

## Neuroscientists create 'atlas' of the brain

### Level 3 • Advanced

#### 1 Warmer

Match these words containing the word *brain* with their meanings.

- |                 |  |
|-----------------|--|
| 1. brainwave    | a. an extremely intelligent person   |
| 2. brain teaser | b. a sudden very good idea   |
| 3. brainless    | c. a difficult question or problem you try to solve for fun  |
| 4. brain drain  | d. extremely stupid  |
| 5. brain box    | e. a situation in which a country's most intelligent people, especially scientists, go to another country in order to make more money or to improve their living or working conditions |

#### 2 Key words

Fill the gaps in the sentences using these key words from the text.

cortex  
elusive

clump  
compelling

decode  
benign

cerebral  
quilt

tour de force  
transcript

- A \_\_\_\_\_ is a fairly thick cover for a bed, consisting of several layers of cloth sewn together, often with attractive patterns of cloth on its top layer.
- The \_\_\_\_\_ is the outer layer of the brain.
- A \_\_\_\_\_ is a mass of a substance.
- A \_\_\_\_\_ is something that impresses people because it is successful and is done very skilfully.
- If you \_\_\_\_\_ information, you succeed in understanding it.
- A \_\_\_\_\_ is a written copy of the exact words that people say.
- The adjective \_\_\_\_\_ is used to describe matters relating to or affecting the brain.
- If something is described as \_\_\_\_\_, it is interesting or exciting enough to keep your attention.
- If something is described as \_\_\_\_\_, it is difficult or impossible to achieve.
- If something is described as \_\_\_\_\_, it is not harmful in its effect.

#### 3 Find the information

Look in the text and find the following information as quickly as possible.

- How many people were scanned in the study?
- How many words did they listen to in the experiment?
- How many different words did they hear?
- What does the 'atlas of the brain' reveal?
- According to the article, the idea of which word is represented a lot in the brain?
- Why were stories from *The Moth Radio Hour* used in the study?

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#### Neuroscientists create 'atlas' showing how words are organized in the brain

Using brain imaging, scientists have built a map displaying how words and their meanings are represented across different regions of the brain

Ian Sample, science editor

27 April, 2016

- 1 Scientists have created an "atlas of the brain" that reveals how the meanings of words are arranged across different regions of the organ. Like a colourful quilt laid over the cortex, the atlas displays in rainbow hues how individual words and the concepts they convey can be grouped together in clumps of white matter.
- 2 "Our goal was to build a giant atlas that shows how one specific aspect of language is represented in the brain, in this case semantics or the meanings of words," said Jack Gallant, a neuroscientist at the University of California, Berkeley.
- 3 No single brain region holds one word or concept. A single brain spot is associated with a number of related words. And, each single word lights up many different brain spots. Together, they make up networks that represent the meanings of each word we use: life and love, death and taxes, clouds, Florida and bra. All light up their own networks.
- 4 Described as a "tour de force" by one researcher who was not involved in the study, the atlas demonstrates how modern imaging can transform our knowledge of how the brain performs some of its most important tasks. With further advances, the technology could have a profound impact on medicine and other fields.
- 5 "It is possible that this approach could be used to decode information about what words a person is hearing, reading or possibly even thinking," said Alexander Huth, the first author on the study. One potential use would be a language decoder that could allow people silenced by motor neurone disease or locked-in syndrome to speak through a computer.
- 6 To create the atlas, the scientists recorded people's brain activity while they listened to stories read out on *The Moth Radio Hour*, a US radio show. They then matched the transcripts of the stories with the brain activity data to show how groups of related words triggered neural responses in 50,000 to 80,000 pea-sized spots all over the cerebral cortex.
- 7 Huth used stories from *The Moth Radio Hour* because they are short and compelling. The more enthralling the stories, the more confident the scientists could be that the people being scanned were focusing on the words and not drifting off. Seven people listened to two hours of stories each. Per person, that amounted to hearing roughly 25,000 words – and more than 3,000 different words – as they lay in the scanner.
- 8 The atlas shows how words and related terms exercise the same regions of the brain. For example, on the left-hand side of the brain, above the ear, is one of the tiny regions that represents the word "victim". The same region responds to "killed", "convicted", "murdered" and "confessed". On the brain's right-hand side, near the top of the head, is one of the brain spots activated by family terms: "wife", "husband", "children", "parents".
- 9 Each word is represented by more than one spot because words tend to have several meanings. One part of the brain, for example, reliably responds to the word "top", along with other words that describe clothing. But, the word "top" activates many other regions. One of them responds to numbers and measurements, another to buildings and places. The scientists have created an interactive website where the public can explore the brain atlas.
- 10 Strikingly, the brain atlases were similar for all the participants, suggesting that their brains organized the meanings of words in the same way. The scientists only scanned five men and two women, however. All are native English speakers and two are authors of the study published in *Nature*. It is highly possible that people from different backgrounds and cultures will have different semantic brain atlases.
- 11 Armed with the atlas, researchers can now piece together the brain networks that represent wildly different concepts, from numbers to murder and religion. "The idea of murder is represented a lot in the brain," Gallant said.
- 12 Using the same data, the group has begun work on new atlases that show how the brain holds information on other aspects of language, from phonemes to syntax. A brain atlas for narrative structure has so far proved elusive, however. "Every time we come up with a set of narrative

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features, we get told they aren't the right set of narrative features," said Gallant.

