations, often of animals and people who may cohabit peacefully with the affected individual.

IMAGINATION UNLEASHED

Hearing voices is another case of imagination slipping off its leash. Healthy voice-hearing – the type that isn't associated with any psychiatric condition – is estimated to occur regularly in around 1 per cent of the population. In another 1 per cent, however, it is a symptom of psychosis, in which people become persuaded of the reality of their hallucinations and of the truth of delusions, defined as bizarre false beliefs that aren't shared by others, like that we are "the left foot of God" or the victims of a global conspiracy.

Voice-hearing has sometimes been traced to "misattribution" of inner speech – if the background inner commentary that many of us describe becomes projected into the outer world and experienced as if it were autonomous. What can we learn about the brain from these dramatic disturbances? They remind us that our experience isn't delivered to us directly by the world but is the outcome of complex brain processes.

If our normal awareness can be understood as a "controlled hallucination" in the sense that all our experience is "generated" by the brain, then our experience of the real world is a hallucination that corresponds – more or less – with reality.

If this is true, we should expect, at times, to be challenged by the distinction between the real world and fantasy.

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CAN AN AI IMAGINE?

When you watch an artificial intelligence model write passable poetry or conjure up images from text prompts, it is easy to ascribe human-like imagination to the computer program. But is that what's happening, or is it merely a stochastic parrot regurgitating training data?

Iyad Rahwan at the Max Planck Institute for Human Development in Germany has spent a career trying to understand AI not just from a technical point of view, but also as a social and behavioural phenomenon. He believes there are two styles of imagination relevant here. One is combining concepts, like when an AI draws a chair in the shape of an avocado on demand. The other is understanding the consequences of actions and being able to develop plans. (Both fit under the "productive/creative imagination" bracket – see "Inside the different types of imagination", page 35.) We know AI is capable of combining concepts, says Rahwan. And ask a large language model complex questions and you realise that it has at least some understanding of cause and effect.

"If you think of it at this kind of mechanistic level, then you could say that machines can totally replicate this process," he says. "They do very good analogical reasoning." For Rahwan, there is nothing inherently lacking in an AI model that prevents it from having an imagination, unlike consciousness or self-awareness – traits that AI doesn't yet possess and, arguably, cannot, depending on how you think about such concepts.

But while AI can certainly imagine, it may be incapable of the precise sort of imagination we have, which is a product of our bodies, senses and experience of the world. AI may lack our embodied understanding of our surroundings, but, on the other hand, it has direct access to mountains of data, instant worldwide communications and vast processing power, which we don't. As such, AI imagination is likely to vary in ways that are hard for us to comprehend.

Just as AI has beaten the world's best human players at chess and Go by inventing counterintuitive moves and tactics, it may look at battlefield strategies, drug design or nuclear fusion with similarly fresh and capable eyes. "It's able to then, perhaps, create strategies that are alien to us," says Rahwan. "I can imagine that, in principle, they may even have superior imagination to us in certain domains."

But – for the moment, at least – Rahwan isn't convinced that AI can imagine truly groundbreaking concepts like those dreamed up by our most revered human geniuses. "Could machines that we have today, had they been trained on knowledge up to 1900, imagine general relativity?" asks Rahwan. "I don't think so. But this is a very rare ability in humans too."

Matthew Sparkes

"AI MAY LOOK AT DRUG DESIGN OR NUCLEAR FUSION WITH FRESH AND CAPABLE EYES"



HOW VIVID IS YOUR MIND'S EYE?

By Adam Zeman

Reckon you are highly imaginative? Or fear you are lacking in the creativity department? Put your presumptions to the test, with these challenges

The type and vividness of imagination we have varies greatly (see "What our differing imaginations tell us about the brain", left). As it exists in several forms, no single test can measure it – but here is a handful of ways to gauge the resources of your own imagination.

TEST 1

The strength of reproductive imagination – our ability to visualise the appearance of things in their absence, hear their sound or recreate their tactile feel – has typically been assessed using vividness surveys. Here are four scenarios adapted from the Vividness of Visual Imagery Questionnaire.

