

A Blueprint for Building a 21st Century Worker

Brief Summary

It is becoming increasingly clear from neuroscience research that intelligence is not fixed and that the ability to learn, think and problem-solve can be enhanced at any age. The implications of this new knowledge in the workplace are profound. It means that poorly prepared entry-level workers can make significant improvements in their ability to meet workplace requirements in weeks. It means that the effectiveness of corporate training programs can be dramatically improved, whether the training is for job-specific skills or for so-called “soft skills” like critical thinking, communication or collaboration. It means that it is possible to develop the overall cognitive capacity of both individuals and organizations. This paper explores the implications of neuroscience research for the preparation and training of workers for 21st century work.

The Role of Cognitive Capacity

Every year U.S. companies and other employers spend over \$100 billion on employee training and development.¹ Employee training programs range from remedial reading and math to executive coaching and development, and from job-specific skills to so-called soft skills, such as creativity and leadership.

Many employers bemoan the fact that too many workers are unprepared for the demands of today’s workplace. There is plenty of evidence that entry-level workers do not possess the skills employers require, but is also true that our education system just cannot prepare students for specific jobs. Because the amount of new technical information is doubling every 2 years, a student starting a 4-year technical or college degree today will find that half of what they learn in their first year of study will be outdated by their third year of study.² Following that logic, much of what that student learns by the time they earn their diploma and find a job will be obsolete and will need to be updated and relearned on the job. According to Cathy Davidson, co-director of the annual MacArthur Foundation Digital Media and Learning Competitions, 65 percent of today’s elementary school children may eventually work in jobs that haven’t yet been created.³

Thus, the job of training a workforce is vastly different than it was just a few decades ago. As one leading researcher characterizes it, “Today’s central managerial challenge is to inspire and enable knowledge workers to solve, day in and day out, problems that cannot be anticipated.”⁴ And if most workers must be knowledge workers, they must be adept at acquiring knowledge. In other words, they must be learners. Whatever the specific skills workers need to acquire, each individual employee’s cognitive capacity to take in and process information, store, retrieve and problem-solve with it, and to continue to learn determines his or her effectiveness. This paper examines the cognitive skills involved in learning various types of skills required in the workplace and explores the relationships among them. The evidence is becoming stronger every day that, as one group of researchers expresses it, “The modern workplace runs very largely on the cognitive abilities of its workforce.”⁵

The dramatic nature of the change over the last several decades is illustrated by a list of occupations typical of various IQ levels created in 1977:

¹ American Society for Training and Development, *The State of the Industry*, 2006.

² <http://www.glumbert.com/media/shift>, www.oecd.org/sti/ict/broadband.

³ http://opinionator.blogs.nytimes.com/2011/08/07/education-needs-a-digital-age-upgrade/?_r=0.

⁴ Amy Edmondson, “The Competitive Imperative of Learning,” *Harvard Business Review*, March 2008.

⁵ Earl Hunt and Tara Madhyastha, “Cognitive Demands of the Workplace,” *Journal of Neuroscience, Psychology, and Economics*, February 2012.

IQ Level	Typical Occupation
140	Top Civil Servants; Professors and Research Scientists
130	Physicians and Surgeons; Lawyers, Engineers (Civil and Mechanical)
120	School Teachers, Pharmacists; Accountants; Nurses; Stenographers; Managers
110	Foremen; Clerks; Telephone Operators; Salesmen; Policemen; Electricians
100+	Machine Operators; Shopkeepers; Butchers; Welders; Sheet Metal Workers
100-	Warehousemen; Carpenters; Cooks/Bakers; Small Farmers; Truck/Van Drivers
90	Laborers; Gardeners; Upholsters; Farmhands; Factory Packers and Sorters

Generally, one can observe that occupations typical of higher intelligence pay more than those typical of lower levels of intelligence. Interestingly, research indicates that the cognitive ability ratings of occupations explain about 60% of the variation in income across occupations. In other words, people with higher general cognitive capacity (or intelligence) will usually make more than people with lower general cognitive capacity.⁶

Of critical importance is that fact that, in 21st century America, the demand for machine operators, sheet metal workers and warehousemen is in decline. The jobs that remain require a higher level of cognitive functioning and comfort with technology. What happens in our workplaces when the demand for workers at higher IQ levels increases while the number of jobs suitable for lower IQ levels declines?

Fortunately, there is growing evidence that intelligence can be developed – not just for remediation, but to improve fluid intelligence, the kind of intelligence required for problem-solving and thinking creatively and flexibly.

