CHAPTER

8

Distortions of perception

KEY KNOWLEDGE

- the fallibility of visual and gustatory perceptions, demonstrated by visual illusions and the judgment of flavours (influence of perceptual set, colour intensity and texture)
- distortions of perception of taste and vision in healthy, intact brains as providing insight into brain function related to perception, illustrated by synaesthesia

Visual illusions 336
Judgment of flavours 341
Synaesthesia 345
Perception occurs when sensory information reaching the brain is meaningfully interpreted. What we see, taste, hear, smell, and so on, is the result of brain activities that construct reliable representations of reality. This allows us to adapt to the environment and make sense of a constantly changing world.

Most of the time, our perception of the world closely matches the physical environment around us. However, this does not mean that perception is always error-free or perfect. We sometimes make mistakes and experience a perceptual distortion.

A perceptual distortion involves an inconsistency, or ‘mismatch’, between a perceptual experience and physical reality. Visual illusions demonstrate cases in which reality is misperceived for no immediately apparent reason. For example, the horizontal lines in figure 8.1 below are parallel. You can confirm this with a ruler yet, whenever you look at the pattern, it is impossible to perceive the horizontal lines as parallel.

**FIGURE 8.1** Are the horizontal lines parallel or do they slope?

Similarly, consider the naturally occurring ‘real life’ moon illusion, whereby the moon appears larger when it is low in the sky near the horizon than when it is high in the sky. The moon does not actually change in size. Yet when the moon illusion is apparent, we cannot avoid perceiving the moon as bigger.

**FIGURE 8.2** Why does the moon look so much larger when on the horizon than when it is high in the sky? (See box 8.1.)

Perceptual distortions occur with all other senses too. For example, some people can perceive taste in something that has no chemical basis for what is tasted and some can hear things that may not exist in reality. Pain can also persist long after the injury that caused it has healed. For example, consider people with an amputated limb who continue to perceive chronic pain after the loss of an arm or leg (see box 4.4 on page 161).

Consider also examples of when you perceive movement that is not real. Have you ever noticed how the moon appears to be moving across the sky as clouds pass in front of it on a cloudy, windy night? A similar effect can occur when you are sitting in a car at a stoplight and the vehicle next to you starts to move forward. For a moment you may feel that you are moving backwards. This is despite the fact that your vehicle has not actually moved and the adjacent vehicle is the source of real movement.

In this chapter we examine the fallibility of perception demonstrated in visual perception by visual illusions and in taste perception by the judgment of flavours. We also consider a specific type of distortion involving interaction of the senses in synaesthesia — when stimulation of one sense produces experiences in another sense.
VISUAL ILLUSIONS

A visual illusion is a consistent misinterpretation (distortion or mistake) of real sensory information. It is an experience in which there is a mismatch between our perception and what we understand as physical reality. Every time we view the same sensory information, we have the same illusory experience.

Psychologists have identified over 200 visual illusions, some of which are shown in figure 8.3. Generally, the illusory effects are unavoidable. Even when we know that we are looking at an illusion and have an understanding of why the illusion occurs, we continue to see the illusion as powerfully as when we first saw it.

Psychologists have enhanced their understanding of visual perception by examining the conditions under which it fails. For instance, visual illusions demonstrate the important role our brain plays in constructing our view of the world. They also demonstrate the effect of perceptual principles and factors such as learning (past experience) and context on the formation of our perceptions.

Two of the most widely studied illusions in psychology are the Müller-Lyer and Ames room illusions.

Fraser spiral: Although we perceive a spiral, this is actually a picture of a series of concentric rings.

Zöllner illusion: The vertical lines are all parallel but do not look parallel because of the changing direction of the small diagonal lines crossing them.

Orbison illusion: The smaller inner circle appears misshapen when placed in the ‘spokes’ of the larger circle.

Horizontal–vertical illusion: Although the two lines are equal in length, the vertical line appears to be longer.

Hering illusion: All four horizontal lines are parallel although the middle two appear to ‘bow’ around the central point where all the diagonal lines meet.

Poggendorf illusion: The diagonal line running from bottom left to top right appears to exit the vertical bar too high. A ruler placed on the line can confirm that the line is perfectly straight.
Müller-Lyer illusion

Are the vertical lines in figure 8.4 the same length? Since illusions are being examined in this section, you probably realise that they are the same length and therefore answered ‘Yes’. But do they appear to be the same length?

The answer is ‘No’. Measure the two vertical lines to confirm that they are identical in length. Look again at the two lines. Despite the fact that you know they are of equal length, they still do not look equal. Your distorted perception has been caused by the configuration of lines that make up the Müller-Lyer illusion — an illusion that has attracted a great deal of research by psychologists.

Named after Franz Müller-Lyer (1857–1916) who originally described it in 1889, the Müller-Lyer illusion is a visual illusion in which one of two lines of equal length, each of which has opposite shaped ends, is incorrectly perceived as being longer than the other. As shown in figure 8.4, the line with the ‘feather tail’ at each end (b) is perceived as being longer than the line with the ‘arrowhead’ at each end (a).

