Feel the FLAVOUR

You'd think it was simple. Taste comes from your tastebuds, right? Well, no. As Andy Ridgway discovers, the latest research shows our perception of food is far more complicated...

Imagine a chord ringing out on a guitar and the moment you hear it, a colour dances across your eyes. Each chord produces a different hue, so when you hear a piece of music, it's like staring into a kaleidoscope. That's apparently how Jimi Hendrix 'saw' music. And he isn't alone: 19th-century composer Franz Liszt once asked an orchestra to play a piece as "deep violet" and "not so rose".

Unlike many neurological conditions, this confusion of the senses, known as synaesthesia, isn't seen as an affliction. In fact, it's often regarded as something to be revered – a condition that adds an extra dimension to a 'sufferer's' perception of the world, blessing them with profound abilities.

But the truth is, synaesthesia is far more common than we're led to believe. In fact, you might experience it yourself. Just place an ice cube underneath your tongue and let it rest at the front of your mouth near the tip. What happens? There's a good chance you'll taste something salty or sour, despite the fact that the only thing you have in your mouth is tasteless. Here one sense, the sense of touch (or more specifically temperature), is kicking another sense into action – synaesthesia.

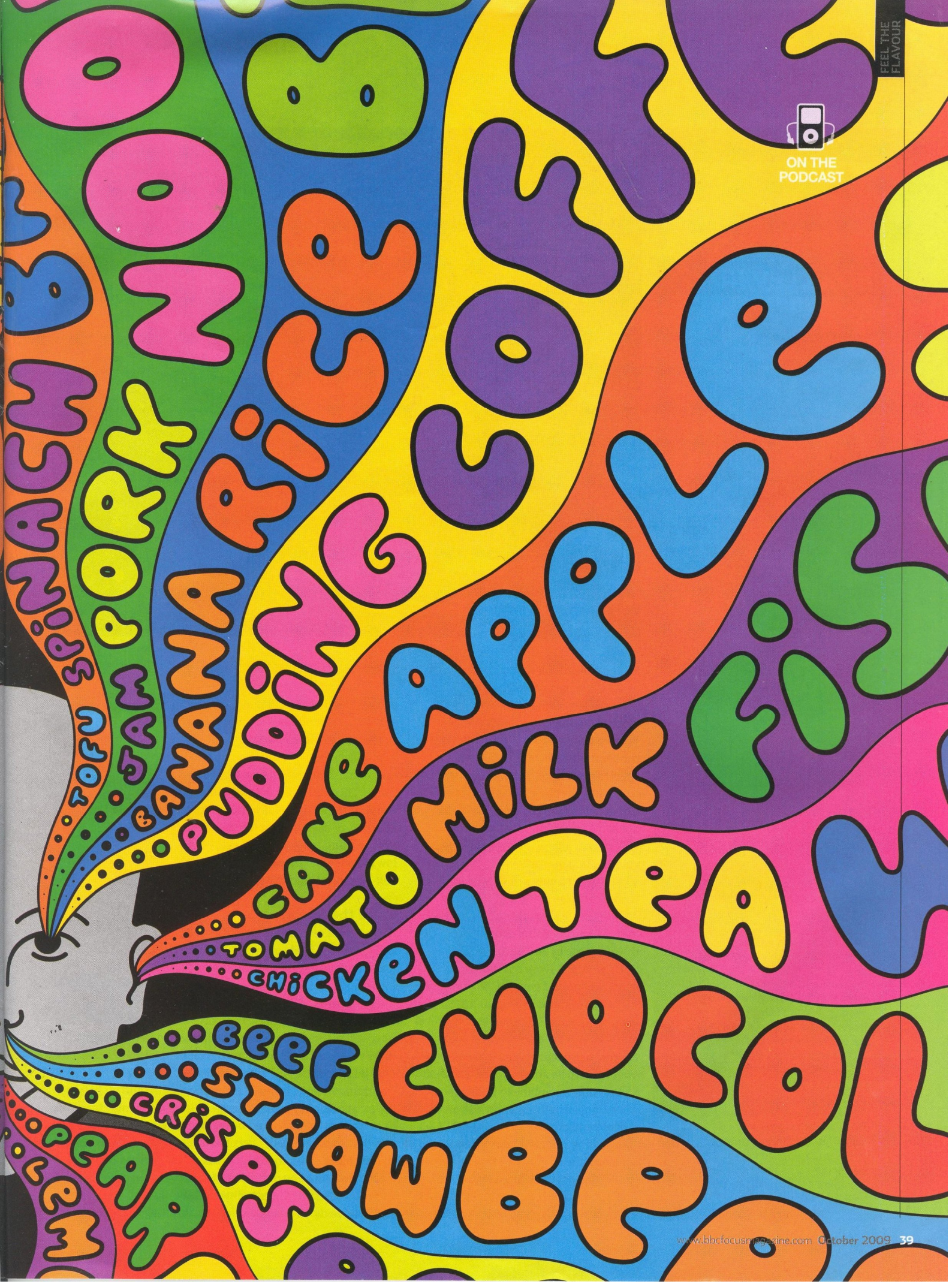
Our synaesthetic abilities can be even more subtle. What we experience as 'taste', we imagine to simply come from our taste buds on our tongue, where in fact up to 80 per cent of our 'taste' comes through the nose. But we localise the whole experience in the mouth – what one food psychologist, Professor Charles Spence at the University of Oxford, describes as a 'ventriloquism'.

