CogniFit Training: The key to cognitive vitality

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What is cognitive vitality?

In order to effectively interact with the world around us, our brains have to continuously process large amounts of complex information. We need to select the information most important and relevant to us at any given time, properly attend to it, perceive its message and store it in memory for long enough to act on it. In the absence of well developed capacity for attention, perception, and memory, a person walks through life as a moonwalker oblivious to his/her circumstances. These most basic cognitive skills do not come easy, and the brain has to invest in learning how best to perform them from the very first day of life.

What sights, sounds, and smells are more important than others and must not be missed?

What type of touch and taste are more central to survival and well being?

How to make sense of complex visual patterns and build an internal database of familiar people and places?

How not to be distracted by less important and less meaningful stimuli, even if they glitter and tempt our attention?

How to disregard the highly predictable and the repetitive around us?
And, perhaps most critical of all, how to safeguard important information from oblivion for future use?
In short, how to best store in memory our impressions, experiences, and discoveries, and thus build our own private version of the world in which we live?

Throughout our life-span, our ability to deal with the many challenges we face, is to a large extent a function of our cognitive vitality. Consider, for example, the paramount importance of language skills. As we try to communicate an idea, any idea, even while talking, our brains run ahead of us searching for the most appropriate words to use. Those of us, who have built a rich and often utilized lexicon, or developed well practiced search skills, would be far more effective. Good long-term memory for faces, names, and events, is yet another example of a highly advantageous cognitive skill.

Can we prevent cognitive decline?

For many years the accepted wisdom was that everything that grows must eventually shrink, and things that develop would inevitably decline. Consequently, so went the argument, cognitive loss is a necessary by-product of normal aging, and there is not much that we can do about it.
Indeed, initial studies comparing groups of people from different age groups, tended to corroborate this notion. It was only with the publication of the important prospective studies, following the same individuals over many years, that the true picture started to emerge:

While there is a clear slowing down in cognitive processing in older people, this is not of a magnitude that has functional implications. In other words, as we grow older things take longer than before, but the delay does not lead to quality decline as well. One would have to look at some specialized activities that are extremely speed sensitive, such as being a fighter pilot, in order to translate this slowing down process to a meaningful loss of function. Safe driving of a car is clearly an important issue in its own right.

There are very significant individual differences in the amount of cognitive loss between different people. While some show major loss, there are others that have very little or no loss at all. Furthermore, even in case of loss, it is not evenly distributed across areas of activity. The areas of particular interest to the person tend to be protected from loss.

Given these findings, the obvious intriguing question became:

Who were the individuals that maintained their cognitive vitality well into advanced age? Was this yet another case of hereditary pre-determination, or was there something which they did during their lifetime that made a difference?

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One factor, whose major role in predicting cognitive vitality that has been systematically found in many different studies, is years of formal education. Thus, people with higher education have much smaller age-related cognitive decline. This cognitive resilience of those who have some years of college or university cannot, however, be attributed to the actual experiences of the studies themselves.

There is little in those three-four years that can account for the huge benefits more than forty years later. It is much more realistic to assume that on the average, those with higher education were employed in jobs which were mentally more challenging.

Consequently, for the entire duration of their work-life their brains were necessarily more active. Current studies of the role of work complexity on cognitive vitality support this interpretation.

Investigation of the lifestyle of people who maintain their cognitive vitality well into advanced age throws yet additional light on what might be the key protective factors.
Hobbies such as chess, bridge, and crossword puzzles, are well represented in this group. So are lifelong habits of reading books, playing a musical instrument, and generally leading a life of active mental involvement. The more passive ways of spending leisure time, such as watching TV, tend to be risk factors rather than protective ones.

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Cognitively challenging activity protects against Alzheimer's disease

It is hard to marshal a more persuasive argument than protection against Alzheimer's disease.

While the precise cause for its onset, and certainly ways to cure or prevent it, are still far from understood, the evidence for the beneficial effects of cognitively challenging activities is well established.

Statistically, the risk of people with higher education is about one third of the general population. This enormous difference in risk surpasses by far the genetic factor as it is understood at this time.