Psychologists have proposed a variety of explanations for the Müller-Lyer illusion. We consider explanations from biological, psychological and social perspectives.

Biological perspective

Explanations from the biological perspective emphasise the role played by our eyes, brains and/or nervous system when we view the illusion. One of the earliest biological theories proposed that the Müller-Lyer illusion was caused by the eye itself and explained the illusion in terms of eye movements and a failure of the brain to properly process differing information about eye movements.

Eye movement theory proposes that the arrowheaded and feather-tailed lines require different types and/or amounts of eye movements. Because the entire feather-tailed line in the illusion is longer, it lengthens the eye movements required to view the line. Therefore we perceive this line as longer. Another version of the eye movement theory is that we perceive the feather-tailed line as longer because it takes more eye movements to view a line with inward pointing arrows than it does a line with outward pointing arrows.

Despite these different interpretations of eye movements, eye movement theory was rejected by psychologists when researchers found that the illusion continues to be seen even when there is no eye movement at all.

More recent biological theories have been based on neuroimaging studies; for example, scanning the brain while participants with or without brain damage are looking at the illusion. These studies have identified specific brain areas that are active and inactive when we view the illusion, but they have not been able to satisfactorily explain why we perceive the illusion as they do. It may be the case that we have an inborn tendency to misperceive simple geometric patterns when they are viewed in a two-dimensional form.

Psychological perspective

Some explanations from a psychological perspective emphasise the role of learning and past experience. For example, it has been proposed that we experience the illusion because it contradicts what we have learned throughout life about physical reality. Therefore, we cannot make sense of the illusion whenever we view it, even after the illusion is explained to us.

One learning-based explanation of the illusion that created a lot of interest is known as the carpentered world hypothesis. This explanation proposes that the illusion occurs because of its similarity to familiar architectural features in the real three-dimensional world we experience as part of everyday life (as shown in figures 8.4(c) and (d) below).

FIGURE 8.4 The standard Müller-Lyer illusion
In our three-dimensional world, we have grown accustomed to seeing corners everywhere and often use these and other angles and lines to judge depth and distance. As a consequence of this experience, the arrowheaded line looks like the nearer, outside, vertical corner and roofline of a room or building, whereas the feather-tailed line looks like the farthest, inside corner (including ceiling and floor) of a room. Consequently, the two vertical lines appear to be at different distances from the observer — the feather-tailed line appears further away. Our brain overrides information from the retinal images showing the two vertical lines as equal in length. Therefore, the line that appears further away (feather-tailed line) is perceived as longer.

Other psychological explanations of the illusion emphasise how we take in and process visual information in order to perceive the illusion. For example, it has been proposed that the perceptual error we make with the illusion may be due to using inappropriate mental strategies when interpreting the incoming visual information. For example, we may incorrectly use the principle of size constancy. This would lead us to make an interpretation that when two lines appear to be at different distances, and cast retinal images of equal size, then the line which appears further away (the feather-tailed line) must be longer. The incorrect interpretation results in the illusion.

In this way, the Müller-Lyer illusion can be said to result from inappropriate use of perceptual processes involved in maintaining size constancy, when we know from depth cues (same-sized retinal images) and past experience, that objects appearing to be at different distances can be of identical size or length. Furthermore, our perception of the illusion suggests that we sometimes don’t interpret a retinal image as being what it really is, but rather what it represents.

Critics of this misapplication of size constancy theory have questioned why the illusion works equally well when the two lines are horizontal rather than vertical, as shown in figure 8.5. Furthermore, psychologists have produced other variations of the Müller-Lyer illusion which use different shapes on the ends, which are also shown in figure 8.5. These variations of the illusion are equally effective in producing the illusion as the original figures.

Social perspective

Research studies conducted from this perspective have focused on the role of social factors, particularly cultural influences on the perception of the Müller-Lyer illusion. These studies have also provided evidence for the role of learning and past experience in perceiving the illusion. For example, in some cultures, people have spent most of their lives in ‘non-carpentered’ worlds (see figure 8.6(b)).

One such group are Zulus who live in tribal communities within remote areas of Africa. These Zulus live in circular houses with roundish doors and domed roofs — without all the familiar angles, corners and edges of our Western three-dimensional world. When shown the Müller-Lyer illusion, these Zulus are more likely to view the lines in their actual two-dimensional forms and therefore perceive the lines as equal in length. They have only limited, if any, experience of angles and corners in their three-dimensional worlds and are consequently less likely to perceive the illusion.

A socio-cultural study has also been conducted to compare responses to the illusion by white American children and Zambian children in Africa. The study included a comparison of Zambian

![Figure 8.5](image-url) Variations of the Müller-Lyer illusion. These figures work just as well to produce the Müller-Lyer illusion without the depth cues said to cause the illusion in the original vertical figure.
children living in tribal communities in rural areas and Zambian children living in urban areas such as towns or cities. The results showed that the white American children were more likely to perceive the illusion than were the Zambian children living in urban areas. Furthermore, the Zambian children living in urban areas were more likely to perceive the illusion than the rural Zambian children. Since the rural Zambian children were much less exposed to rectangular structures, it seems that experience associated with the environment in which we grow up is a relevant factor in perceiving the Müller-Lyer illusion (Segall et al., 1990; Segall, Campbell & Herskovits, 1966).