In the 1970s, Arthur Whimbey documented a variety of interventions that enhanced the cognitive functioning of preschool children, that helped poorly performing college students take a more organized and effective approach to their academic work, and that improved individual performance on IQ tests.⁷

More recently, the National Academy of Sciences published research suggesting that training in cognitive skills can very significantly increase human intelligence. As one of the researchers explained, the key part of this work is the demonstration that it is possible to improve fluid intelligence – the type of intelligence that measures how people adapt to new situations and solve problems they've never seen before.⁸

In a multi-site controlled study, other researchers evaluated three different methods of improving fluid intelligence skills – a memory training program, an inductive reasoning skills program and a computer-based program to train processing speed. All three groups who went through an initial five-week intervention improved and retained a significant percentage of the improvement when tested five years later. The most pronounced results were experienced by the group who used the computer program. Of greatest importance, the enhanced cognitive skills developed by the subjects in the study transferred to everyday tasks, such as finding an item on a crowded pantry shelf, reading medication bottles, and reacting to road signs.⁹

Finally, as will be discussed in more detail in this paper, comprehensive integrated cognitive skills training is being shown to have a significant impact on cognitive capacity, performance in basic

⁶ Hunt and Madhyastha, op. cit.

⁷ Arthur Whimbey, *Intelligence Can Be Taught*, Dutton Books, New York, 1980.

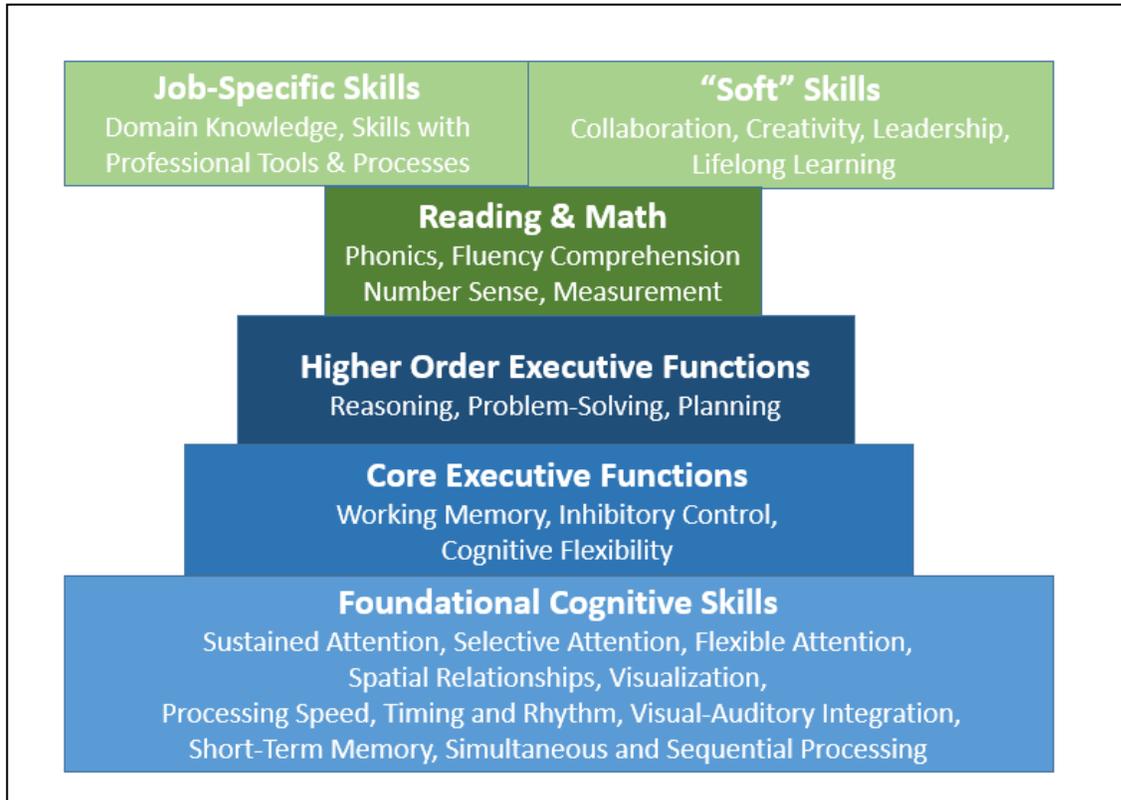
⁸ Alexis Madrigal, "Forget *Brain Age*: Researchers Develop Software That Makes You Smarter," *Wired*, April 28, 2008.

⁹ Willis et al, "Long-Term Effects of Cognitive Training on Everyday Functional Outcomes in Older Adults," *Journal of the American Medical Association*, December 2006.

skills, the effectiveness of job-specific-skills training, and in the development of executive functions required for both hard and soft skills, including leadership.

Cognitive Skills – The Brain’s Infrastructure for Learning

Most of us take for granted the cognitive processes that enable us to learn, because most of those processes happen at a non-conscious level. The graphic below illustrates how processes such as various attention skills, visual and auditory processing skills, processing speed and other basic cognitive functions provide a foundation for higher order cognitive processes and learning. These are examples of some of the cognitive processes (not an exhaustive list) that enable information to get into our brains from the outside world.



On top of those foundational cognitive skills are a set of cognitive skills referred to as core executive functions. These are the directive capacities of our brains and include:

1. Working memory: our ability to hold information in our mind while we manipulate it.
2. Inhibitory control: our ability to not do something we would otherwise do, including over the long-term (defer gratification).
3. Cognitive flexibility: our ability to change our mindset when the rules of the world around us change

The next tier of skills contains higher-order executive functions, like reasoning, problem-solving and planning (among others).

