

7th year

Winner

Young Writers' Competition

# Bilingualism and cognition

*Does bilingualism alter how we think? Babel Young Writers' Competition winner* ***Josephine Holubkov*** *explores the research*

Many people believe that bilingualism has well-attested consequences on cognition, and maybe even on intelligence. These effects are often mentioned in pop psychology texts. Of course, these sources often simplify and summarise research in order to make it simpler and easy to understand. But what has research actually found, and can bilingualism really affect one's cognition?

## Parallel activation

According to Viorica Marian of Northwestern University and Michael Spivey of UCMerced, an essential question about bilingualism focuses on language processing. Does a person who speaks two (or more) languages store them in separate lexical systems, or do these systems interact?

At first glance, it seems obvious that separate lexical systems would be more efficient and less confusing than allowing for processing overlap. In fact, early studies, utilising multilingual priming, which examines if the brain is "primed" to think of related words in one language or multiple when given a random word, concluded that bilingual brains had independent lexicons, and that only one of these could be used at any given time. However, more recent studies show that bilinguals exhibit parallel activation, in which the lexical systems for each language overlap and in which *both* are activated when completing a linguistic task.

So, when we say that bilinguals have overlapping systems, we're saying that their lexical systems – or 'vocabulary networks' – don't exist independently within their brains. For example, if a bilingual speaks English and Spanish, then their network for 'woman' would not only be connected to related English terms, but also with its Spanish equivalent – *mujer* – and associated Spanish vocabulary.

In a monolingual brain, lexical activation means that the person is relying on their lexical system to complete an exercise. Parallel activation, or activating lexicons at the same time, means that a bilingual's brain is simultaneously utilising both networks in order to process language or another linguistic task.

In 1969, Malcolm S. Preston and Wallace E. Lambert conducted the first study to show parallel activation. They relied on a modified version of the Stroop test. In the original Stroop test, subjects were asked to name the colour in which a word was printed, and not to read the actual word (which named a different colour!). Researchers

found that participants were able to give the colour of the word much faster if it corresponded with the identity of the word itself. You can try the Stroop test for yourself; remember, say the colour of the word, not the word itself…

name in one language would *not* affect one's ability to name a different colour in another language – we would call this a *lack* of interlingual interference. However, Preston and Lambert found that bilinguals *did* exhibit interlingual interference, concluding that both lexicons were activated in a parallel manner, even if the speaker was only consciously using one of them.

Preston and Lambert also found that this interlingual interference was more prominent when the languages had visually similar words for colours. For example, 'blue' and 'red' in English and *bleu* and *rouge* in French look similar, accentuating the connection between bilinguals' lexicons. However, other studies found that results showing parallel activation held true, even when bilinguals spoke languages with completely different orthographies. Other researchers found that this was the case for Mandarin- and English-speaking people, and for English and American Sign Language (ASL).

Another study, by Céline Beauvillain and Jonathan Grainger, utilised priming tasks to test lexicon activation.