The Ames room illusion involves a trapezium-shaped room that is longer and higher on one side than the other. When viewed through a peephole at the front of the room using only one eye, the room appears rectangular. The room’s unusual shape and being restricted to the use of monocular vision to view it provides the basis for the illusion.

Although other items in the room such as windows, clocks and furniture may add to the impact of the illusion, these items are not essential for the illusion to occur. The illusion is named after American psychologist Adelbert Ames (1880–1955) who intentionally designed the room to distort visual perception, particularly the size of objects in the room.

The Ames room appears to be a normal rectangular room when viewed through a peephole located in a central position on the front wall. The back wall looks parallel to the front wall and the two back corners therefore appear to be exactly the same distance from the observer.

A crucial aspect of the illusion is that the back wall is actually slanted away from the observer (from right to left). This results in the far left corner being double the distance of the right corner from the peephole. When observing a person standing in the right corner at the back of the room, the image of that person which is cast on the retina is larger because the person is twice as close to the observer (compared to a person standing in the back left corner). In addition, the ceiling slopes upwards from the right upper corner to the left upper corner of the room. This increases the height of the ceiling from right to left, which also helps ensure the illusion occurs.

As a result of these deliberately constructed ‘deceptions’, Ames was able to make people appear small or large, depending on where they stood in the room. When we view the inside of the room through the peephole, our past experience with rectangular rooms leads us to expect that the people in the room are all the same distance away from us. However, in this situation, one person casts a smaller or larger retinal image than the other, so their sizes are perceived as different.

According to apparent distance theory, when two retinal images are the same size, but one image appears to be at a greater distance, then the one that appears further away will be interpreted as bigger or larger.

In the Ames room, the perceived rectangular shape of the room is consistent with the retinal image, but not consistent with the room’s real shape. The back corners on either side of the room actually produce equal-sized retinal images because the vertical length of the further left corner is double the length (but twice the distance from the observer) of the nearer right corner. Therefore the visual angle is the same for both corners from the observer’s view. Because
the observer does not have the depth cues available to ‘work out’ the real difference in distance between the two corners, the equal-sized retinal images of the corners are interpreted as equal in size. This produces an illusion of a rectangular room.

The Ames room illusion also illustrates our inability to maintain size constancy when our use of depth cues is restricted or the depth cues are misleading. Size constancy fails because the retinal information — the changing sizes of the people as they cross the floor — cannot be corrected due to the lack of accurate depth information. The illusion is so strong that a person observed walking from the right corner to the left corner is perceived as ‘shrinking’, even though the observer knows that this is not possible in the real world.

**FIGURE 8.7** There is a distortion of the sizes of objects within the Ames room. A crucial feature of the room that creates the illusory effect is the back wall, which is actually slanting away from the observer, but appears to be a normal rear wall of a rectangular room.
Review questions

1. Why are visual illusions often referred to as ‘distortions of visual perception’?

2. In what way can the study of visual illusions enhance understanding of visual perception?

3. In point form, outline an explanation of the Müller-Lyer illusion that you find the most reasonable and convincing.

4. (a) Briefly describe the Ames room illusion.
    (b) If you watch a person walk from the back right-hand corner of the Ames room to the back left-hand corner of the Ames room, they are likely to appear to shrink. Explain why you would perceive the person to be shrinking.
    (c) Why is the observer’s view restricted to using monocular cues?
    (d) What is a possible explanation of the Ames room illusion?

5. Find an example of a visual illusion that you find intriguing.
    (a) Make a copy of the illusion (or provide information on where to find it).
    (b) Outline the illusory effect.
    (c) What is a possible explanation of the illusory effect?

**BOX 8.1**

**The moon illusion**

Unlike the Müller-Lyer and Ames room illusions, which are artificially created, the moon illusion is a naturally occurring illusion. The illusion occurs when the moon appears considerably larger when near the horizon than when it is high up in the sky, even though the retinal image is equal in both situations, and the moon does not actually change its size as it moves across the sky. The illusion is more obvious with a full moon. It has intrigued people for many centuries and various theories have been proposed to explain it.

The most widely accepted explanation is in terms of apparent distance theory (which is also used to explain the Ames room illusion). This theory is based on the results of research conducted by American psychologists Lloyd Kaufman and Irvin Rock.

Kaufman and Rock (1962) proposed that viewing the moon over a visible stretch of terrain such as a landscape makes it appear further away. They found that when research participants viewed the moon at the horizon over a visible surface (e.g., trees and buildings), it appeared on average 1.3 times larger than the moon seen at its highest point in the sky (its zenith). However, when the terrain was kept out of vision by observing the moon through a hole in a sheet of cardboard, no difference in size between the horizon and zenith moons was reported.

