# **Talk First,** Think Later

During everyday conversations, we often begin to speak before we have decided exactly what we want to say. **Antje Meyer** and her team at the **Max Planck Institute for Psycholinguistics** in Nijmegen are investigating how we plan sentences and what obstacles may stand in the way. To this end, the researchers test volunteers on a treadmill, construct virtual environments and travel to India to study whether illiterate individuals process language differently.

Photo: Mauro Rodrigues/Fotolia

TEXT **STEFANIE REINBERGER**

A cartoonish sketch flickers on the monitor. The image shows a dog biting a mailman. Click. Next image: this time, a girl is pushing a boy on a sled. Then: a woman giving a boy a cookie. The volunteer stares intently at the screen and tries to describe the brief, changing scenes as quickly as possible. Her head rests on a chin support to prevent it from wobbling. While the volunteer describes the images, a scientist, using a special eye-movement camera, follows her gaze as it scans the drawings. In this way, Antje Meyer and her team in the Psychology of Language Department at the Max Planck Institute for Psycholinguistics hope to discover how people plan sentences.

During a conversation, questions and answers often follow each other seamlessly. We appear to form sentences effortlessly – evidently without taking much time to plan them beforehand. In fact, many speakers start their sentences before they know precisely what they want to say. This is possible because we plan speech faster than we're able to articulate the words. For example, as one says "The young girl …," there is ample time to prepare the second part of the sentence in the background: "… throws the ball."

## "UMS" AND "ERS" HELP IN PLANNING SENTENCES

But how does this work exactly? Do we have general strategies for language planning that help us formulate answers without having to give them much thought? The scientists are seeking to answer this question with the help of experiments using an eye-movement camera. The device determines precisely, to within a millisecond, where the viewer's gaze lingers. For example, while the volunteer is looking at the picture of a dog biting a mailman, the camera system detects which section of the image she is gazing at most intensely before expressing the scene in words. This, in turn, reveals what information she has given the most attention to while preparing her sentence.

In simple situations such as "The dog is biting the mailman," the eye movements of most subjects follow the same pattern: after a brief orientation phase, during which the subjects often look at the center of the image, they gaze at the sections of the image in the order in which they appear later in the sentence. In other words, the eye wanders from the dog to the place at which the dog sinks its teeth into the mailman's leg, and finally, to the mailman's face.

However, when subjects are called upon to describe more complex situations, or when descriptions are longer, their eye movements increasingly vary.