- 13 Uri Hasson, a neuroscientist at Princeton University, praised the work. Unlike many studies that looked at brain activity when an isolated word or sentence was spoken, Gallant's team had shed light on how the brain worked in a real-world scenario, he said. The next step, he added, was to create a more comprehensive and precise semantic brain atlas. Ultimately, Hasson believes it will be possible to reconstruct the words a person is thinking from their brain activity. The ethical implications are enormous. One more benign use would see brain activity used to assess whether political messages have been effectively communicated to the public. "There are so many implications and we are barely touching the surface," he said.

- 14 Lorraine Tyler, a cognitive neuroscientist and head of the Centre for Speech, Language and the Brain at Cambridge University, said the research was a "tour de force in its scope and methods". But, the brain atlas in its current form does not capture fine differences in word meanings. "While this research is path-breaking in its scope, there is still a lot to learn about how semantics is represented in the brain."

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### 4 Comprehension check

Choose the best answer according to the text.

- How did the scientists create the atlas?
  - They created networks that represent the meanings of each word we use.
  - They recorded people's brain activity while they listened to stories.
  - They laid a colourful quilt over the cortex.
- Where is the word *victim* located?
  - on the left-hand side of the brain above the ear
  - on the right-hand side near the top of the head
  - exactly in the centre of the brain
- Would people from different backgrounds and cultures have different semantic brain atlases?
  - definitely
  - definitely not
  - possibly
- What, according to Lorraine Tyler, does the brain atlas fail to do?
  - capture fine differences in word meanings
  - show how the brain works in a real-world scenario
  - provide a narrative structure

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#### 5 Find the word

Find the following words and phrases in the text.

1. a noun meaning *colour* (para 1)
2. a two-word phrasal verb meaning *come alive* (para 3)
3. a three-word noun phrase meaning *a serious condition of the nervous system in which people gradually lose control of their muscles* (para 5)
4. a verb meaning *cause* (para 6)
5. an adjective meaning *so interesting or exciting that it holds your attention completely* (para 7)
6. a two-word phrasal verb meaning *start to sleep* (para 7)
7. an adverb meaning *attracting your attention or interest because of some unusual feature* (para 10)
8. a two-word phrasal verb meaning *learn the truth about something by considering all the separate bits of information you have* (para 11)

#### 6 Verb + noun collocations

Match the verbs in the left-hand column with the nouns or noun phrases in the right-hand column.

- |            |                |
|------------|----------------|
| 1. convey  | a. light       |
| 2. make up | b. information |
| 3. perform | c. networks    |
| 4. decode  | d. a response  |
| 5. trigger | e. concepts    |
| 6. shed    | f. a task      |

#### 7 Word-building

Complete the sentences using the correct form of the word in brackets at the end of each sentence.

1. Modern \_\_\_\_\_ can transform our knowledge of how the brain performs. [IMAGE]
2. One part of the brain \_\_\_\_\_ responds to the word *top*. [RELY]
3. The same region responds to words that describe \_\_\_\_\_. [CLOTHE]
4. The brain atlases were similar for all the \_\_\_\_\_. [PARTICIPATE]
5. Certain brain networks represent \_\_\_\_\_ different concepts. [WILD]
6. A brain atlas for narrative structure has so far proved \_\_\_\_\_. [ELUDE]

#### 8 Discussion

Discuss the statements.

- This research is worrying. It could lead to machines being able to read people's thoughts.
- What is the point of this research? Why does it matter if we know where words are in the brain?
- This research could be really useful if it can help people with serious illnesses to communicate.

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### KEY

#### 1 Warmer

1. b
2. c
3. d
4. e
5. a

#### 2 Key words

1. quilt
2. cortex
3. clump
4. tour de force
5. decode
6. transcript
7. cerebral
8. compelling
9. elusive
10. benign

#### 3 Find the information

1. seven
2. roughly 25,000
3. more than 3,000
4. how the meanings of words are arranged across different regions of the brain
5. murder
6. because they are short and compelling

#### 4 Comprehension check

1. b
2. a
3. c
4. a

#### 5 Find the word

1. hue
2. light up
3. motor neurone disease
4. trigger
5. enthralling
6. drift off
7. strikingly
8. piece together

#### 6 Verb + noun collocations

1. e
2. c
3. f
4. b
5. d
6. a

#### 7 Word-building

1. imaging
2. reliably
3. clothing
4. participants
5. wildly
6. elusive