"Some people come to me claiming to have lost their sense of taste after flu or a car accident and in every case they have lost their sense of smell," says Spence. "There's a confusion between smell and taste, so we're all synaesthetic to that."

In fact, when we put food into our mouth, the sight, sound and texture of it – and even our preconceptions – work together to produce an overall sensation of flavour. It's only now that scientists are starting to understand this multisensory perception of food.

Even more surprising is the recent discovery that our taste buds aren't confined to our mouths. And if we can find a way to harness all of this new knowledge, the implications could be even more profound. The interplay of our senses, particularly taste and smell, when we ▶

ILLUSTRATION BY OLIVER HIBERT


ON THE PODCAST
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BOX CLEVER

How packaging speaks volumes

In 1957 the manufacturer of the drink 7 Up added just 15 per cent more yellow to the green of its cans. Those who tasted the drink thought it had been flavoured with more lime or lemon. In fact, the drink was unchanged. "It makes sense. Our brains use the cues from the packaging to inform us about what's inside," says Charles Spence, professor of experimental psychology at the University of Oxford.

This knowledge about colour cues is used today. "In Denmark, one of the big orange juice sellers has found that if they get complaints about the acidity of their juice, what works best is to change the amount of orange colouring on their carton," says Spence.

These days, there's a movement towards allowing consumers to see the food inside the packaging to make sure they are getting the right signals. Texture is important too – Hovis has treated the plastic bags containing its soft crust bread to give them a softer feel.

The influence of packaging's colour and texture on our perception of its contents has been known for years – what has changed is the cost of changing your box or can. "Now there are relatively cheap prototyping and coating technologies," says Spence. "So there's a big push towards multisensory packaging."

When it comes to taste it's the nose that knows

▶ eat is something that's being studied at the University of Nottingham. Its Food Sciences department has developed a piece of equipment called the MS-Nose. When a volunteer sticks a piece of rubber tubing that's linked to a mass spectrometer into one of their nostrils, it can detect the chemicals being released from the food as they eat. And it's turned out some pretty interesting results.

If you eat a piece of chewing gum, you lose that minty flavour after only about three minutes, or at least you do with a cheap gum. Now, it would be easy to assume that this was due to the mint flavouring being chewed out. But that's not the case. The MS-Nose shows that the mint flavour chemicals, such as menthone and menthol, are present in the nose for about 20 minutes. So what's happened? It seems that the level of sugar, this time detected on your tongue, has declined and you need the sweetness to be able to 'taste' the mint. So the senses combine to build one sensation, something known as multi-modal perception.

Watching what happens when someone chews gum in a brain scanner (fMRI) presents a clear picture. "You find areas of the brain that only respond to the stimuli together," says Andy Taylor, Professor of Flavour Technology at Nottingham. "That suggests there is some synergistic reaction in the brain."