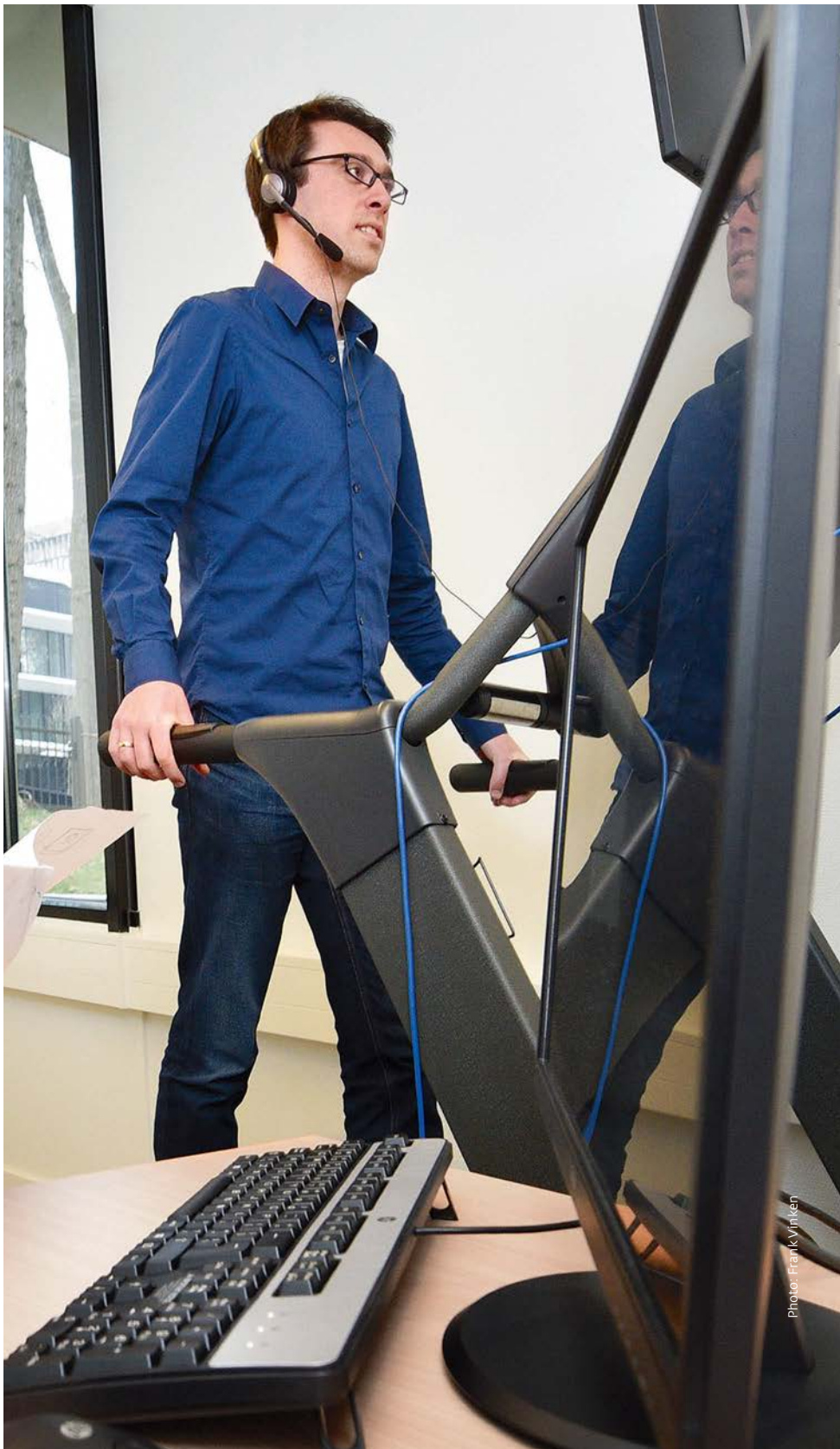
The very same person may then proceed extremely flexibly in describing different scenes – and variations are particularly pronounced between different speakers. Ultimately, a certain amount of flexibility probably helps people plan and choose their words in order to express themselves quickly and appropriately.

But not everyone is able to describe a scene or answer questions with equal speed and fluency. "Many factors come into play, such as how well an individual masters a particular language," Meyer says. Those speaking a foreign language will have to break sentences into smaller bits while planning them. This reduces the speech rate, forcing the speaker to introduce brief pauses that are then often filled with "ums" and "ers".

"We should therefore never conclude that non-native speakers (speakers not using their mother tongue) are unable to take in a situation just because they take longer to formulate their answer," the researcher cautions. "The delay is not in their thought process but in their ability to express themselves in a foreign language."

Antje Meyer cites another real-life example: "In school, pupils are expected to process sentences they're unable to comprehend because they don't have the requisite vocabulary and language skills." Textbooks for vocational schools, for example, are often formulated in a style normally found in scientific papers – replete with long, convoluted sentences, technical terms and the like. "So it's no wonder that a young woman who wants to be a hairdresser mentally blocks out the material," the Max Planck Director says, with a note of criticism. Yet vocational students probably wouldn't have any trouble following relevant material if it were expressed using words they're familiar with.