Furthermore, individuals practicing the various above mentioned cognitively challenging hobbies are at significantly lower risk.

It seems that the same factors that protect us from the deleterious effects of age-related cognitive decline also protect us from the debilitating effects of dementia. The underlying principle behind all these factors is the benefit of cognitive effort.

How to maintain Peak Cognitive Performance?

The work places of most of us expect high level cognitive functioning on a continuous basis. While this is clearly a tall order, there is a lot our companies can do to help us achieve this goal. Just like our physical fitness, the state of our cognitive fitness fluctuates depending on many factors. By systematically investing in mental workouts such as CogniFit, corporations can significantly improve the cognitive status of their workers. Thus, by challenging our brains we do not only reduce the risk for old age decline, but also directly contribute to effective performance throughout the years. Modern companies are growingly aware of the enormous contribution of high level work force and there is hardly anything that can pay greater dividends than investing directly in the brains of people.

Some reasons for the fitness of cognitively active brains

With the recent advances in neuroscience came several discoveries about the health of active brains.

All of them, without exception, enhance the principle of "use it or lose it". This has now become such a pervasive notion that there is a good chance that additional reasons will be discovered in the future. The list of available ones is, however, convincing enough:

- Active brain cells (neurons) need a better blood supply, and get a better blood supply than idle ones. This preferential supply of oxygen and a variety of nutrients enhances their function. Neurons are particularly vulnerable to inadequate oxygen supply, and their activation ensures that they will not starve for oxygen.
- As the activity of neurons increases, so does their tendency to sprout dendrites that connect between brain cells. Consequently, the more active a particular brain cell is, the more connections to neighboring cells it develops. It is estimated that a single neuron can have up to thirty thousand such connections, making it a centre of a highly developed network of activity. One outcome of belonging to such a network is that the chances of being stimulated by others are also higher, thus increasing the chances of future activation. Neurons that for some reason reduce their activity tend, over time, to lose this connectivity. The importance of being part of an active network cannot be overstated, and for he brain cells involved, it can easily become a matter of life and death.

The reason is as follows:

From adolescence onwards, our brains lose a high number of neurons every day. Unconnected cells indicate that they have been idle for quite some time, and thus their loss would not heavily impact the functioning of the individual. Consequently, they become a prime target for cell death. This competitive advantage of active and well connected neurons was beautifully argued by Edelman in his seminal work on "neural Darwinism."
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- Active neurons enhance the production of Nerve Growth Factor (NGF), a substance that contributes to the maintenance of healthy neurons. Since brain cells can often be quite old, their continuous maintenance is of primary importance to their function. Once again, the higher the cognitive challenge, the greater the secretion of this beneficial NGF.

- Last but not least, recent research discovered that contrary to accepted common wisdom, there is regeneration of new brain cells throughout the entire life span. Stem cells develop in the part of the brain called the hippocampus (an area closely related to memory consolidation), and migrate inside the brain itself to the area of highest need for "reinforcement" of function.

Once they reach that area, they mature and learn from the surrounding cells how to perform their function. This local education of the cells is a particularly striking example of the brain's exquisite specialization.

A good example is the process launched after brain injury or stroke. As the person tries hard to activate the damaged area, this can stimulate higher production of new cells that will eventually migrate to the area of the lesion, and over time contribute towards restoration of the lost function.

Once again, the effort to activate the brain during the rehabilitation period is the key to the entire sequence of events.
It is doubtful whether a passive acceptance of the loss of function would have similar results.

Cognitive effort builds cognitive reserves

It is not clear whether higher education, a complex working environment, or mentally challenging hobbies can ensure risk free cognitive aging. The same, of course, goes for dementia, the prevention of which cannot be guaranteed by any of these factors. Rather, they might lead to the development of sufficient cognitive reserves that will effectively delay these problems.

Thus, if available brain cells are in good shape, they may well compensate for cumulative cell loss over the years. The building of such cognitive reserves becomes, therefore, an excellent investment, ensuring cognitive vitality well into the future.

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How can we build cognitive reserves?