Kaufman and Rock concluded that the terrain offers many depth and distance cues that provide ‘evidence’ to allow us to perceive the moon as more distant, whereas the sky offers no depth and distance cues, so we misperceive distance and underestimate the moon’s size.

Not all psychologists agree with this explanation. For example, Coren and Aks (1990) have found that people sometimes perceive the horizon moon as closer, not more distant; Reed and Krupinski (1992) have found that the illusory effect cannot be created when the visual stimulus is a star rather than the moon; and Suzuki (1991) found that the illusion can still occur even when the moon is projected at different points in the sky without the presence of depth and distance cues, as in the total darkness of an indoor planetarium. In sum, a completely satisfactory explanation of the moon illusion has yet to be proposed (Kassin, 1995).

**LEARNING ACTIVITY 8.1**

**Review questions**

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**JUDGMENT OF FLAVOURS**

The perception of taste is a relatively limited experience that is based on five basic taste qualities. When we taste, what we actually perceive is the combined input from different senses, not just taste and other oral sensations. This overall experience results in flavour. Flavour is not in the food (or drink) — it is created from the food by the brain. Flavour tells us whether a food is delicious, good, unpleasant or even disgusting.

Flavour is a perceptual experience produced by a combination of taste and other sensations. A crucial component is smell. In addition, there is sensory information from receptors in papillae that detect temperature (e.g. hot or cold porridge), pain (e.g. too much chilli or spiciness) and the tactile sensation of texture (e.g. chunky or smooth peanut butter).

Many psychologists have broadened the concept of flavour to include auditory sensations, such as the sounds heard when food is bitten or chewed, especially noisy foods such as carrots, celery and potato crisps, and visual sensations involving what a food or drink looks like and how it is presented (Spence, 2015; Spence, et. al, 2010).

The pleasure of food and beverages is critically dependent on all the sensory components being ‘right’. The ideal lasagne, salad, milkshake or mocktail is a perfect mix of all the sensory inputs. This also means that the taste of food can, for example, be ruined simply if...
it has an inappropriate colour or is not crunchy enough. In such cases, the influence of one type of sensory input may dominate or override other sensory input.

Given the multi-sensory nature of flavour, its perception is influenced by numerous factors. These include perceptual set, colour intensity and texture. Food producers and retailers recognise these influences when manufacturing and marketing their foods and beverages. Millions are spent on packaging and appearance to influence our choices, in our homes as well as in supermarkets, restaurants, school canteens and wherever else we may purchase food.

**Perceptual set**

The flavour we experience is influenced by expectations based on preconceived ideas about how foods (and drinks) should taste. These form through past experience. It is not even essential to have actually tasted something to have an expectation of flavour. For example, the mere thought of eating a live cockroach is likely to disgust you without knowing what it actually tastes like. Your expectation is enough to produce disgust.

One of the most significant influences on flavour judgment is our expectation of how food should look. Colour tends to be the single most important visual cue when it comes to our expectation about the likely taste and flavour of food (Spence, 2015). We start to associate specific colours with various types of foods and drinks during childhood and link them to certain tastes and flavours throughout life. For example, we expect yellow pudding to have a banana or lemon flavour and brown pudding to have a chocolate flavour. We also use colour to determine the ripeness and/or freshness of fruits, vegetables, meats, fish, dairy products and even lollies. If colour does not match our expectations, we may perceive the flavour of any one of these foods differently.

When the colour of a food or drink is different to what we expect, our brain can interpret that it tastes different too. Researchers have used colour to manipulate expectations and distort flavour judgments of participants in numerous studies.

One of the best known demonstrations of this effect was reported by the American food researcher John Wheatley (1973). A group of people were served a meal of steak, French fries and peas under lighting conditions that masked the true colour of each food. All thought the meal was fine until the lighting was changed. Halfway through the meal, normal lighting was restored and it became apparent to the diners that they were eating blue steak, green fries and red peas. Upon realising this, many lost their appetite and some became ill.

According to Wheatley, the mere sight of the unnaturally coloured food was sufficient to induce nausea. In particular, the colour blue is often associated with spoiled, mouldy meat, creating an expectation that food of this colour won’t taste very good and/or is likely to be off and cause some kind of food poisoning (Zampini & Spence, 2012).

![Figure 8.8](image)

**Figure 8.8** We have expectations of how food should look and this perceptual set can influence our flavour judgment of the food.

Researchers have also investigated the effect of perceptual set on our judgment of drink flavours. In one of the best-known studies, the colour of a cherry-flavoured drink was manipulated. The addition of an odourless orange or green food-colouring solution that was actually neutral in flavour led participants to incorrectly identify the flavour. For example, when the red, cherry-flavoured drink was manipulated. The addition of an odourless orange or green food-colouring solution that was actually neutral in flavour led participants to incorrectly identify the flavour. For example, when the red, cherry-flavoured drink was changed to an orange colour, 41% of the participants reported that the drink tasted of orange.