Such findings may sound mundane, but that's precisely what piques Antje Meyer's interest. The psychologist



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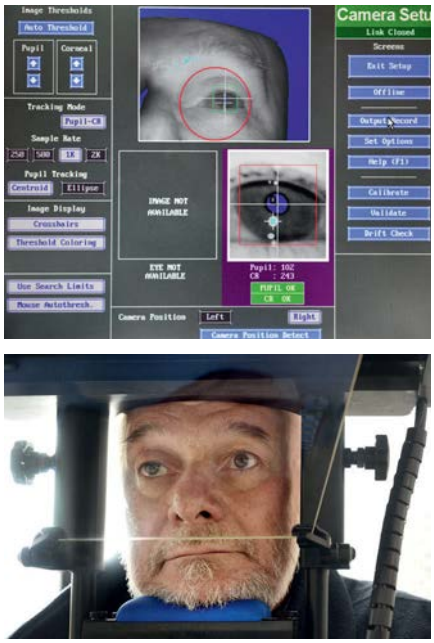


Speaking time in the laboratory: An eye movement camera (right) pinpoints exactly where the subject looks before speaking. Normally, any distraction should be avoided while speaking. However, experiment participants on a treadmill (left) are able to name images more quickly than participants who are sitting.

wants to know how language works in natural contexts, such as in normal conversational situations when an individual responds to what has just been said. "You might think that listeners use the time during which their counterparts are speaking to prepare their own response," the researcher says. "That may be possible sometimes, but comprehension suffers as a result."

To prove it, the team in Nijmegen again uses an eye-movement camera. This time, two volunteers sit in front of a monitor on which two rows of objects are displayed. The task is simple: the first speaker names the objects in the upper row, and the second, those in the lower row, doing so one after the other, as in a question-and-answer pattern.

While subject number one is "reading out" the first line, the researchers track the eye movements of the "responder." If he were preparing his utterances early on, his eyes would tend to dwell on the bottom row – but that is not the case. The listener first dutifully follows the speaker through the top row and then jumps to the lower row just before the end of the first speaker's utterance. The temporal overlap of listening and preparing one's own articulations is less than half a second.

## THE RESEARCHER THINKS LITTLE OF MULTITASKING

Another experiment provides the explanation. When volunteers are shown images of objects to name while listening to words read aloud through headphones, they are usually unable to remember later what they heard. The only exceptions are words that are played back while the subjects are looking at "scrawled" images containing no identifiable objects. When the speaker then – necessarily – inserts a pause, their mind registers the auditory input. This means that our capacity for listening is severely hampered while planning our own speech.

"It's not a good idea at all to encourage our students to think of clever questions during a lecture," Meyer says. Instead, the motto should be: listen before formulating your own thoughts and questions. Anything else will be to the detriment of our ability to assimilate the information. "In fact, you shouldn't write anything down either," says Antje Meyer, looking at the journalist diligently taking notes during this conversation.

In general, the psycholinguist thinks little of multitasking, because it's impossible to give one's full attention to more than one activity. The only exception is moderate exercise. Subjects walking on a treadmill were able to name images faster than subjects sitting on a chair. "That surprised us," says the scientist. "We had originally assumed that running would distract people from verbal tasks and that the subjects would therefore do more poorly."

But exercise appears to act as a stimulus and thus enhances alertness. "It's

Photos: Frank Vinken (3)

The search for variety: Antje Meyer and her team make a point of seeking out a variety of participants for their experiments. One study is investigating how reading affects speech among members of the Dalits, the "untouchables," in India. This allows the researchers to compare illiterates and literates from the same social class.

also likely that the subjects notice the distraction and therefore try harder to solve the task well," says Meyer, adding with a smile: "That's also why we're standing here while we're talking."

But be careful: not all types of movement are equal, and they don't always enhance concentration. The team in Nijmegen is currently carrying out a series of tests in which the treadmill rotates at a slower rate than the subjects' normal walking pace. They have to pay attention in order not to stumble and are therefore forced to divert capacities from the verbal task.

However, tests with human subjects in front of monitors and on treadmills model only a relatively artificial situation in the laboratory. And while it's true that this can answer basic questions about attention and language planning, a real dialogue consists of far more than a string of objects named sometimes simultaneously and sometimes in succession. Conversation partners interact and have to respond spontaneously to what has been said. On the one hand, the speaker commands the listener's attention, so that she is unable to consider her response during this time. On the other hand, sentence planning is supported by what was said before, because the responder can refer to thoughts and phrases the previous speaker used. For example, when one person asks: "What's your favorite food?", the other buys time by responding: "My favorite food? It's pizza."