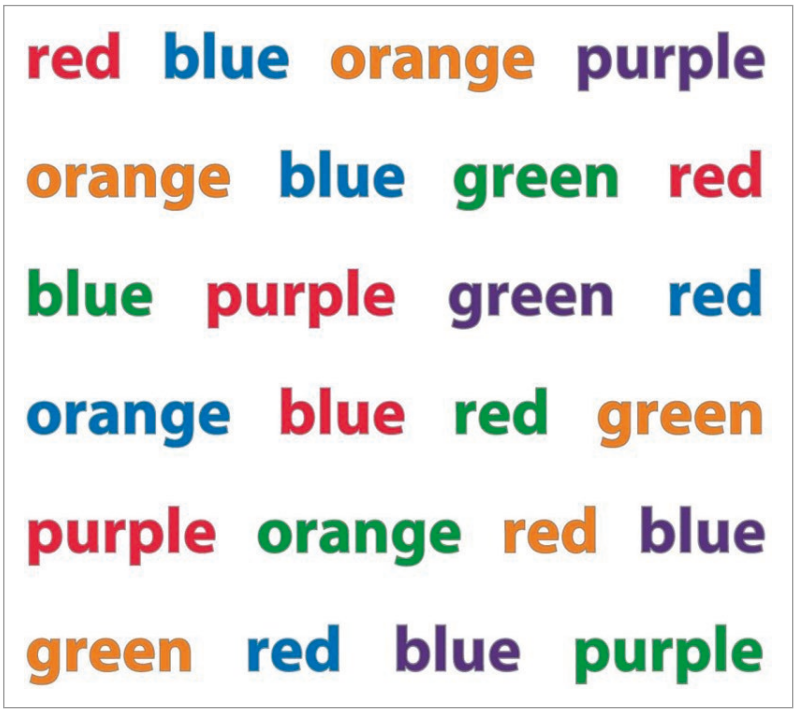



Figure 1 .

In their experiment, Preston and Lambert modified the Stroop test for bilinguals. The test was exactly the same, except the words were in a different language from the language that the participants were asked to speak. For example, a French and English speaker could be asked to name the colour of the word in English, while the word itself would be a colour in French. If the participant saw the word *vert* ('green') printed in red ink, they would be expected to say 'red'.

In the monolingual Stroop test, it's hard to name the colour of a word if the word names a different colour, because our brains are reading the word. In the bilingual case, if different languages were stored in separate lexicons, then we would expect that reading a colour's

## What is a lexical system?

**A person's lexicon is their vocabulary, and it is informed by experiences such as their culture, upbringing, and other factors. A lexical system is a network in a person's brain that models this vocabulary, especially how words relate to each other.**

**To visualise this, Armand Rotaru of University College London and fellow researchers have modeled an example of the local lexical system surrounding the word 'woman'.**

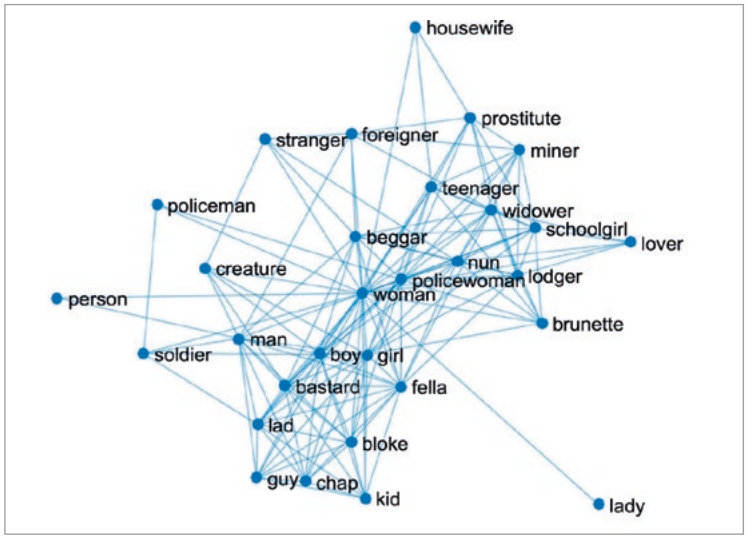



Figure 3 .

**Note that this network is hypothetical, as each person's individual experience shapes their lexical system(s). It also represents a very small portion of an actual lexical system.**