Even expert flavour tasters can be misled when their flavour expectations are manipulated. For example, some professional wine tasters and wine makers have been found to describe a white wine that had been artificially coloured red as having key characteristics of red wine. One explanation of wine experts being deceived in this way is that their expectations of the taste, aroma and flavour characteristics are much more strongly associated with a particular wine colour than in the non-expert (Spence, 2010).
Colour intensity

Colour tends to dominate over other sensory information when it comes to influencing our expectations about taste and flavour of food. In addition, changing the intensity of a colour can exert a sometimes dramatic impact on our expectations, and hence on the taste and flavour experiences. For example, a brighter or richer coloured food item can seem to taste different to a blander coloured one, even when there is no change in the ingredients that make up the flavour (Spence, 2015).

Regardless of age or culture, there tends to be an expectation that more intensely coloured foods are likely to be more intensely flavoured. Research studies have found that simply adding more colouring to a food can lead participants to rate the taste and/or flavour as more intense. Most studies have been conducted with beverages. This is mainly because it is easier to manipulate the level of colour in solutions (Delwiche, 2012; Watson, 2013).

In one study, researchers investigated the influence of varying the intensity of colour on ratings of sweetness intensity. The participants were given two glasses of orange juice to compare and to rate in terms of their sweetness. The juices were lighter and darker shades of orange. The tasters rated the orange juice with the more intense, darker shade as being much sweeter. When later given two glasses of orange juice that had the same colour intensity but differing degrees of sweetness, most tasters did not report a different in taste. Then, when asked to taste orange juice in which a flavourless green colour tinge was added, a significant number of participants reported the presence of sourness. In a similar study, participants who drank strawberry-and cherry-flavoured juices reported that drinks with more red colour tasted stronger and had ‘more’ and ‘truer’ strawberry and cherry flavours. The effect was stronger among older than younger tasters (Fernández-Vázquez et al., 2014).

Studies that have manipulated the colour intensity of food have also reported distorted perceptions of flavour. As with drink studies, the colour is intensified using a food dye but there is no actual change in flavour. The results of food studies also show that overall flavour intensity is influenced by the amount of colouring that is added — the more intense the colour the more intense the flavour that tends to be reported and vice versa. For example, chocolate pudding that is a richer shade of brown has a stronger flavour, as does chicken bouillon that has twice the level of normal colouring added. Egg yolks taste better when a rich orange colour; butter when pale yellow, margarine when it looks more like butter and brighter red salsas are perceived as spicier. When bright white colouring is added to skim milk it is perceived to be smoother, better tasting, and higher in fat than the uncoloured milk.

This type of colour intensity effect has been found with everything from noodles to vegetables, and from cheese through to yoghurt, as well as cake, jams, jellies, chocolates and sherbets (Chan & Kane-Martinelli 1997; Shermer & Levitan 2014).

Texture

We often describe ice cream, yoghurt or custard as having a creamy taste. That ‘creaminess’ is more about how the food feels in the mouth than about actual cream content. Texture is the property of food or beverage that is felt in the mouth and contributes to flavour along with taste, vision and other sensations. Crispy, crunchy, crackly, gritty, grainy, chewy, sticky, soft, hard, smooth, rough, runny, lumpy, slimy, oily, greasy, dry, bubbly, fizzy, moist, rich, juicy and succulent are some of the other words that refer to texture when eating or drinking.

Texture stimulates tactile sensations and is therefore perceived in response to touch, primarily in the mouth. It can affect flavour in at least two important ways. First, the texture of the food we eat helps to determine how much of its surface area can come in contact with our taste receptors. For example, consider the difference in flavour intensity between carrot chunks, grated carrot and carrot juice. When you put a big chunk of carrot in your mouth, you do not taste much until you crunch down on it and break it into smaller pieces. Taste a forkful of grated carrot, and its flavour is much more noticeable. Sip on a glass of carrot juice, and you are likely to get a blast of carrot flavour immediately (Zimmerman, 2004).
The length of time food spends in the mouth also affects how strong its flavour seems. Thicker liquids and rich foods coat the mouth. Consequently, their tastants spend more time exposed to taste receptors than thinner liquids and leaner foods, so they often seem more flavoursome. Dense foods, likewise, come into contact with more receptors than do aerated, lighter foods. Chewy foods take longer to break down enough to swallow than do softer foods, so we get more flavour from them. Studies show that people, for example, tend to judge the flavour of yoghurt or custard as creamier and more flavoursome and filling when it is thick, provides more mouth coating and is slow to melt (McCrickerd et al, 2012; Zimmerman, 2004).

In many cases, what we like and dislike about the texture of our food is a direct result of what we expect from a particular food. ‘Chewy’, for example, is a textural feature that we like when we are talking about a muesli bar or licorice, but not when we are talking about steak or biscuits. Similarly, crispy or crunchy is what we expect and want from Twisties or pretzels but not from custard or scrambled eggs.

