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# Does Cognition Deteriorate With Age or Is It Enhanced by Experience?

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Clearly, the description and explanation of cognitive decrements with aging is the domain of cognitive neuroscience, not of functional-level cognitive science. Nope! Not so fast! say Michael Ramscar, Peter Hendrix, Cyrus Shaoul, Petar Milin, and Harald Baayen, the authors of *The Myth of Cognitive Decline*, the latest addition to our occasional topic, *Visions of Cognitive Science*.

Many things covary as we grow up and grow older and, just as in the nature versus nurture debate over childhood development, a rush to judgment obscures and confuses the search for mechanisms and for the achievement of scientific, as well as personal, understanding of the changes that we all pass through.

Who is more impressive, our authors might ask, "young" Harry, who can keep three balls in the air for 10 min, on 95% of the trials? Or "old" Sally who can keep five balls in the air on 90% of the trials? And where do we search for an explanation? Do we argue that Sally's performance shows her poorer physical conditioning? Or do we argue that a more important difference is that the task of keeping five balls in the air is more difficult than that of keeping three balls in the air? If the latter, do we also conclude that Sally's performance is more impressive than Harry's?

Although it is not clear to us what Ramscar and colleagues would say about our two jugglers, they nonetheless make the point that age is not merely a situation where older individuals simply do the same task more poorly than younger individuals. Indeed, Ramscar and colleagues make the following quite clear: (a) standard vocabulary tests, which are commonly used to control for knowledge growth in studies of aging, underesti-

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mate the size of older adults' vocabulary and confound vocabulary size with lexical decision speed; (b) letter classification speeds slow with age due to increases in vocabulary size; (c) a life-time of experiencing (and learning) word co-occurrence frequencies leads to poorer pair-associate learning for infrequently co-occurring pairs; and (d) our poorer memory for names as we age, over the last several decades at least, is a result of the massive cultural proliferation of novel names alongside the increasing number of names experienced over a lifetime.

Our authors model a series of behavioral tasks on which old versus young populations have been shown to differ. For each task they construct two models that vary in the size of their vocabularies but which are otherwise the same. The exact assumptions of the models vary with the nature of the material being tested, but they all have the same flavor. For example, for their *simulation study 2* they conservatively estimate that the average reader reads at 85 words/min, 45 min/day, for 100 days/year and that 21-year olds would have 12 years of experience at this rate of reading, whereas 70-year olds would have 61 years of experience. They then estimate that the average 21-year old would have read 1,500,000 total words (tokens) and 21,307 different words (types), whereas the average 70-year old would have read 9,000,000 word tokens and 32,536 word types. Pretty much any cognitive theory with which we are familiar would have to predict that the more things you have in memory the longer will be your search time. With variations due to the nature of the task, this is what Ramscar and his colleagues show. Much of the performance on standardized tests that have been interpreted as showing *age-related decrements in performance* are shown by these simulations to reflect *experience-based increments in vocabulary size* and/or *discrimination learning* which results in a finer sense of which words are likely to co-occur and which are not. Commenting on these differences in interpretation, they cite Shannon (1948) and MacKay (2003) and conclude that "In information theoretic terms…. a measure of processing speed that ignores information load is meaningless."

The thesis is much more than a one-trick pony. Using Big Data techniques to more fully describe the task environment of modern human cognition, the authors marry the rational analysis approach of Anderson (1990, 1991) to discrimination learning theory and use statistical modeling techniques to show a close match between predictions and data across a wide range of effects. In tests which truncate their vocabularies to a small number of high-frequency words, the increase in vocabulary size of the old is not measured and, ironically, differences due to the smaller vocabulary of the young are falsely attributed to faster processing, rather than to a smaller set of items to search.

Our authors end their article by concluding that "it is important to note that absent a model of what is being processed and how, neurobiological studies can reveal only that the structure and/or biology of neural processing changes; interpreting this as evidence of decline (or increased efficiency) requires a model of the relationship between neural activity and cognitive *function*."

Many of you will not find these results surprising, as our field has ample demonstrations of the ways in which the acquisition of extreme expertise influences the assumed fundamentals of cognition in things as basic as memory span (e.g., Ericsson, Chase, &

Faloon, 1980; Ericsson & Kintsch, 1995) and brain structure (e.g., Polk et al., 2002). Unfortunately, the voices of functional-level cognitive science are often ignored or drowned out, not so much from our colleagues in neuroscience, as from the press and various well-intended others, who simplistically view human cognition as the outcome of purely biological processes. As Ramscar and colleagues make clear, it is time we rethink what we mean by the aging mind before our false assumptions result in decisions and policies that marginalize the old or waste precious public resources to remediate problems that do not exist.

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