One common denominator of the entire list of factors mentioned so far is cognitive effort. In other words, for some activity to be useful in maintaining or enhancing cognitive vitality, it has to require some effort. This is not unlike physical exercise whose effectiveness calls for at least some minimal investment in physical effort. Engaging exclusively in very easy exercises would have only marginal impact on one's physical fitness. By effort, we imply the need to actively focus on the task at hand and allocate sufficient resources of attention to carry it to its successful completion.

A wonderful illustration of the benefits of cognitive effort is provided in the famous "Nun Study" by Showdown. As part of the attempt to study the antecedents of cognitive health in elderly nuns, the study analyzed one page autobiographical essays written by them at the average age of twenty- two when they were in college.
These short descriptions were analyzed blindly by linguistic experts for "idea density" (i.e., number of different ideas per every ten words) and "grammatical complexity" (simple versus complex sentence construction, branching, etc.).

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To everybody's astonishment, the results were able to predict cognitive health sixty years later, at the average age of eighty.

Sisters with higher idea density in college had significantly higher scores on standard cognitive tests, and were less likely to have Alzheimer's disease than those with lower idea density.
A similar relationship, though somewhat weaker, was found between grammatical complexity and cognitive scores.

Both high idea density and grammatical complexity require greater effort on the part of the writer (and for that matter the reader as well). The ability and willingness to invest in such cognitive effort bode well for the future cognitive vitality of the sisters.

The opposite of cognitive effort is automatic processing. Cognitive activity that can be carried out automatically does not require any effort at all. As certain activities become gradually more familiar with experience, they become easier and less effortful. At some point they might become fully automatic, thus releasing us from the need to attend to them altogether.

One of the best ways to build cognitive reserves is to engage in activities that are relatively new, and preclude automatic processing.

The brain's capacity for developing automatic sequences of routine tasks is on the whole a major blessing. The number and variety of activities that we are able to carry out without attending to the process itself is impressive indeed. Consider the way we walk home from the station without the need to rehearse the directions. In fact, we may be deep in thought about other matters and yet will find ourselves entering our home.
Think about the complex hand-eye coordination necessary for a smooth handshake. We just do it; there is not need to think about it anymore. Reading itself becomes an automatic activity through experience.
Thus, the visual pattern of whole words is stored in memory and the jump from looking at a page and extracting the meaning becomes effortless. In the same way, with years of experience, some elements of driving become automatic as well, freeing the driver to talk, listen to music, or otherwise engage part of his/her attention.
Automatic processing, however, is not without its costs.
The convenience of well-rehearsed actions, allowing the brain to manage without cognitive effort, encourages certain forms of mental laziness to take root. The outcome of such idleness, just like in the case of physical idleness, is getting out of shape and losing some cognitive vitality. Consequently, one of the best ways to build cognitive reserves is to engage in activities that are relatively new, and preclude automatic processing.

When on a trip to a new place, the road back to the hotel cannot be taken without proper attention allocation on our part.
We must be well aware of the surrounding circumstances, remember a few key reference points and plan the route accordingly. In the same manner, when driving a new car in a new location, the driving would involve much more deliberate attention than typically. Novelty, the natural opposite of routine, poses important challenges to the brain, and contributes to cognitive well-being.

Our brains are well-suited to profit from experience, and very few things retain their novelty for a long time. On the contrary, we are capable of developing routines extremely fast. This gives us the good feeling of mastering a new situation.
Even the most complex activities have significant components that are routine. The cognition-enhancing qualities of novelty must be therefore actively pursued, and we cannot rely on opportunities provided by everyday life experience to do the trick for us. This is further augmented by the natural preference of the human brain to develop routine procedures that save energy and effort.

Just as we need to seek specific ways to "work-out" physically, we have to seek ways to exercise our brains

There are two very different modes of action our brains can take when faced with a particular cognitive challenge. The first one, involving situational analysis and choice between alternatives, is clearly effortful. The second, on the other hand, relies entirely on prior experience.
Our mental database is searched for similar instances in the past, and the precedents serve as the basis for the current solution. This is much less effortful, and most of the process can be carried out automatically without our awareness. As we grow older and more experienced, this second mode takes over a growingly larger segment of our personal decisions. The opportunities for effortful cognitive processing would be fewer, and its beneficial contribution to cognitive vitality would be gradually reduced.

