WHEN DANCERS ARE BUTTERFLIES: HOW THE BRAIN UNDERSTANDS METAPHORS

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YOUNG REVIEWERS:

KIRSTY
AGE: 9

ROSA
AGE: 10

When we speak, we often say things that are different from what we actually mean. For example, at a ballet, we might say that the dancers are butterflies. Dancers are not really butterflies, but this statement is not a lie; it is a metaphor. A metaphor is a figure of speech quite common in our everyday language and in books. In this article, we explain what metaphors are, why we use them, and what happens in our brains when we must understand a metaphor. Understanding metaphors requires a lot of brain work, which is why it is not always easy. Some people might find metaphors particularly difficult to understand, for example, very young children and people who are autistic. At the end of the article, we suggest things that teachers and speech and language therapists can do to help those who have difficulty understanding metaphors.

WHAT ARE METAPHORS AND WHY ARE THEY USEFUL?

A **metaphor** is an expression, or **figure of speech**, that is used as an alternative way to communicate ideas that might otherwise need a complex explanation. A metaphor does this by creating images in a person's mind. Almost any type of word can be used metaphorically, especially nouns, verbs, and adjectives. Take for example the noun "butterfly." Imagine that a friend of yours, Sarah, is talking about a ballet and says, "Those dancers are butterflies!" You probably think of graceful colorful insects, but you also understand that Sarah does not mean that the dancers are insects. Sarah is speaking metaphorically, and she means that the dancers are beautiful. Why does not Sarah simply say that? The magic of metaphors is that they can communicate a lot of information with just a few words. The mental images metaphors create provide more information faster than when someone describes something with a **literal** sentence, that is, a sentence in which words are used only in the way they are defined in the dictionary. With a metaphor, Sarah communicates more details than simply saying that the dancers are nice. For instance, the butterfly metaphor tells us that the dancers' movements are so elegant and delicate that they resemble those of butterflies. Metaphors have a sort of superpower compared to literal expressions, as they allow us to say more than our words mean.

Metaphors can also be helpful when talking about things that are difficult to explain, such as feelings, emotions, or complex scientific ideas. Imagine that, during your science class, your teacher says, "The atmosphere is the blanket of gases that surrounds the Earth" [1]. The sentence is not stating that the atmosphere is a blanket in the literal sense, but that the atmosphere surrounds the Earth and helps keep it at the right temperature, as a blanket might cover you and keeps you warm. This metaphor is a very simple and effective way for your teacher to explain how the atmosphere works. Imagining the atmosphere as a blanket also helps you remember what the atmosphere is and how it works, because you know what a blanket looks like and what it is used for. The fact that metaphors help us to remember concepts is another metaphor superpower.

The superpowers of metaphors have been studied for more than 2000 years. Ancient Greeks and Romans were interested in metaphors but, at that time, metaphors were seen mostly as a device for creative language, such as poetry. Nowadays we know that metaphors are also quite common in our daily language and communication. When someone is talking to you, they might use six metaphors for every minute they talk! However, the price of this powerful communication tool is that the brain must put more effort into understanding a metaphor compared to a literal sentence.

WHAT HAPPENS IN THE BRAIN WHEN WE TRY TO UNDERSTAND METAPHORS?

To understand a metaphor, you must create a link between what is being talked about (in our example, dancers) and another word that seems completely unrelated (butterflies). You must figure out which characteristics these two words might share (such as looking beautiful and moving elegantly). To do this, your brain must first search for the meaning of the words in your mental vocabulary—a sort of dictionary in your brain, where the words that you have learned are stored. Then, the brain must use your knowledge of grammar to understand how the words in the sentence can be connected. Additionally, your brain needs to find extra information in memory about the things being compared. In our example, the information to retrieve is that dancers in a ballet usually move in elegant and graceful ways, that they often jump and spin, and that butterflies also move elegantly from flower to flower. The brain must also understand the point of view of the person saying the metaphor. Does Sarah like dancers, or dislike them? The brain's ability that helps us to understand what other people are thinking or feeling is called **theory of mind**. Luckily for most of us, our brains can do all these tasks very quickly so that, in less than a second, we are able to understand the meaning of a metaphor.