Visualise a rising sun. Carefully consider the picture that comes before your mind's eye:

1. When the sun rises above the horizon into a hazy sky
2. When the sky clears and surrounds the sun with blueness
3. When clouds appear and a storm blows up with flashes of lightning
4. When a rainbow appears

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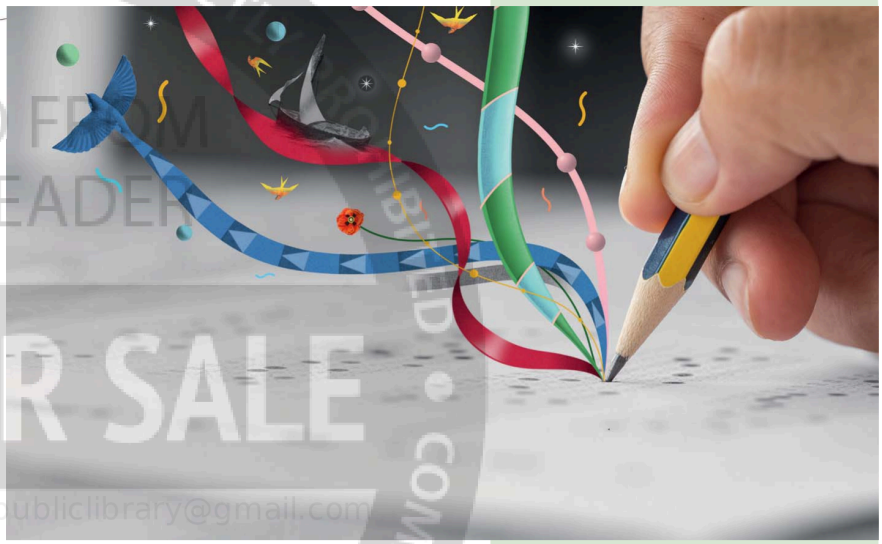

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Then rate each of the four images you formed, if any, on the following scale:

Perfectly clear and as vivid as real life = 5
Clear and reasonably vivid = 4
Moderately clear and lively = 3
Vague and dim = 2
No image at all, you only "know" that you are thinking of the object = 1

A score of 4/20 would raise the possibility of aphantasia, the inability to visualise mental images. A score of 20 might point to hyperphantasia, the ability to "see" incredibly vivid mental imagery, often as detailed as actual vision.

Most of us will score in the low to mid-teens for these four examples (the full test has 16 such scenarios, with a score range from 16 to 80).

TEST 2

Here are some questions tapping into other aspects of our senses from the Plymouth Sensory Imagery Questionnaire:

IMAGINE:
The sound of children playing
The smell of a rose
The taste of a lemon
Touching a soft towel

Rate the vividness of your image on a scale from 1 to 10, where 0 is "no image at all" and 10 is as clear and vivid as real life.

People score 6 to 7 on each of these images, on average.

The vividness of imagery in one sense aspect typically correlates with vividness in others, but there are exceptions: people who lack a mind's eye sometimes have an active mind's ear, for example.

TEST 3

Creative or productive imagination, the ability to come up with novel solutions to problems – novel to you, at least – can be tested with either open-ended tasks that have a large set of solutions or convergent tasks that have a single solution. In real life, your capacity to make things that are both new and useful, the standard definition of creativity, seems to depend on a happy combination of well-developed skill and playful spontaneity.

Here is an open-ended task: How many uses can you think of, in 2 minutes, for a brick?

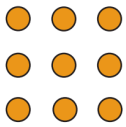
Answers can be scored on variables including fluency (the number of uses) and flexibility (the number of categories of use).

The average number of uses thought of is nine. The average number of categories thought of is four.

TEST 4

The next is a visuospatial task:

Without lifting your pencil from the paper, use four straight lines to connect all nine dots in the grid below



TEST 5

The final test comprises two examples of a verbal task from the Remote Associates Test:

What single word relates the three that follow:
Pine, tree, sauce
Room, blood, salts

Tests 4 and 5 can be solved either by racking your brain or, if you are creative and lucky, by a moment of illumination. The Remote Associates Test, for example, has been used to study the brain activity linked to sudden insight. Don't get disheartened if inspiration deserts you on this occasion – but be very proud if you came up with the answers, which are found on page 41.

DAYDREAM YOUR WAY TO NEW IDEAS

The uses of imagination aren't limited to controlled visualisation (see " How to harness the power of your inner world", right). We can also benefit from directionless daydreaming, when we allow our thoughts to wander from idea to idea. Evidence suggests that daydreaming can be especially important for creativity, allowing the brain freedom to form connections between disparate elements and, hopefully, to come up with something original.

Those light-bulb moments don't appear out of nowhere, however. In general, you need to have done some preparation first, researching the area or consciously brainstorming a few initial ideas. Then you need to allow some time for the information to "incubate", setting aside whatever you are working on and not consciously thinking about it.

