By Catalin Cimpanu, Science Editor

The Limit of the Human Mind

We can operate with 3-4 items at a time

Few people are in any way like Napoleon and that happens because on average our conscious mind, based on working memory, can juggle with a maximum of 3 to 4 items at a time, informs the Proceedings of the National Academy of Sciences journal. **Working memory** is a temporary storage place for information, the data that we can pay attention to and manipulate. Previous studies established that the limit of the working memory is of about 7 items, thus explaining why telephone numbers usually are no more than seven digits long. But this new research shows that the real capacity of the working memory is lower when people cannot employ tricks like repeating or grouping items. "For example, when we present phone numbers, we present them in groups of three and four, which helps us to remember the list. That inflates the estimate. We believe we're approaching the estimate that you get when you cannot group," said co-author Nelson Cowan, a psychologist at the University of Missouri-Columbia. To impede the use of memory tricks, subjects were shown sets of different-colored squares. Afterwards, they were shown the same squares, this time without the colors. Then they were presented a single colored square in one location. The subjects had to tell if the color was the same as in the case of the square in the same initial position."What's nice about this visual task that they used is that it really makes it difficult to use some of those common strategies that are helpful with verbal lists," said Michael Kane, a psychologist at the University of North Carolina at Greensboro. For instance, it is a known fact that contestants at the World Memory Championships can recall hundreds of digits in a particular order after just 5 minutes, but their skills are boosted by strategies and tricks. "A very famous study was a test done of a long-distance runner who learned to associate digits together in ways that were meaningful to him with respect to running times. He could repeat back lists of up to 80 digits in the right order, but if you gave him a list of words, he was at seven plus-or-minus two like everyone else," said Kane. The study was based on a mathematical model assuming that people possess a limited number of slots in their working memory, and each one can operate with only one item at a time. When no free slots are left, people could no longer make precise assumptions. The model forecast the results of tests with extreme accuracy. The "number of slots" (working memory capacity) vary from person to person, and this has been connected to higher learning, reading comprehension and problem solving skills. "People accept that intelligence seems to be related to working memory. The information you can hold in your mind at one time is the information you can interrelate," said Cowan. These differences in working-memory abilities may be partially genetic, but they could also be influenced by early childhood training or education. Certain working-memory tasks can be improved with training even in adults. Higher memory capacity also has been connected to increased attention and reasoning. "We don't know quite how they work together, but attention and working memory seem to be very close cousins," said Kane. The debate now is regarding the connection between working memory and long-term memory: are they independent processes or is working memory that bit of long-term memory we can access only at the present moment? In the case of the latter variant, forgetting could be simply the inability to access long term memory information. "Everything gets encoded into long-term memory almost immediately, but it gets encoded in a way that may not be distinct enough to be retrieved," Cowan explained.