How do we know all this? Scientists have developed powerful tools to explore how the brain works. For example, there is a technique called **functional magnetic resonance imaging** (**fMRI**) that allows us to take pictures of the many parts of the brain that are involved in understanding metaphors. Let us think about each area of the brain as a cog in a clock. When understanding a metaphor, the cogs of vocabulary and grammar are active; these are in the frontal part of the brain, close to your forehead. Then we have the memory cogs, which are placed below the language cogs. Finally, the theory-of-mind cogs are involved, which are toward the back of the brain [2]. All these cogs are located in both sides of the brain, the left and the right (Figure 1).

LEARNING TO UNDERSTAND METAPHORS: EASY FOR SOME, DIFFICULT FOR OTHERS

The brain is more complex than a clock because the cogs of the brain change as you learn new things. This is also true for the cogs involved in understanding metaphors. In very young children, these cogs do not yet connect to each other to make the mechanism work the way it does in adults. Young children do not have enough vocabulary and grammar knowledge, they do not have enough experience in their memory storage, and they may not yet understand other people's thoughts as well as adults do. Therefore, young children may interpret metaphors more literally, which means they may misunderstand what the person using the metaphor really means. They might take our

THEORY OF MIND

The ability to understand your own and others' thoughts, intentions, and emotions. Thanks to theory of mind, we can understand other people's points of view.

FUNCTIONAL MAGNETIC RESONANCE IMAGING (FMRI):

A technique that measures blood flow in the brain and can detect which parts of the brain are active when we do something, such as reading or counting.

Figure 1

The metaphor cogs in the brain. In this figure, you can see the left side of the brain and, reflected in the mirror, you can also see the right side of the brain. Both sides of the brain are involved in understanding metaphors. The parts of the brain that contribute to understanding metaphors are shown as interconnecting cogs. These brain areas work together to search for the meaning of the words in the metaphor, connect the words in the sentence, explore information in memory and understand the point of view of the person saying the metaphor.

AUTISM

Also called Autism Spectrum Disorder; a condition that affects brain development and causes communication difficulties or the repetition of movements or behavior. Approximately 1% of people in the world have autism.
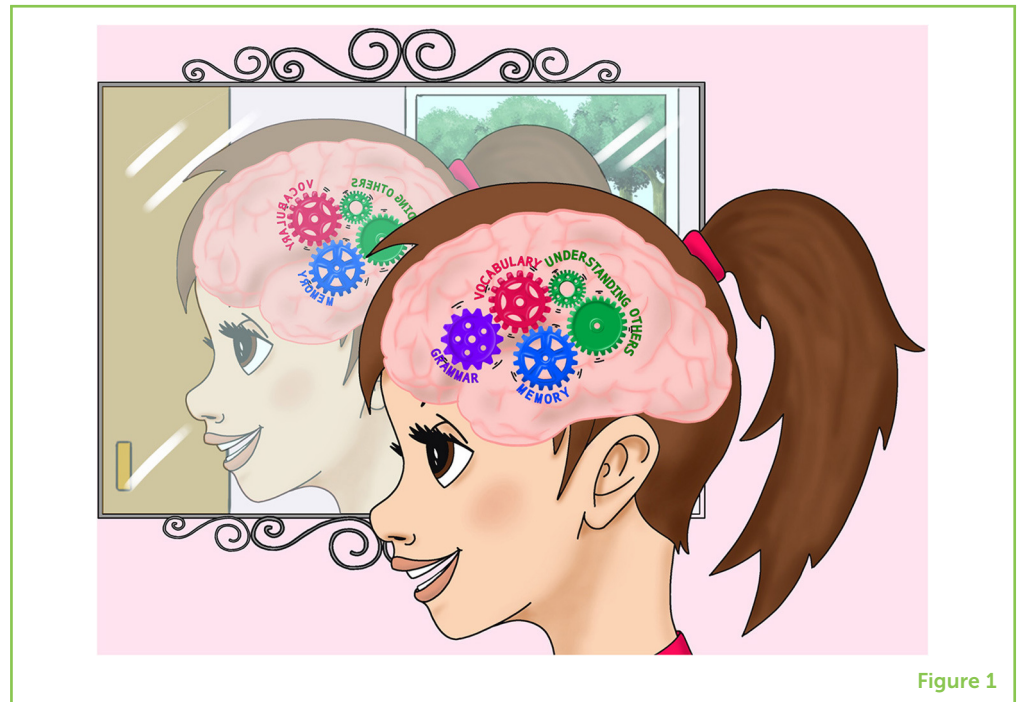
Figure 1