A virtual reality laboratory is currently being built in the basement of the Max Planck Institute for Psycholinguistics to simulate situations that more closely approximate the natural conditions of interactive conversation. Here, instead of speaking to a monitor, subjects will talk to projected 3-D avatars in as natural an environment as possible – for instance in a virtual cafe. This has the advantage that the scientists can control the speech patterns of the avatars down to the smallest detail, and the virtual actors never act unpredictably.

To study speech in its natural context, it's important to involve as broad a range of subjects as possible. "Most of what we believe we know about the psychology of language has only been investigated with students, most of whom were female," says Antje Meyer. It's virtually impossible to extrapolate findings from such an elite group to the general population.

## READING AFFECTS VISUAL CONCENTRATION

The scientist has therefore taken great pains to set up heterogeneous groups of subjects – for example in the NEMO Science Museum in Amsterdam. The participants were mainly parents with their children. This was an opportunity to conduct dialogue experiments with people of various ages and from various social groups. The data has not yet been fully analyzed, but regardless of the scientific result, Meyer is heartened by the enormous interest the museum's visitors have shown in the research.

Another research field of the Psychology of Speech Department largely requires participants outside universities: studies on cognitive processing in illiterates. Falk Huettig, who heads his own research group in the department, is focusing on this topic. Specifically, he is delving into the question of whether and, if so, how literacy affects the brain, speech and cognition.

One of the pioneers in this field is French neuroscientist Stanislas Dehaene from the Collège de France in Paris. Together with international colleagues, Dehaene published a highly acclaimed paper in the journal Science in 2010. In the paper, the researchers compared the brain activity of illiterates with that of literate participants. Using imaging techniques, the researchers observed that reading influences the network in the brain that is responsible for spoken language.

They also discovered that, with readers, certain areas in the brain are more strongly activated – not only by written words, but also by images and symbols – than is the case with illiterate individuals. However, the region responsible for recognizing faces appeared to be diminished in literate participants compared with their illiterate counterparts. Could this mean that reading has an adverse effect on facial recognition?

The problem with Dehaene's study is that the participants came from diverse cultural and socioeconomic backgrounds – even from different continents. Moreover, the study compared a relatively small group of illiterate individuals with individuals who only learned to read and write as adults. The control group was also very mixed and largely comprised of academics. "Too many potentially confounding variables are at work, such as significant differences in all areas of general education, as well as the participants' social background," Huettig criticizes. "Differences in vocabulary, for instance, as well as poverty and poor access to basic healthcare, can have an impact on networks in the brain."

The psychologist therefore set out to find study participants from the same social group. This would allow him to investigate the influence of reading skills more directly. And he was successful: in a small village in the In-

Photos left page: Frank Vinken (top), brianindia/Alamy/Mauritius images (bottom)

dian state of Uttar Pradesh, among members of the Dalits – often referred to as "untouchables" in the West – a traditionally disadvantaged class in Indian society. "In this group we find both people with reading and writing skills and illiterates, but all from the same social and cultural background," says Falk Huettig and adds: "On top of that, we have the opportunity to carry out longitudinal studies on a large sample to test how speech, cognition and the brain are influenced when illiterates learn to read."

These studies are possible only through collaboration with scientists at Lucknow University in the capital of Uttar Pradesh. Huettig and his colleagues can also use functional magnetic resonance imaging (fMRI) there to investigate processes in the participants' brains.

Spoiler alert: Falk Huettig's team was unable to confirm Dehaene's hypothesis that literacy adversely affects facial recognition. Nor was the alleged positive effect of literacy on the phonological processing of speech verified. On the other hand, the scientists discovered a number of other differences between the two groups – including effects on visual attention. For example, participants with reading and writing skills scored better in certain search tasks than illiterates.