Using such knowledge, the Nottingham food scientists are able to re-engineer foods. Want a yoghurt that's low fat but tastes as good as the real thing? They can analyse exactly how you experience a full fat yoghurt – the interplay of chemicals in the nose and tongue – and try to replicate that in the low fat version, but without using those belt-busting components.

"There's research showing that if you get the colour of a fruit drink right, you can take 11 per cent of the sugar out and people will not be able to taste the difference. You have an illusion of sweetness"

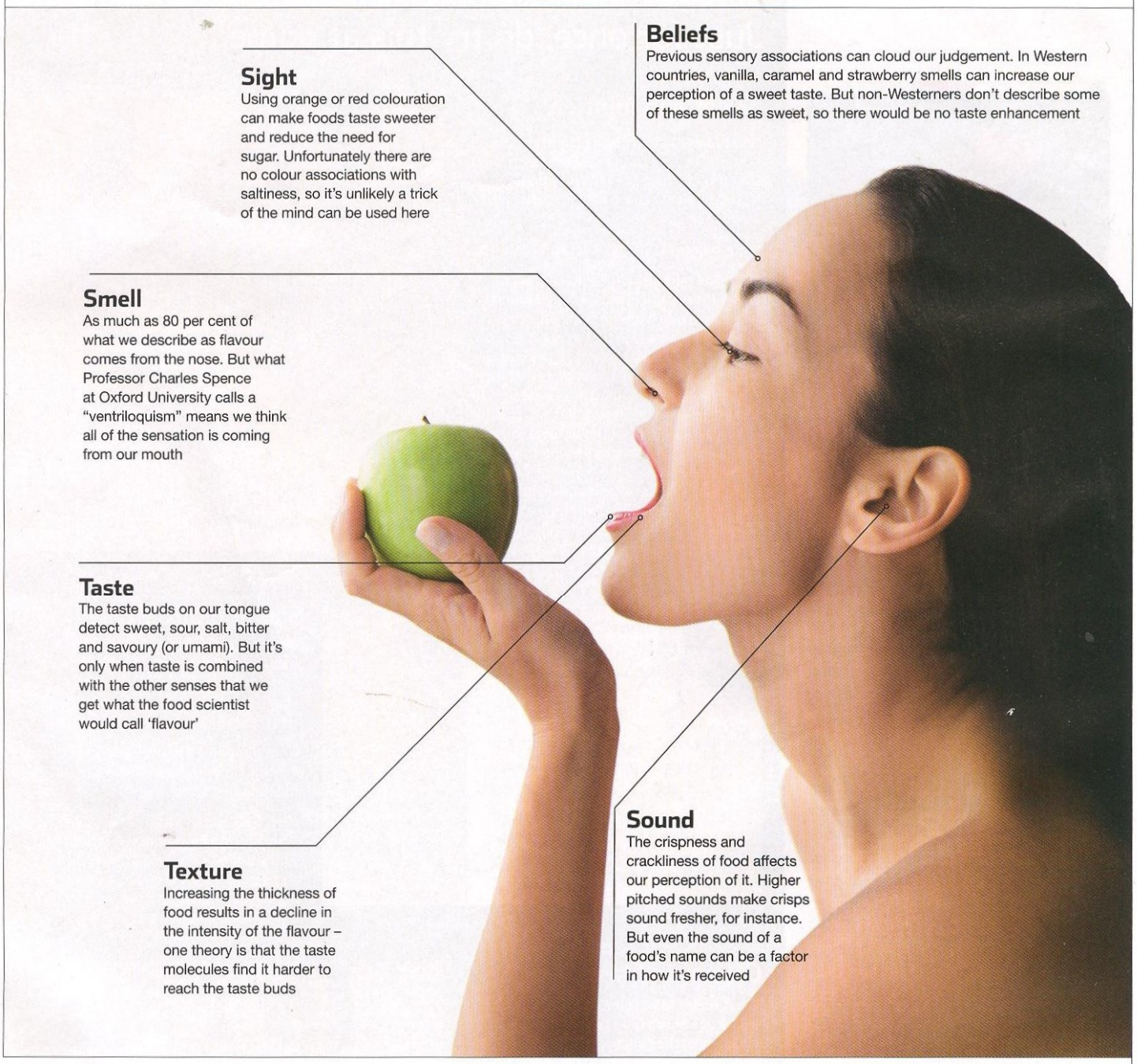
Taste the rainbow

It's this kind of multisensory work that will shape our foods of the future. But if you underestimate how the senses interact, the consequences can be pretty dramatic. In 1993, Coca-Cola introduced Tab Clear. A transparent version of its cola-flavoured namesake, the *only* difference was its colour, or rather lack of it. But the drink was withdrawn after less than a year. "I suppose when you see a clear drink, there's all sorts of expectations that it should be lemonade, and that's why it failed," says Spence.