Go for a stroll, take a shower or even a nap, and allow your brain to relax the constraints on its thinking. And, as you daydream during or after these activities, you may find that an ingenious new idea floats into your mind of its own accord.

David Robson

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HOW TO HARNESS THE POWER OF YOUR INNER WORLD

By David Robson

Sharpening your imagination is the secret tool of top athletes and business people. Here's how you can develop yours

FEELING stressed about an upcoming event? Imagine, for a moment, that you have a magic anti-anxiety pill in front of you that will take away your nerves. Picture its packaging, and feel yourself popping the pill from its foil. Now, visualise bringing it to your mouth, dropping it in, and conjure up the sensation of swallowing it.

These were the instructions that Jens Gaab and his colleagues at the University of Basel in Switzerland gave participants in a recent study investigating the possibilities of the placebo effect. The participants, university students who were studying for an exam, were instructed to repeat the procedure twice a day for three weeks.

Remarkably, it worked — those who took an imaginary pill experienced less test anxiety than control participants who were simply asked to report their anxiety levels as the exam approached. "And their performance was significantly better," says Gaab.

It is now well accepted that placebo pills can sometimes relieve symptoms, and the results from Gaab and his team suggest we can achieve the same effect when that pill exists only in our mind. It is just one of many surprising ways that imagination may help to improve our health, happiness and success. So, what can we do to make the most of these benefits?

The power of visualisation is well known in sports science. "Multisensory imagery is a game changer when it comes to performance," says Jonathan Rhodes at the University of Plymouth, UK. "If you can rehearse all the challenges that you might come up against, you'll be better prepared in the moment."

When imagining a movement, we often activate the same areas of the brain associated with its execution. These mental rehearsals or simulations help refine the neural pathways we use to perform the task for real, and so can improve our performance.

For instance, researchers at Manchester Metropolitan University and the University of Chester, both in the UK, asked one group of skilled golfers to mentally rehearse bunker shots twice a week for six weeks. A second group was told to practise on a real course, while a third was asked to use both kinds of practice. Both the mental and the physical practice groups improved more than a control group who didn't practise at all – but the greatest gains were made by those who combined the two.

Mental rehearsal has been shown to offer similar benefits for gymnasts and basketball players, while a 2020 review of the evidence found that performance improved across different skill levels and settings. And it isn't just athletes who can reap these rewards: research shows that musicians can enhance their speed and timing accuracy with mental practice.

"There's now a lot of evidence," says Francesco Pagnini at the Catholic University of the Sacred Heart in Milan, Italy. "I think that a lot of the techniques that come from the sports side will definitely be helpful in health as well."

Pagnini points to a recent study by Kaya Peerdeman at the University of Leiden in the Netherlands and her colleagues: participants were asked to hold their hands in a bucket of icy water, first without any guidance on what to think and then later imagining that they were wearing a warm, waterproof glove.

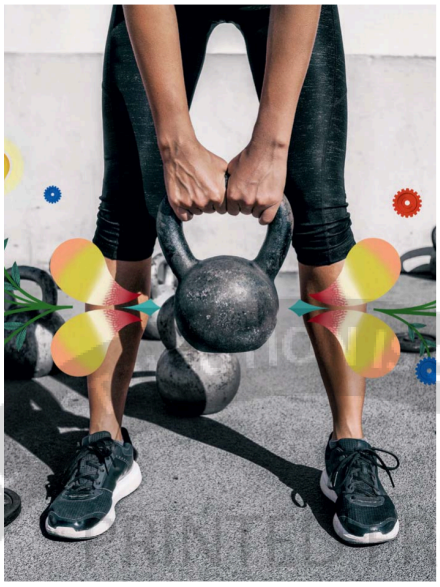
Peerdeman found that when participants imagined wearing a glove, they reported a reduction in their pain. Findings like these could have clinical applications. Other studies have suggested that guided imagery can reduce the pain experienced by people going through uncomfortable medical procedures or recovering from operations.

If you struggle to conjure up mental imagery or scenarios (see "How vivid is your mind's eye?", page 37), don't worry – Rhodes's research suggests we can all develop these skills. In 2023, he tested the multisensory imagination of 329 athletes, selecting the 27 with the lowest scores. Half of these athletes were given "functional imagery training", while the rest were put on a waiting list. The training included individual coaching that expanded on whatever vague images and sensations the participants could already imagine. For example, they might be presented with photos or sounds that would help to place them in the necessary scenario and then encouraged to elaborate.

VIVID EXPERIMENTATION

Sure enough, the first group developed more vivid imaginations compared with the controls on the waiting list, who also improved once they were allowed to take part in the training. Importantly, the effects lasted for six months after the training ended. "Some people react really quickly, and love it," says Rhodes.