example of the dancers that are butterflies literally, and think that the dancers are really insects (Figure 2). As kids grow older, all the skills necessary for understanding metaphors improve and, between the ages of 10 and 14, children usually begin to understand and explain metaphors as well as adults do [3].

In people with **autism**, the cogs for understanding metaphors might not work as expected. Scientists have suggested two reasons why autistic people might have difficulty understanding metaphors. First, in autistic children, the vocabulary cogs often do not develop at the expected age. So, these children might not know all the different meanings of a word or all the parts of an idea. Therefore, like very young children, they might not be able to figure out which characteristics are shared between the two elements of a metaphor. It is also possible that the theory-of-mind cogs in autistic people sometimes do not work properly. For example, they might have difficulty understanding that Sarah really likes the dancers. Using fMRI, scientists have seen that the cogs in the brains of autistic children do not always connect with each other as expected when they try to understand metaphors [4]. Autistic people are not the only ones who can find metaphors challenging. People with a mental illness called schizophrenia, for example, might also have difficulties going beyond the literal meaning of words.

HOW CAN WE HELP?

Since metaphors are used very often in communication, children, and adults who struggle with metaphors might be confused and

Figure 2

THINKING MAPS

A sort of game with words that can be used as a tool to learn what characteristics two words share.

feel awkward in many situations. They might also feel lonely in class or at work. Children might have more difficulty learning because they do not understand the metaphors that teachers use or that they encounter in schoolbooks. Therefore, those who struggle with metaphors need help.

Scientists have provided some recommendations for teachers and speech and language therapists, so that they may help children develop their skill with metaphors. **Thinking maps**, a sort of game with words, are one commonly used strategy (Figure 3). Thinking maps contain two big bubbles: one bubble lists one word of the metaphor (dancers, in our example), and the other lists the second word (butterflies). In the surrounding smaller bubbles, children must write the characteristics they know about the two words and connect those characteristics to the word in the metaphor that they refer to. Then, the children are asked to identify characteristics that are shared by the two words of the metaphor, which might be used to explain the metaphor. This game can be taught to children who struggle with metaphors, so that they can use it when they encounter metaphors that they do not understand. Teachers can also use this game in class, to help their students learn about metaphors.

HAVING FUN WITH METAPHORS

Did this article inspire you to play with metaphors? Then start training your brain! Count the metaphors in this article, or maybe take the first book or newspaper you can find, open it to a random page, and see how many metaphors you can find. Probably you will find many of them. Metaphors are very common and the ability to identify and understand them is crucial to clear communication in our lives. Another exercise you can do is to try to replace the encountered metaphors with literal sentences. You will notice that the text would