We cannot, therefore, rely on everyday life to provide sufficient opportunities for exercising our brains. In the same manner, the sedentary lifestyle of most modern people does not provide sufficient physical exercise. Consequently, just as we need to seek specific ways to "work-out" physically, we have to seek ways to exercise our brains.

Computerized cognitive training

Certain kind of games and hobbies served us well for many generations as tools for sharpening our wits. However, even the best among them, such as chess and bridge, have some very obvious limitations. Chief among them is the narrow band of cognitive skills that they exercise.
In the case of chess, it is primarily visual perception, long term focusing of attention, and memory for similar positions. Experienced chess players can recall hundreds of important games played by themselves or others and rely heavily on experience. Many moves become almost automatic, drawing on well rehearsed routine openings.
Bridge trains short-term memory and some basic combinatorial skills. The bidding conventions become routine. Crossword puzzles exercise almost exclusively retrieval from lexicon, and are often repetitious.

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Reading books is another good way to exercise cognitive skills, particularly if their proper understanding requires some effort.
The more varied the genre, the better.
Descriptions of new places and unfamiliar situations further challenge the reader. So does, of course, travel. New sights, sounds, smells, and tastes, are all capable of pulling our cognition from its traditional grooves. Playing a musical instrument and learning a new language are also highly beneficial.
So are some sports that in addition to physical skills often require highly developed cognitive skills as well. Even though some of these activities might feel difficult when started later in life, their benefit is guaranteed, and it is never too late to engage in them.

In many respects the personal computer, more than anything, provides an ideal tool for exercising the mind. This is primarily due to its ability to adjust the level of challenge to each person individually. It is very easy to err on this account. Consider, for example, the level of challenge of a crossword puzzle. If it is too difficult, after a few futile attempts we would likely give up. If it is too easy, and we feel that there is little or no challenge involved, this will quickly become boring and we will lose interest.

It is only when the puzzle is at some optimal level of challenge that it has the capacity to mobilize our attention and get us deeply involved. In the case of the crossword puzzle this is merely a matter of luck, and there is nothing that can be done to effectively optimize the level of challenge for us.

The computer's ability to present well designed stimuli in both visual and auditory modes, is another important advantage.

The situation becomes dramatically different when a computer is involved. It can measure the precise time it took us to carry out a particular task, and whether we completed it successfully. On the basis of such information, it can adjust the difficulty of the current task, or select another one best fitting our needs. The computer's ability to present well designed stimuli in both visual and auditory modes, is another important advantage. The storing of detailed information about the users' performance allows important lessons to be learned both online and offline.

"CogniFit" is a program designed specifically for the effective training of a variety of important cognitive skills. It covers a wide range of abilities, such as: visual search, time estimation, naming, categorization, visual short term memory, auditory short term memory, location memory, spatial orientation, planning, ability to inhibit planned action, speed of reaction, and hand-eye coordination.

A key feature of CogniFit is its Individualized Training System (ITS) algorithms that are continuously learning the specific features of the trainee.

Initially, CogniFit evaluates the starting point for each user, and on the basis of this information it designs an individual training program. The training itself consists of tasks to be worked on for about fifteen to twenty minutes, three times a week. The software measures the person's progress and provides feedback on ongoing performance.By utilizing one's strong points, the personal coach is able to maximize the effectiveness of the training itself.

At every step of the road, the instructions are simple and clear, presented both in written words and audio, as well as an actual demonstration of the actions to be taken. This user-friendliness probably accounts for the gratifying fact that quite a few older people, who have never used a computer before, were able to overcome their hesitation, and discover the hidden treasures of computers.

As one moves through the exercises, the impact of training becomes quickly apparent. The tasks that appear difficult at first, gradually become easier, and the mind becomes more focused. Faster and more precise reactions follow each other and the exercises slowly move to a higher level of complexity or speed. Skills that have become rusted over the years slowly regain a sense of familiarity. The experience is one of mastery and growth.