Cognitive decline? Pah!

If you believe fading brainpower is an inevitable part of growing older, think again, say Michael Ramscar and Harald Baayen

Michael Ramscar and Harald Baayen are at the Department of Linguistics, University of Tübingen, Germany. Their research focuses on a computational understanding of languages and minds.

It is one of life's eternal mysteries: why does it get ever more difficult to recall the name of the person you were just introduced to? Surely it is a no-brainer that our cognitive powers fade as we grow older? Research seems to back this up: as we age, our scores in tests of cognitive ability decline.

Is this picture really correct? When we applied the techniques we use to study language learning to this evidence, we came to a different conclusion. In fact, counter-intuitively, many of these lower scores reflect cognitive improvement.

To illustrate the point, let's look at a test often used to measure our ability to learn and recall new information, called paired associate learning (PAL). In this test, people learn word pairs. Some are easy, *baby-cries*; others harder, *obey-eagle.* People perform worse on this task as they get older, supporting the conclusion that learning ability declines with age.

We think PAL tests paint a misleading picture of our cognitive abilities because they do not take into account prior knowledge of the words being tested, which grows with age and experience. To explain why this matters, we need to take a close look at the learning process.

The Russian physiologist Ivan Pavlov is famous for conditioning dogs to salivate at the sound of a bell. This led to a view of learning called associationism: if a cue is present, and an outcome follows, animals learn to associate them. Although humans can learn this way, the word "associate" is misleading. Our brains actually learn by making and testing predictions about the world. These are used to determine cues that are unreliable, which our brains then ignore and hence eliminate. It turns out that a dog associates a bell with food only because it has learned to ignore all other cues available to it.

We can apply this understanding of the role of elimination in the learning process to the PAL test. Results not only show that we find this test harder as we grow older but also that harder word-pairs become more difficult to learn. Why? An obvious answer is that words such as *baby* and *cries* often appear together in everyday language. This is what makes these pairs easy to remember. Meanwhile, learning nonsense pairs of words such as *obey-eagle* is hard because experience teaches us that *obey* is uninformative about *eagle* in English. This suggests a reason why older adults find PAL learning harder: they have greater experience of how words do and don't occur together.

In the past, this suggestion would have been impossible to test. There was simply no way of measuring how differences in experience might play out in learning on something like a PAL task. However, computational models enable us to estimate the connections between words based on their patterns of occurring together in billions of words of English text and speech. We used these techniques to assess the way that PAL words should behave in English. We

found that as adults grow older, whether they find PAL pairs easier or harder reflects how difficult the information structure of English says they ought to be.

Traditional interpretation of PAL results assumes that all participants have equal knowledge of the words being tested. This is clearly wrong. Once we correct for the effects that increased experience can be expected to have on subsequent learning, any evidence of cognitive decline disappears. What we find instead is evidence that older people have a superior knowledge of how the English language works. In a similar vein, it is well known that as we age we get slower at discriminating real words from non-words in tests. What is less well known is that age also makes us more accurate at this task. Interestingly, people who speak two languages respond more slowly than monolingual people on similar tests, yet this is not taken as evidence that bilinguilism leads to cognitive deficits. Rather, bilingual people's slower responses are thought to reflect the time it takes to search their larger "mental dictionaries".

The problem of understanding the effects of prior learning on performance are unlikely to be unique to PAL and word-recognition tasks. Other psychometric tests of cognitive ability (intelligence or short-term memory, for example) also assume that the participant's prior knowledge of items being tested is irrelevant. What our research shows is that increased knowledge brings costs as well as benefits. Learning increases the amount of information that our brains have to process, which inevitbly affects test performance.

Contrary to popular belief, neuronal loss does not play a significant role in age-related changes in brain structure. Rather, consistent with our findings, most of the changes that occur as healthy brains age are difficult to distinguish from those that occur as we learn. Thus, understanding the costs and benefits of learning is critical if we are to establish the facts of cognitive ageing. For example, memory experiments show that, as we age, we "encode" less contextual information, such as what we were wearing when we learned a new fact. This makes the fact harder to recall, and is seen as a sign of cognitive decline. Yet everything we know about the way our brains learn indicates that people must inevitably become insensitive to many background details as life experience grows. This is simply because detuning our attention to irrelevant information is integral to the process we call "learning".

This observation hints at a way to overcome age-related problems with memory recall. As we age, varying the contexts of our lives more can help counteract the way our minds have evolved to continually tune out irrelevant information. This also means that, when retirement leads older people to spend most of their time in highly familiar environments, they will find it difficult to absorb the "context" that separates one memory from another. As a result, memories will become confused, even without declines in underlying brainpower.

Our research sheds similar light on another problem associated with old age: the inabllity to recall people's names. It turns out that names, at least in the US, have become more complex at an almost exponential rate since the 1880s. This has made the task of recognising American-English names harder over time, independent of the fact that people also learn more names as their experience grows with age. In a computer simulation, we found that simply processing the information required to recognise a name ought to take today's 70-year-olds half-a-second longer than when they were 20.

The processes involved in forming memories and recalling names highlight how the way we learn interacts with the environment throughout our lifetimes, and shows how difficult it is to separate changes caused by learning from those of decline.

This is important. We are not arguing that the functionality of our brains stays the same as we grow older, or that cognitive decline never happens, even in healthy ageing. What we do know is the changes in performance seen on tests such as the PAL task are not evidence of cognitive or physiological decline in ageing brains. Instead, they are evidence of continued learning and increased knowledge. This point is critical when it comes to older people's beliefs about their cognitive abilities. People who believe their abilities can improve with work have been shown to learn far better than those who believe abilities are fixed. It is sobering to think of the damage that the pervasive myth of cognitive decline must be inflicting.