The colour of our food and drink is a major influence on our perception of its taste. And sometimes our eyes really can deceive us. In one experiment last

MULTISENSORY OVERLOAD

Senses we consider to be separate work together when we eat



year, Spence gave hundreds of Oxford students different coloured Smarties and asked them what flavour they could taste. In many cases, the volunteers reported tasting different flavours for different coloured Smarties – green ones tasting of lime, for instance.

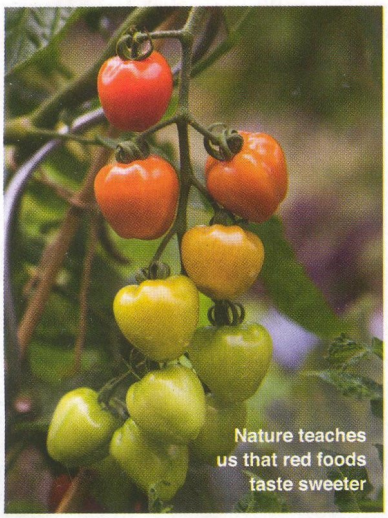
"But those beliefs are completely unfounded because all Smarties, apart from the orange ones, taste the same," says Spence. "People's beliefs influence the flavour they get." (Incidentally, orange Smarties are only flavoured orange in the UK).

Our knowledge about colour is being put to good use. "There's currently a lot of feverish activity trying to use colour to enhance [our perception of] sweetness," says Spence. "There's research showing that if you get the colour of a fruit drink right, you can take 11 per cent of the sugar out and people will not be able to taste the difference. You have an illusion of sweetness."

Our brains pick up a correlation with nature. As fruits ripen they typically change from green to yellow to orange to red. And red colours seem to be particularly effective at driving sweetness perception.

Audible taste

Even the sound of food has a huge impact. In 2008, Spence received an Ig Nobel Prize – a spoof alternative to the Nobel Prize – for his work with crisps. ▶



Nature teaches us that red foods taste sweeter

▶ He stuck volunteers in a sound-proof booth with some Pringles and a microphone. While the volunteers ate, the crunching noises were tweaked on a graphic equaliser and played back to them in real time to see the influence of sound on their perception of the crisps' flavour. The human guinea pigs rated crisps as tasting fresher if the overall sound was increased or the high frequency components were boosted.

This research has real practical consequences. If you can mimic the perfect crisp sound, or the perfect biscuit for that matter, you're onto a winner. "We were working with Nestle and Unilever when we did this research, says Spence, "but when Proctor & Gamble, who make Pringles, heard about it, they were keen to get involved."

The deceptive power of sound could also be used to make fizzy drinks less unhealthy. When CO_2 is added to a liquid to provide the fizz, carbonic acid is created – stuff that can cause tooth decay. So one drinks maker is working with Spence to reduce the acid's concentration, using sound to mimic its effects. "Your perception of how fizzy a drink is comes not just from what you feel in your mouth, but also what you hear," says Spence. He's been working in the lab to find out which sound leads to an enhanced perception of fizz. "And once we have got the sound, we will say to the engineers, 'Can you think of a new

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TASTE TESTS

Just for once, do try this at home...