Texture contributes to the overall acceptability of a food or beverage, as well as to its appearance and flavour. Our expectation of how food should feel in the mouth is manipulated by food producers and marketers to influence our choices. For example, potato chips and crackers are advertised as crispy, butter and margarine as smooth, oranges as juicy, meat and chicken as succulent, ice cream as creamy, gravy as rich and carbonated drinks as fizzy or bubbly. This occurs whether or not it is true. Chefs and food manufacturers use starches, thickeners and emulsifiers to help create the ‘creamy’ taste they promote. However, a sauce’s flavour can be judged as being ‘creamy’ without actually containing cream.

**BOX 8.2**

**Does the colour of the mug influence the taste of the coffee?**

About a billion cups of coffee are consumed in cafes, restaurants and other outlets throughout Australia each year. Australian psychologist George Van Doorn and his colleagues (2015) conducted research to find out if consumers’ perception of a café latte would be influenced by the colour (transparent, white or blue) of the mug from which it was drunk.

In one experiment, nine male and nine female volunteer participants aged between 18 and 62 years with a mean age of 31.5 years were randomly allocated to either of three groups, with three males and three females in each group. Participants were told that the purpose of the study was to assess certain characteristics of coffee.

All drank ~200 mL of café latte (~135 mL of full-cream milk and ~65 mL of coffee). Group 1 were given their coffee in a white porcelain mug, group 2 in a transparent, glass mug and group 3 in a blue, porcelain mug (like the mugs shown below).

Once the participants had drunk their coffee, they rated the coffee on five characteristics using a 100-point scale for example, for flavour intensity, a score of 0 = not intense at all and a score of 100 = very intense. These results are shown in table 8.1.

The researchers concluded that the colour of the mug influenced participants’ ratings of the coffee taste/flavour. On the basis of this finding, they recommended that ‘café owners, baristas, as well as crockery manufacturers should carefully consider the colour of the mug and the potential effects that its colour may exert over the multisensory coffee drinking experience’.

**TABLE 8.1** The mean subjective ratings of the perceived intensity, aroma, bitterness, quality and acceptability of the coffee as a function of mug type

<table>
<thead>
<tr>
<th>Mug</th>
<th>Flavour intensity</th>
<th>Aroma</th>
<th>Bitterness</th>
<th>Quality</th>
<th>Acceptability (likeability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>35.46</td>
<td>38.18</td>
<td>36.00</td>
<td>50.57</td>
<td>40.38</td>
</tr>
<tr>
<td>Glass</td>
<td>29.97</td>
<td>24.08</td>
<td>24.86</td>
<td>33.85</td>
<td>43.80</td>
</tr>
<tr>
<td>Blue</td>
<td>31.16</td>
<td>29.71</td>
<td>27.34</td>
<td>49.48</td>
<td>55.58</td>
</tr>
</tbody>
</table>

SYNAESTHESIA

When Matthew Blakeslee shapes hamburger patties with his hands, he experiences a vivid bitter taste in his mouth. Esmeralda Jones sees blue when she listens to the note C sharp played on the piano; other notes produce different colours — so much so that the piano keys are actually colour coded, making it easier for her to remember and play musical scales. And when Jeff Coleman looks at printed black numbers, he sees them in colour, each a different colour. Blakeslee, Jones and Coleman experience the ordinary world in extraordinary ways. For them, the senses get intertwined instead of remaining separate. They are among a few otherwise normal people who have synaesthesia (Ramachandran & Hubbard, 2003).

Synaesthesia (pronounced ‘sin-ess-THEE-zah’) is a perceptual experience in which stimulation of one sense produces additional unusual experiences in another sense. The experience associated with the additional sense ‘adds’ to the overall perceptual experience without replacing the initial sense.

Researchers have found that synaesthesia is a real experience (rather than imagined) and can be distinguished by a number of characteristics. Synaesthesia is involuntary and occurs automatically in response to the relevant sensory stimulation. It is extremely difficult to suppress. The experience is also vivid, highly memorable and consistent across time. For example, the synaesthete always associates the same colour with the same number, letter of the alphabet or sound. Blue will always be experienced with the number three, or T’s are always red to the individual synaesthete. However, these specific cross-sensory experiences vary among individual synaesthetes. For example, one synaesthete may always experience blue with the number three, whereas another may always experience yellow with the number three. Finally, synaesthesia also tends to be one-way rather than bidirectional. If a sound produces a taste, the taste will not necessarily produce the sound (Hubbard & Ramachandran, 2003; Ward & Mattingly, 2006).

(a)

(b)

FIGURE 8.11 When synaesthesia occurs, stimulation of one sense triggers an unusual experience in another sense. Figure (a) shows how letters usually appear and (b) how letters might appear to a synaesthete.

Although synaesthesia was first scientifically investigated around 1880, it was brushed aside as fakery or a mere curiosity for many years. More recently, psychologists have developed renewed interest in synaesthesia and are now conducting research investigations on the phenomenon.
Much research still needs to be done, but it has been found that there may be unusual brain processes associated with synaesthesia and that there may be a genetic basis to its experience, as it tends to run in families. However, there is no strong evidence for sex differences in its experience (Hubbard & Ramachandran, 2003).