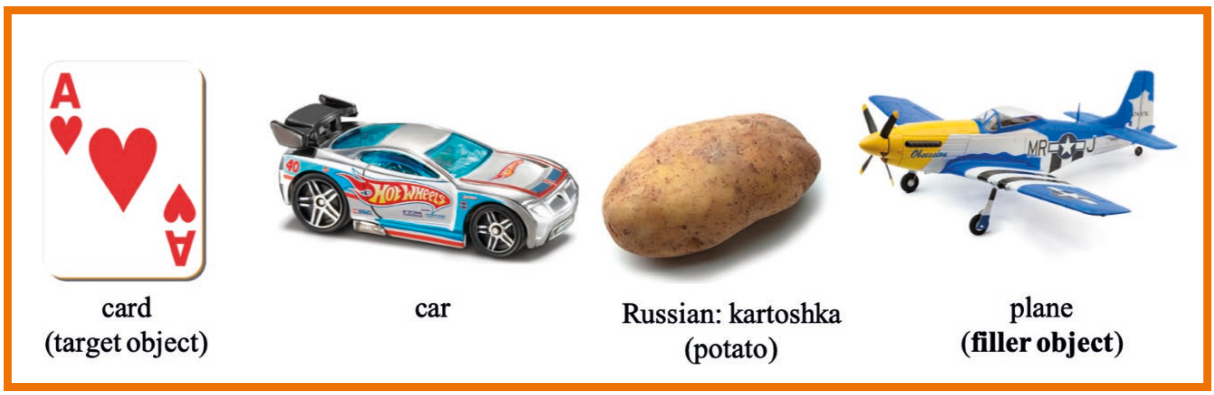



Figure 2. Similar sounding objects in different languages

These researchers showed that both lexical networks are initially activated, but that the stimulation of one fades with time. Their results also suggest that if a word with the same spelling appears in both languages, then lexicon activation favours the language in which that specific word is more common. For example, 'four' is more common in English than in French, in which this string of letters means *oven*. Hence, if a bilingual saw the word 'four', they would expect the word to be in English.

This is all very interesting, but how do parallel activation and bilingualism shape cognition? Let's look at some effects.

## Effects in the moment

In 2003, Viorica Marian and Michael Spivey studied Russian- and English-speaking bilinguals. These bilinguals were Russian native speakers attending an American university. The reseachers created an experimental setting that was as monolingual as possible: one set of trials was entirely in Russian, and the other was entirely in English. Neither condition mentioned the bilinguals' skills in the other language. All participants' first language was Russian.

The experiment included multiple setups to test how bilingualism affected the test subjects' cognition. In one English-only version, where English was the target language and Russian was the unused language, the researchers specifically chose a target object, an object that sounded similar to the target in English, another object that sounded similar to the target in Russian, and a further object that sounded different in both languages. The objects were placed in front of the participant. For example, one setup in the English-only experiment included these objects (notice how the non-filler objects sound similar to the target object, but in different languages) – see Figure 2 above.

All objects were similarly sized, and clearly identifiable.

Other setups included: only the target object and similar-in-English item with two filler objects; only the target and filler objects, or only the target object and similar-in-Russian item with two fillers. These setups were the same in the Russian-only experiment, but with the roles of the target vs. unused language swapped. On page 4 is one example of a Russian-only setup – see figure 4.

In both versions of the experiment, the participant was asked to look at a mark on the table, pick up the target object (e.g. 'pick up the card'), or pick up a filler object (e.g. 'pick up the plane'). All instructions were given in the language of the experiment, and a device was used to track the eye movements of the test subject as they followed the instructions. The name of the object that was similar in the other language was never mentioned. For example, in the English-only setup, the researcher would never use the word *kartoshka*, the Russian for 'potato'.

In the English experiment, even though the participant never heard any words in Russian, and the Russian language was never even mentioned, the researchers still found that if there was a non-target object on the table that sounded like the target object in either English or Russian, then the participant would look at it in a statistically significant manner before choosing the target object. They would not do this if filler objects were present. For example, if asked to pick up the card, the participant would look at the car and/or potato (*kartoshka*) in a non-random manner before choosing the card. This means that these Russian speakers exhibited both within-language interference (English on English), and between-language interference (Russian on English). This second point shows the effect of parallel

activation on the participants' ability to complete the task.