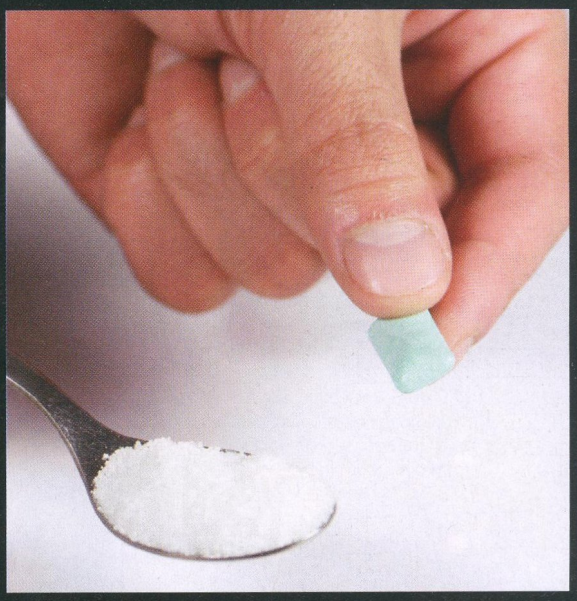
Sweet and mint

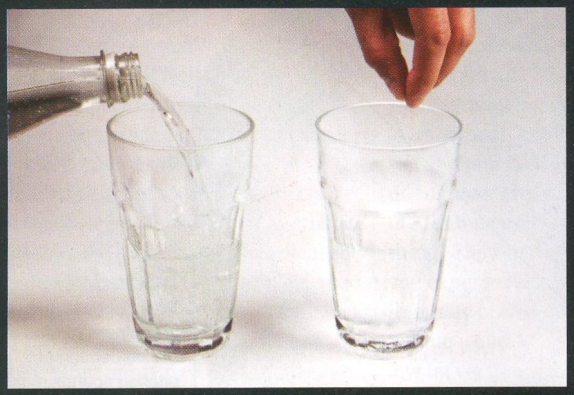
What to do: Take a piece of mint chewing gum and chew it until you can't taste the mint anymore (usually around three minutes). Now place a little sugar in your mouth and chew the gum again.

What happens: The minty flavour returns.

Why: The mint flavour chemicals such as menthone and menthol hang around in the gum much longer than you might think. When you lose that minty flavour it's not that you've chewed all the minty goodness away – what has gone is the sweetener. But you need the sweetness to be able to detect the mint.

You detect the mint flavourings in your nose and the sweetness on your tongue. The brain combines the two weak signals to produce an overall effect, something known as superadditivity. Brain scans show that a part of the brain only sparks to life when mint and sugar are combined.





Salt and bitterness

What to do: Pour two glasses of tonic water and add a small amount of salt to one. Now get a friend, who doesn't know what you've done, to sip from both the glasses and say which one is sweeter.

What happens: Chances are, your friend will think that the water with the salt added tastes sweeter.

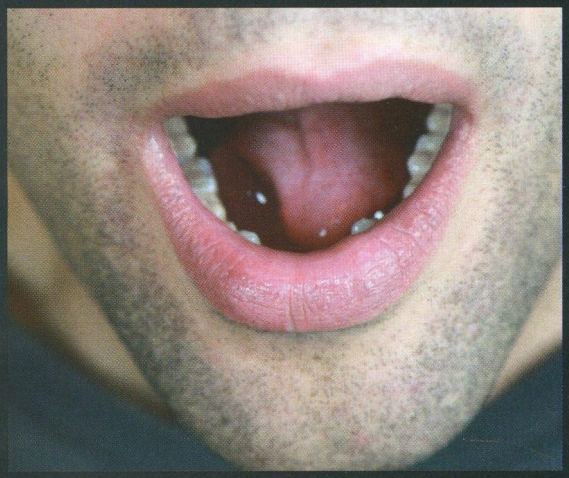
Why: Salt masks bitterness, while bitterness and sweet mask each other. So the added salt masks the bitterness of the quinine in the water, allowing the sugar to become apparent.

Colour and taste/smell

What to do: Take some white wine and add drops of red food colouring until it closely matches some red wine you have. Now give a friend some of the white wine you didn't colour, some red wine and finally the coloured wine without telling them what you've done. Get them to smell and taste each wine and describe what they experience.

What happens: They will probably describe the coloured wine using the same terms as the red wine, despite the fact they should be detecting a white wine's characteristics.

Why: Your sight can completely dominate your sense of taste and smell – a case of sensory deception.



Temperature and taste

What to do: Place an ice cube against the underside of your tongue, at the front and the side. What can you taste? Once you've decided, rinse your mouth out with warm water and then pop the ice cube under your tongue again.