Figure 3

Thinking maps. Thinking maps like this one can be used to help children learn to understand metaphors. The large bubbles contain the two words of the metaphor. Children are asked to list characteristics of these words in the smaller bubbles, and then to identify the characteristics that are shared between the two words. In this case, the bubbles contain shared characteristics of "dancers" and "butterflies."
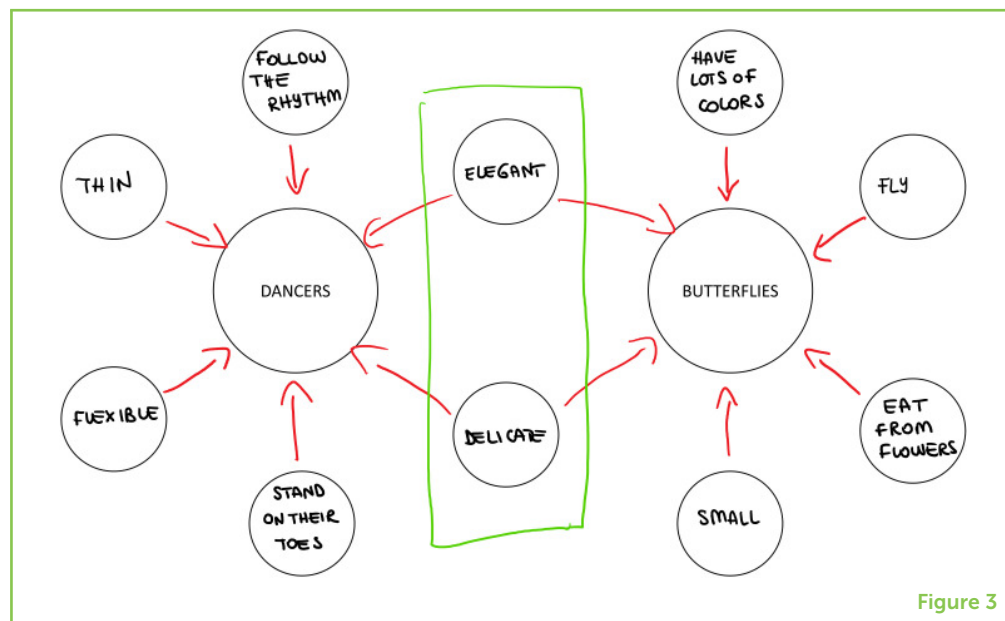
Figure 3

be less nice and less memorable. This is because metaphors quickly make use visualize and understand ideas, and the text would be poorer without metaphor superpowers. We hope this article has inspired you to have fun with the metaphors you will meet in the future.

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YOUNG REVIEWERS

KIRSTY, AGE: 9
My name is Kirsty and I like maths. I love to read books on my Kindle. I also have a little sister who is 3 years younger than me. I also enjoy playing Roblox.

ROSA, AGE: 10
I was born in Italy and then moved to the UK when I was 8 months. I am bilingual and very interested in in Language Learning. I have also a passion for football. Actually I do play football everyday, it is an obsession! I like staying active, listening to others and cooking, not baking! I have performed in a couple of Science Festivals, promoting the benefits of bilingualism. I trully love science and I in particular want to know more on how the brain works.

AUTHORS

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I am an associate professor in special education and neurodevelopmental disorders at Østfold University college, Norway. My Ph.D., thesis was about comprehension of figurative language in autistic people. My main research interests, in addition to neurodevelopmental disorders, include language and communication difficulties and literature reviews. I try to make my research as open and accessible for everyone as possible. *tamara.kalandadze@hiof.no
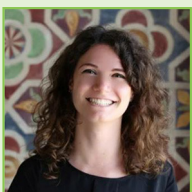
ELISABETTA TONINI
I am a Ph.D., candidate at the University School for Advanced Studies IUSS in Pavia, Italy, and I am currently in the third and last year of my doctoral program in cognitive neuroscience and philosophy of mind. I am mainly interested in investigating how people understand and use figurative language, such as metaphors, idioms, and proverbs. I am currently developing ways to train children, the elderly, and patients with cognitive disorders to use and understand figurative language.

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I am an associate professor of linguistics at the University School for Advanced Studies IUSS in Pavia, Italy. I study and teach how the brain supports the ability to use language to communicate and how people can understand each other when using words non-literally. This field is called neuropragmatics. I am also interested in the communicative difficulties of people with brain disorders and I have developed tools to measure and to train communication in these people.