It is important to note that the Russian experiment did not show a statistically significant level of between-language interference, meaning that for this task, the speakers' second language activation (English) did not interfere with their first language (Russian). However, their first language did interfere with their second language. The fact that participants looked at both objects before choosing the target object in their second language could imply that parallel activation creates a delay in bilinguals' completion of tasks when it happens alongside within-language interference that a monolingual would also experience.

This interference seems to have an effect on other linguistic functions, as well. According to Ellen Bialystok and fellow researchers, bilinguals exhibit deficits compared to monolinguals in certain tasks. These include having a smaller vocabulary in each language than monolinguals, naming pictures more slowly, and comprehending or producing words more slowly and with more difficulty, even in their dominant language. These researchers claim that the delay and deficits that come from parallel activation stem from the need to accurately select the speaker's target language.



Figure 5. A reunion of some 300 members of the Lothian Birth Cohort in 2019

## Effects over time

Many studies have noted the difficulty of examining bilingualism's long-term effect on intelligence and cognition, because in some cases, intelligence may shape acquisition of another language, rather than the other way around. Thomas H. Bak and fellow researchers resolved this issue by interviewing the 1936 Lothian Birth Cohort – "remarkably homogenous" English speakers from Edinburgh who are still being studied to determine how various life factors influence intelligence and aging.

The researchers completed a longitudinal study of 853 members of this cohort, first interviewing all of them at the age of 11 (in 1947), then interviewing them again in the years 2008–2010 (at the ages of 61–63). Both interviews included a variety of tests that can be combined to calculate cognitive intelligence. The second interview included a bilingualism questionnaire, in

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Figure 4. Russian only objects

which participants were asked whether they spoke any language other than English, how often they used the language(s), and at what age they had learned them. By conducting the study in this manner, the researchers were able to adjust for their research subjects' baseline childhood intelligence.

After conducting these two rounds of interviews, the researchers found that bilingualism protects against age-related cognitive decline, even when accounting for baseline childhood intelligence. Bilingualism seemed to offer this protection at a higher rate for verbal fluency, reading, and general intelligence than memory, reasoning, and speed of processing. There were some differences in the effectiveness of bilingualism's effects based on the age of second-language acquisition, but these positive trends existed even in those who had acquired their second language as an adult. The researchers concluded that they found no negative effects associated with the acquisition of multiple languages.

The research team also noted that the positive effect of bilingualism on intelligence may be a result of frontal executive advantages, "the best documented nonverbal cognitive feature of bilingualism". This feature essentially means that bilinguals may complete executive control functions more efficiently than monolinguals. Examples of these functions include self-control, decision-making, sustained attention, and working memory.

Multiple studies document these benefits to executive control. Using fMRI scans, Gigi Luk and other researchers found that the mechanism that helps switch between languages relies on the same systems that are used for non-verbal executive control functions. These results were corroborated by Jubin Abutalebi in 2011, who located these systems in the anterior cingulate cortex, and by Franco Fabbro in 2000, who found that bilinguals with damage to the executive control system could not correctly select their intended language.

Judith F. Kroll and Ellen Bialystok take these findings together to mean that parallel activation creates a requirement for this selective 'language switching' mechanism to exist, and its location in the frontal cortex leads bilinguals to perform executive control functions more efficiently. Thus, parallel activation, a fundamental aspect of our understanding of the bilingual brain, may be the root cause of this enhanced function. While researchers have this foundational knowledge, there is still a great need for studies that show how exactly bilinguals' language processing networks can modify non-verbal cognition. ¶

**Josephine Holubkov** is an undergraduate Linguistics student at Yale University and a research assistant for the Yale Grammatical Diversity Project. As well as the effects of multilingualism on cognition, she is interested in how smaller linguistic differences, such as dialect, shape language processing. Josephine grew up as a polyglot and is always looking to learn a new language. Following graduation, she hopes to attend law school.

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## Find out more

### Online

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