What happens: Many people find they get a salty or sour taste when the ice cube is at the front of the tongue, despite the fact that it's made from water. Placing the ice cube elsewhere on the tongue may produce different tastes. And when the tongue is warmed up with warm water, an ice cube at the front is likely to produce a sweet sensation.

Why: This illusion shows how temperature can influence what we taste and this kind of thing happens each time we put a piece of food in our mouth.

There's another way to demonstrate the thermal-taste illusion. Allow half a can of fizzy drink to warm to room temperature while the other is cooled in the fridge. When you drink the cooled liquid it will taste less sweet than the warmer drink. It's because colder things taste less sweet that so much sugar has to be added to ice cream.

WHAT DO YOU THINK?

Let us know how you got on with these experiments!
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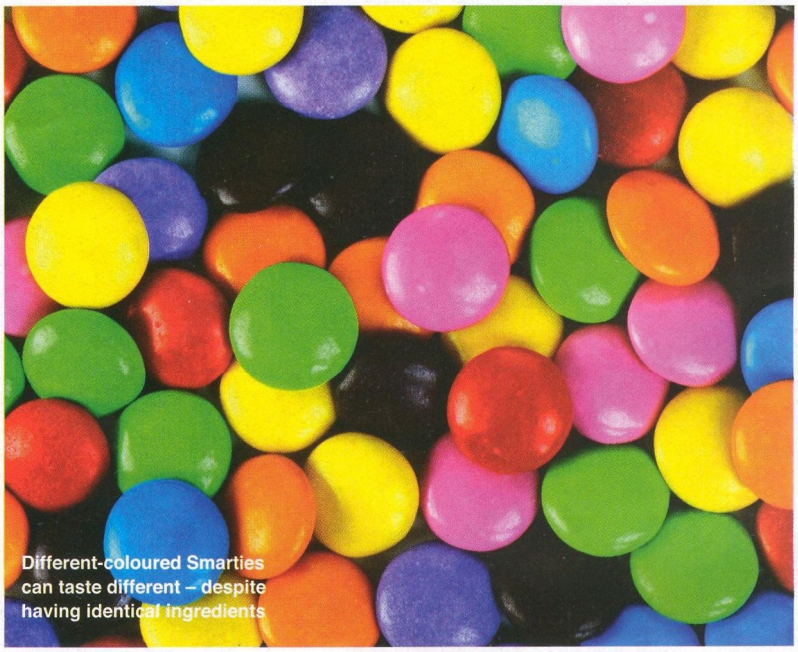

Different-coloured Smarties can taste different – despite having identical ingredients

type of canister or cup that will create that sound?' And if they can, we can reduce the carbonic acid."

Gut instinct

But there's another discovery that could have even bigger implications for the food industry. It turns out that we don't just have receptors in our mouths and noses for taste and smell – they are also found in the gut.

Now, these detectors don't feed into our perception of flavour. So what do they do? For most of the receptors, we simply don't know. But in the past two years, it's been discovered that the sweetness receptors in the gut control the uptake of sugars into the bloodstream. "If you are taking up glucose, that's obviously fattening," says Taylor. "So if you could have a food that produces a sweet taste in the mouth and then something is released in the gut that blocks the receptors there, so you don't take the sugar up, you could then use taste as part of your obesity control."

But, before we all think we've solved the problem of obesity, there are some pretty big hurdles to jump. "If you don't absorb the sugar, you will probably get lots of bugs in your stomach going 'Whoopee!'," says Taylor. "However, as a new area that might help our understanding of obesity and general nutrition, it's fantastic."

Research is now taking place to see whether there's a link between a person's threshold for sweetness in their mouth, and the uptake of sugar in their gut. It could be that those with a higher threshold are those who are less likely to become obese. "If I could do a quick test on you and work out your general propensity for sweetness," says Taylor, "I could suggest certain products for you. It would be personalised food. That would be a fabulous prize." ■

***Andy Ridgway is news and features editor of* Focus**

FIND OUT MORE

www.bbcfocusmagazine.com/video
FOCUS TV How sugar and mint interact in chewing gum

http://bit.ly/flavourperception
Summary of the latest flavour perception research by Charles Spence and Malika Auvray

http://bit.ly/nottinghamfood
An overview of food research at the University of Nottingham