Synaesthesia is relatively rare and there are substantial individual differences among people in how they experience it. Estimates of its prevalence vary from as much as 1 in 20 people to as few as 1 in 25,000 people. An estimate of about 1 in 2000 people seems to be widely accepted within psychology. Some forms of synaesthesia are more common than others. For example, the experience of seeing colours produced by sounds, or seeing letters in specific colours, is more common among synaesthetes than a smell produced by touching a particular shape or a taste produced by hearing words.

One of the most common and widely studied forms of synaesthesia is called grapheme-colour synaesthesia, in which viewing letters or numbers produces the experience of colours. Synaesthetes who have this experience report that looking at a specific letter of the alphabet will evoke a specific colour or a ‘coloured overlay’. Other synaesthetes report that they do not actually see the colours but instead just ‘know’ that a particular letter is a particular colour. Still others report experiencing specific colours but say that the colour is experienced somewhere within their ‘mind’s eye’ (Hubbard & Ramachandran, 2003).

Explanations of synaesthesia
Researchers still know relatively little about synaesthesia and why it is experienced. Many explanations have been proposed for its occurrence. Some researchers have suggested that synaesthetes are unusually sensitive to external stimuli. Others have proposed that synaesthesia may result from a breakdown in sensory and perceptual processes. It has also been suggested that synaesthesia can be linked to the excess of neural connections formed during early development that are normally pruned and refined as the brain matures over time. Therefore, synaesthetes may be people who retain rather than lose these neural connections.

Many psychologists agree that it is likely that the brains of synaesthetes possess unique structural and/or functional properties. Consequently, explanations often refer to the possibility of differences in the architecture of the synaesthete’s brain. For example, the brains of synaesthetes may have abnormal neural pathways or be ‘wired’ differently, so that neighbouring sensory areas in the brain cross-activate one another, thereby triggering additional sensations — the experience of seeing colour when looking at shapes might be due to cross-activation of the colour and shape recognition.

Neuroimaging technology has been very useful for studying brain areas that are active during synaesthesia, but the images are not yet detailed enough to allow researchers to see whether the individual connections in the brain are cross-wired. When enough known synaesthetes die and donate their brains for research, post-mortem examinations may provide valuable information on what is actually different about their brains and what may therefore account for their extraordinary perceptual experiences.

It is likely that something is ‘going on’ in the sensory areas of the brain, but precisely what still remains unclear. It is, however, clear that synaesthesia is not associated with any serious brain abnormality or problems with cognitive functioning. Nor is it some kind of ‘sixth sense’.

Researchers usually study synaesthesia not only because it is an unusual perceptual experience, but also because it may shed new light on how the brain is organised and how we sense and perceive the world. It may offer new insights on brain areas and cognitive processes involved in perception. For example, it raises questions on how the different senses interact in the brain; how we ‘bind’ all perceptions together into one complete whole; how different types of information are represented in the brain; and on the overlap between cognitive processes such as perception, imagery, language, memory and conscious awareness.
A special few can ‘taste’ a word before they can say it

By J.R. Minkel

TASTE OF THE UNKNOWN: Words caught on the tip of the tongue elicit tastes in people with an unusual mixing of the senses called synesthesia.

Having a word stuck on the tip of the tongue is enough to activate an unusual condition in which some people perceive words as having different tastes, according to a new study. When people with the inherited condition, called synesthesia, looked at pictures of objects that come up infrequently in conversation, they perceived a taste before they could think of the word.

Some researchers believe synesthesia is an extreme version of what happens in everyone’s mind. If so, the result suggests that all abstract thoughts are associated with specific perceptions, says neuropsychologist Julia Simner of the University of Edinburgh, co-author of the report. ‘The extent to which abstract thought is truly abstract — that’s really what the question is.’

Simner and her colleague Jamie Ward of University College London tested six synesthetes by showing them pictures of 96 uncommon objects such as gazebos, sextants, catamarans, artichokes or castanets. Out of 550 trials in total, Simner and Ward induced 89 tip-of-the-tongue states. In 17 of these ‘um, um’ moments, the synesthete reported perceiving a taste while still trying to conjure the word. In short, the word’s meaning alone elicited the taste.

To confirm that these reports were truthful the researchers called the participants out of the blue a year later and retested them. The synesthetes consistently associated the same tastes with the same words, the researchers report in the November 22 Nature.

‘This looks pretty clever,’ says neuroscientist David Eagleman of Baylor Medical College, who was not involved in the study. Synesthesia research has blossomed in the last five years, as researchers have gained confidence in the subjective reports of presumed synesthetes, especially those who perceive letters or numbers as being colored, he says. ‘Essentially all the synesthesia literature is about color just because it’s easier to study. This is stepping beyond that.’ Some experts have estimated that there are more than 150 kinds of synesthesia, based on the possible combinations of subjective sensations, he says.