Rhodes emphasises that improving your imagination is an incremental process. He recommends starting with a sense that is relatively easy to imagine and slowly adding more details as your confidence builds. "Play around," he says. "Be an experimenter."



ADOBE STOCK/BRETT RYDER

CAN IMAGINING A BETTER FUTURE REALLY MAKE IT COME TRUE?



By Helen Thomson

Manifestation is easy to dismiss as unscientific nonsense, but neuroscientist **Sabina Brennan** believes there are aspects we could all benefit from

FIRST popularised by the bestselling New Age book *The Secret*, manifestation has remained a cultural phenomenon for decades, championed by people from Oprah Winfrey to Deepak Chopra. Advocates claim you can attract whatever you want – whether that's a romantic partner, a new business opportunity or even a material object – by asking the universe for it and believing that it can deliver. Some practitioners propose physics-defying explanations that evoke mysterious vibrational forces to explain its effectiveness.

This is clearly nonsense, but neuroscientist Sabina Brennan was nevertheless intrigued. What might be the real reason that the practices involved in manifesting can benefit people's lives? She realised that there were several fascinating, evidence-based explanations for why such interventions can rewire the brain in ways that help you achieve what you desire. In her new book, *The Neuroscience of Manifesting*, Brennan unpacks some of the mechanisms behind this enduring practice.

Helen Thomson: Can you start by telling me what manifestation is?

Sabina Brennan: Manifesting is the practice of transforming thought into reality by visualising your goal and then developing the discipline to stay focused on and take action to achieve that goal. You can't magically make things happen – you can't defy physics – but you can change your reality and your future through focused action.

Manifestation is easy to disregard as unscientific nonsense – why did you think differently?

There are a few reasons why manifesting is dismissed by some academics. One is the misconception that manifesting is just wishful thinking rather than the focused discipline of taking action to attain goals. Another relates to the fact that some people who earn a living from helping people manifest their futures invoke quantum mechanics to explain manifesting. This has led some leading scientists to label it as quackery.

Some [manifesting advocates] propose that our thoughts and feelings transmit powerful messages that are received by the universe or some higher power, who then sends back life experiences to match the original thoughts and emotions. That's obviously not scientifically accurate. Another reason manifesting is dismissed is its associations with magic and mysticism.

I am concerned for vulnerable people who may pay hundreds of pounds to "manifestation coaches" [who teach them to buy into such beliefs]. But there's absolutely no need to invoke any of those explanations – there is existing science that adequately explains what's happening. For instance, it was clear to me that there were several parallels between manifestation and components of CBT [cognitive behavioural therapy].

Can you tell me more about that aspect?

CBT is a well-researched, scientifically grounded psychotherapeutic treatment that helps individuals understand the thoughts and feelings that influence their behaviours. Similarly, manifesting holds that by consciously directing our thoughts and emotions, we can influence our actions and, consequently, the events in our lives. Manifestation works, just not for the reasons that many people think.

OK, let's start with what you describe in your book as manifestation's first step: self-compassion. Why might that help us achieve our goals?

It's hard to silence that voice in your head that constantly criticises you, but there's evidence to back up the benefits of being kinder to ourselves. When we use imaging tools to look at the brain while people are thinking self-compassionate thoughts, we see reduced activity in the amygdala, a brain region involved in fear and stress, which suggests that self-compassion may help soothe these states.

We also know that if you practise loving-kindness meditation, which is related to self-compassion, it lowers stress and emotional responses. Uncontrolled stress can hinder learning, harm memory and adversely affect your brain's structure and function. This all makes it more likely that we fall into unhelpful behaviours and habits that may prevent us from attaining our goals.

Part of manifestation is regularly thinking about what you want from your future, such as by making a vision board, a collage of words and pictures illustrating your goals. How does this help?

I believe this has to do with overcoming your brain's cognitive biases. It's to do with a theory called predictive processing.

You might think that everybody sees an objective reality, but neuroscientists know that's not true (see "Inside the different types of imagination", page 35). The brain is constantly bombarded with billions of bits of data from your senses and predictive processing theory suggests that, in order to create your perception of the world, your brain needs to filter the important bits and combine that information with your past experiences, your biases, your ideas of the world. The brain uses predictions and best guesses to build our perception of an external world that it doesn't directly experience.