## PREDICTIONS HELP US SPEAK EFFICIENTLY

For instance, when participants were asked to select the green or the thin chicken from a flock of dissimilar chickens, the literate individuals proved to be significantly faster. They scored particularly well when the animals sought were located in a section of the image to the right of the center. Huettig suspects that this could have something to do with the horizontal left to right direction in which Indian script is read.

Stanislas Dehaene, too, had already found that literate subjects are able to process visual stimuli better horizontally, namely in rows, than illiterates.

In addition, Huettig discovered that literacy has had a direct impact on his participants' ability to anticipate upcoming language input. For example, illiterates are evidently less able to predict what their conversation partner will say next. To arrive at this conclusion, the researchers once again used a camera system to record eye movements. The participant hears the beginning of a sentence and looks at a monitor showing images representing how the sentence might be continued. For his Hindi-speaking volunteers, Huettig chose a sentence construction that accounted for the specific syntax of this language.

Applied to an English example, the experiment might look as follows: The subject hears "The boy will eat …" while a cake and a chair appear on the screen. Those who predict the continuation of the sentence in their mind are more likely to look at the cake than the chair. Whereas the gaze of literate participants does indeed tend to move to the cake before the word is spoken, the researchers found no such tendency in the group of illiterates. The latter's eye movements only moved to the cake when it was mentioned. Although the illiterate participants were able establish a link between the spoken sentence and the displayed symbols, they had great difficulty predicting the continuation of the sentence.

Moreover: further investigations by the Max Planck researchers showed that the ability to predict increases with literacy skills. They compared people with dyslexia, a reading disability, with participants with average reading skills, or second graders who could read well

Photo: Frank Vinken

First listen, then discuss: Antje Meyer follows this principle when conducting meetings with her team. Their experiments have shown that people are unable to follow a lecture and formulate their own thoughts simultaneously.

with second graders with reading difficulties. The effect was significant, even among students: those who could read well were also able to predict spoken language faster and more reliably.

However, this difference is barely noticeable in everyday life. Poorer readers do not necessarily respond more slowly to a question than adept readers – as long as they understand the content. And illiterates are not necessarily limited in their everyday conversation. It appears that prediction is just one of many strategies the brain uses to make language and speech as efficient as possible.

In any case, Falk Huettig's investigations have confirmed that reading has a significant impact on information processing and networks in the brain. He hopes to shed further light on the phenomenon with the help of brain imaging studies, which he is currently carrying out with colleagues in India among illiterate individuals who are learning to read.

The scientist is already convinced of one thing: "Our research and findings have revealed great potential for dyslexia research." So far, he says, much has been reported about what people with dyslexia can do worse or better than literate individuals. But it's almost impossible to determine the cause and effect of the reading disability with this approach. However, if you compare illiterates with individuals with reading and writing difficulties, it's possible to identify the characteristics the two non-reading groups share. This can then be used to narrow down the search for causes.

"The first outcome of our research is that we can advise dyslexics to practice reading as much as possible, even if they find it difficult," Huettig says. "The more one reads, the more his or her visual attention, for example, improves." And so scientific curiosity and basic research merge again at the heart of everyday life – where speech occurs under natural conditions. ◀

## TO THE POINT

- **People are unable to listen and plan a response simultaneously when conversing. Instead, the content of what is said often emerges only during the act of speaking.**
- **The ability to read has a significant influence on information processing in the brain.**
- **Those who can read score better in image search tasks and are better able to predict the content of conversations.**

## GLOSSARY

**Imaging methods:** In the neurosciences, these special techniques allow researchers to watch the brain at work. The most commonly used techniques include positron emission tomography (PET), which uses a weakly radioactive substance distributed in the body to provide sectional images of the brain, and functional magnetic resonance imaging (fMRI).

**Dyslexia:** International term for an intelligence-independent reading disability. It is usually used synonymously with legasthenia. It is characterized by severe, persistent problems with reading and writing at the word level.

**Functional magnetic resonance imaging (fMRT):** This technique is used to visualize perfusion changes in areas of the brain. Based on such changes, scientists can identify which areas of the brain are activated during specific tasks.