Prior experiments found that the word-taste associations are locked in during adolescence and have some definite patterns, Simner explains. These synesthetes tend to taste childhood things such as chocolate and lollipops, she says. ‘Some of these tastes are really strong and some of them are really unpleasant — some of them taste of earwax and bodily fluids,’ she notes. ‘It starts with words like “mince” and “cabbage,” and the taste experience spreads to similarly sounding words.’ ‘Princess’ might also taste of mince, for example. Some of the associations have seemingly obvious roots — ‘newspaper’ might taste like fish and chips, which traditionally comes wrapped in newsprint, she adds.

The brain wiring necessary for synesthesia seems to be present in everyone. Dropping acid or drifting to sleep can both cause synesthetic perceptions, and people who are blindfolded for extended periods may start seeing colors for different sounds, the experts note. ‘It’s possible that we all have that connection but the synesthetes have them to an extreme degree,’ says Simner.

Some scientists have theorized that we are born synesthetic but lose or block most of the pathways that cause the unusual perceptions, Simner observes. Eagleman disagrees, saying that the condition may be the result of an imbalance in brain signals. He hopes to identify the gene for familial synesthesia in order to learn more, he says.


LEARNING ACTIVITY 8.4

Review questions

1. Explain what synaesthesia is.
2. List the key distinguishing characteristics of synaesthesia.
3. Give a possible explanation of synaesthesia that is based on
   (a) brain dysfunction
   (b) healthy brain function.

LEARNING ACTIVITY 8.5

Media response

Read the above article on synaesthesia and explain how accurately it describes and explains synaesthesia with reference to information in this text.
CHAPTER SUMMARY

DISTORTIONS OF PERCEPTION

Visual illusions
- Müller-Lyer illusion
- Ames room illusion

Judgment of flavours
- Perceptual set
- Colour intensity
- Texture

Synaesthesia
- Explanations of synaesthesia

Biological perspective
Psychological perspective
Social perspective
SECTION A – Multiple-choice questions

Choose the response that is correct or that best answers the question. A correct answer scores 1, an incorrect answer scores 0. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Question 1
A visual illusion is best described as
A. consistent misinterpretation of real sensory stimuli.
B. a trick involving the visual perception system.
C. a false belief despite obvious proof that what is being looked at is incorrect.
D. a perception that occurs without external stimulation of the eye.

Question 2
The Müller-Lyer illusion demonstrates that if the retinal images of two lines are identical, then people who grew up in ‘carpentered worlds’
A. cannot be fooled.
B. can make perceptual errors unless a ruler is available.
C. will usually interpret the two lines as being of the same length.
D. can find themselves making errors of judgment by ignoring ‘carpentered world’ cues.

Question 3
An explanation of an illusion in terms of ‘misfiring neural impulses’ is likely to be based on the _____ perspective.
A. biological
B. psychological
C. social
D. biopsychosocial

Question 4
The Ames room illusion demonstrates that
A. viewing objects over a stretch of visible terrain can distort perception.
B. perception is more accurate when we use monocular cues as well as binocular cues.
C. we always maintain size constancy over shape constancy.
D. if two things appear to be the same distance away but have retinal images indicating that they are different sizes, then perceived size is determined by the size of the retinal images.

Question 5
In relation to taste perception, which of the following is a characteristic of texture?
A. colour
B. labelling
C. packaging
D. mouthfeel

Question 6
The physical stimulus for texture perception is
A. colour.
B. mouthfeel.
C. touch.
D. colour intensity.

Question 7
Which of the following points is correct about synaesthesia?
A. an imagined experience
B. involves perceptual distortions
C. causes brain injury
D. caused by brain injury

Question 8
The flavour of food is determined by
A. taste.
B. tastants.
C. the brain.
D. the food properties.

Question 9
The visual cue that tends to be predominant in the judgment of flavour is
A. colour.
B. labelling.
C. packaging.
D. light.

Question 10
Research findings indicate that more intensely coloured foods or drinks are likely to be perceived as
A. sweeter.
B. unhealthy.
C. lacking in flavour.
D. more intensely flavoured.
SECTION B — Short-answer questions

Answer all questions in the spaces provided. Write using black or blue pen.

Question 1 (2 marks)
Explain the meaning of the phrase ‘distortion of perception’.

Question 2 (5 marks)
(a) Give an explanation of a visual illusion from a biological, psychological or social perspective. 3 marks

(b) Explain whether illusions or misperceptions of taste or flavours may be better understood if approached from a biopsychosocial perspective rather than a single perspective. 2 marks

Question 3 (3 marks)
(a) Define food texture. 2 marks

(b) Explain the role of tastants in texture perception. 1 mark

Question 4 (2 marks)
Distinguish between taste perception and flavour perception.
Question 5 (3 marks)
Explain how perceptual set can influence flavour perception with reference to an example.

Question 6 (5 marks)
(a) List three distinguishing characteristics of synaesthesia. 3 marks

(b) Explain whether synaesthesia can be considered to be a perceptual distortion. 2 marks