To filter the relevant data, your brain first focuses on information key to your safety and survival. It also filters unusual or unexpected data. Then it will filter whatever is relevant personally to you. Take this example: just before I got married, our car caught on fire and my partner suggested we buy a Mazda 323. Suddenly, I'm seeing them everywhere. It wasn't that I attracted them to my life. They were always there, they just weren't relevant to me.

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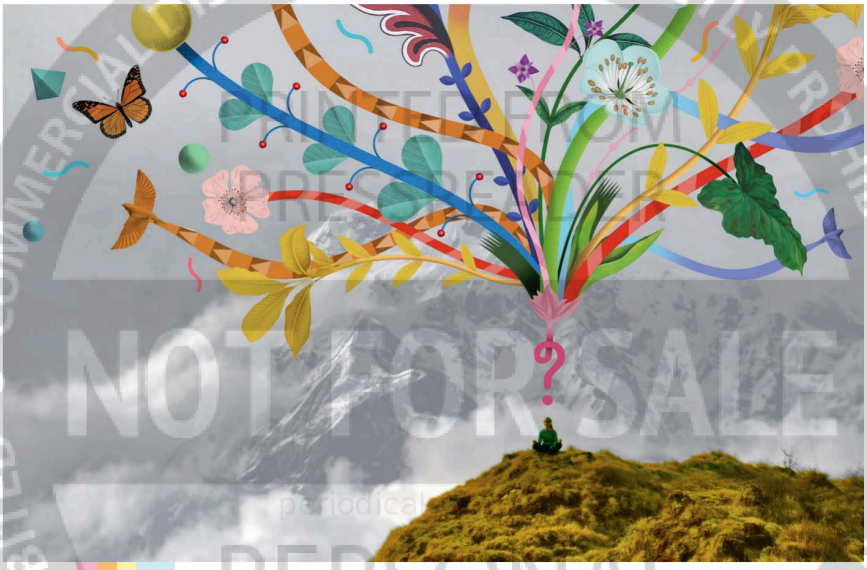

ALAMY/BRETT RYDER

"MANIFESTATION WORKS, JUST NOT FOR THE REASONS THAT MANY PEOPLE THINK"

Understanding predictive processing helps you to understand why this step of manifesting works. Having clarity of vision supports focused attention, activating the [brain's] salience network, filtering in information and new opportunities that are relevant to you achieving your goals.

So, manifesting unlocks a new perception of reality?

Yes. We couldn't survive if our brain didn't take shortcuts. But that means we tend to see and do the same things all the time. When you make a vision board, you're changing the message to your brain – saying, "This is what I want to see" – so that your brain is tagging that as salient information. [Because of how our brain filters information,] it is possible for us to completely miss opportunities that are right in front of us.

Manifesting sounds more difficult than I thought!

Manifesting harnesses neuroplasticity, our brain's capacity to adapt to change in the world. But this requires conscious effort and action, which is hard. Our brains favour the status quo, their primary function being to keep us alive, and with change comes uncertainty and risk. We also have a natural tendency to resist change because it's more effortful than engaging in habitual, routine behaviour.

Can you give our readers some things they can do to best harness the power of manifestation without going down the magical thinking line?

Each time you catch yourself in a self-critical thought, take a moment and make a conscious effort to reframe it as if you were speaking to a much-loved friend. Over time, this gradually rewires the brain to choose self-kindness over self-criticism.

Self-awareness is also foundational. Try answering these questions every evening for a week: "What did I enjoy today?", "When did I feel most like myself?" and "What thought today might no longer serve me?"

Manifesting is fundamentally about change, so choose one small, new behaviour that supports your goal and commit to practising it daily for a week. This helps overcome the brain's resistance to change and reinforces action-driven transformation through consistency and novelty.

Gain clarity by starting each week by identifying actions you need to take and check in with this reminder each day. This sharpens the brain's salience network, and ticking off things you've achieved at the end of the day gives you a dopamine hit, keeping momentum going.

Coherence is vital. Each evening, quickly review your day by considering whether your actions reflected your long-term goal and what adjustments you might make the following day.

Finally, you need to "create" your best life using scientifically grounded techniques. Each morning, do a 5-minute practice that involves one affirmation, such as "I have what it takes, I've put in the work"; one sentence of gratitude ("I'm grateful for my health"); and one tiny reminder to act "as if" you're living the way you want to, like: "stand confidently".

This routine strengthens self-belief, rewires neural pathways through repeated positive reinforcement and helps you live into your desired reality each day. ▮

Answers to tests 4 and 5 on page 39

VERBAL TASK: Apple and bath
DOT TASK: See diagram below, starting your pencil at point A