All of this infrastructure of cognitive processing is necessary to learn to read, to learn to do math, and to learn everything else that depends on reading and math. It is part and parcel of the “applied skills” or “soft skills” that managers refer to as being so necessary in today’s workplace. It is something that is often taken for granted in training workers, in the same way that it is taken for granted, by and large, in school. But if the modern workplace runs largely on the cognitive

abilities of its workforce, then the role of these skills and the ability to develop them must be reexamined and intentionally developed.

Skills Needed in the Workplace

The next section of this paper looks at the relationship between cognitive capacity and skills needed in the workplace.

The table below, from the Workforce Readiness Report Card¹⁰, lists the skills identified in the report as very important to success in the workplace.

Basic Knowledge / Skills	Applied Skills / Soft Skills
English Language (spoken)	Critical Thinking / Problem Solving
Reading Comprehension (in English)	Oral Communications
Writing in English (grammar, spelling, etc.)	Written Communications
Mathematics	Teamwork / Collaboration
Science	Diversity
Government / Economics	Information Technology Application
Humanities / Arts	Leadership
Foreign Languages	Creativity / Innovation
History / Geography	Lifelong Learning / Self Direction
	Professionalism / Work Ethic
	Ethics / Social Responsibility

Basic Reading and Math Skills

According to Workforce Readiness Report, there is a significant gap between the level and types of skills that employers seek in entry-level workers and the level of proficiency demonstrated by recent high-school graduates, including basic reading and math skills.

Moreover, the gap between workplace requirements and workforce readiness is widening. In 2003, 87% of adults tested below the proficient level in prose literacy and even the average score of adults with graduate study was in the Intermediate range (the level below Proficient). Between 1992 and 2003, the average scores for all levels of education decreased in one or more measures of literacy.¹¹

Level of Educational Attainment	Change Between 1992 and 2003
Less than or some high school	Down 9 points in prose literacy
High school graduate	Down 6 points in prose literacy
College graduate	Down 11 points in prose literacy and 14 points in document literacy
Graduate studies/degree	Down 13 points in prose literacy and 17 points in document literacy

Other studies have also identified significant gaps in the skills required for today's jobs, estimating that between 25% and 40% of the current workforce lacks the basic skills to understand written or verbal communications. This workforce illiteracy costs U.S. businesses an estimated \$225 billion a year in lost productivity.¹²

¹⁰ The Conference Board, the Partnership for 21st Century Skills, Corporate Voices for Working Families, and the Society for Human Resources Management, *Are They Really Ready to Work?* 2006

¹¹ National Assessment of Adult Literacy, 2003, <http://nces.ed.gov/NAAL/index.asp?file=KeyFindings/Demographics/Overall.asp&PageId=16>.

¹² http://ccbcmd.edu/ceed/wf_literacy.html.

When elementary and undergraduate education fails to prepare workers adequately, it falls to employers to provide remedial training. However, employers face many of the same challenges that schools and colleges face in remediating basic skills, including a broad diversity of backgrounds, learning styles, intellect and culture among their workers. Organizations that use the same techniques and approaches used by the school systems that failed to prepare graduates for the workplace are likely to get the same result.

Recent research has begun to illuminate the importance of underlying cognitive skills in acquiring what many have previously considered to be basic skills such as reading and math. Researchers are showing that brain (cognitive skill) development can impact school achievement, emphasizing neurocognitive systems such as cognitive control, memory and learning.¹³ Other researchers focus on the importance of cognitive processes such as planning, attention, simultaneous and successive processing.¹⁴

As a result of these and other research efforts, educational and developmental psychology researchers have started to see the need to find ways to add training of basic foundational cognitive skills to the education system to foster the acquisition of basic skills.¹⁵ And in fact, such interventions have been very successful in dramatically improving cognitive skills and reading and math levels for students with learning disabilities¹⁶, students from low SES,¹⁷ and students who are behind grade-level, as well as the general population.¹⁸ Gains from 4 to 6 years of cognitive ability and 1 to 2 years in the level of academic performance have been shown in 12 weeks.

Job-Specific (Hard) Skills

Hard skills generally refer to the specific knowledge and abilities that are needed to perform a particular job. When it comes to the kinds of knowledge that employees need to perform their jobs effectively, this is an area where most organizations provide some kind of explicit training. It might be training on how to cook a hamburger, how to fit pipes together in compliance with the local building code, the categories of learning disabilities that requires that students receive an individualized education plan, or the cumulative knowledge needed to curate a museum's collection of French Impressionist paintings. All of this knowledge (content knowledge) has to be learned, typically in an academic setting or in some kind of job-related training.

While training in job-specific skills and continuing education as one's field advances is clearly critical, many organizations have difficulty showing that training actually improves business performance.¹⁹ Fundamental questions haunt managers and trainers: How much do our employees remember of what we teach them? How well do they apply it on the job?

These fundamental questions beg some other questions: Do they understand the written, verbal and visual information they are provided during training courses? How well can they relate it to

¹³ Kimberly Noble, et. al., "Socioeconomic gradients predict individual differences in neurocognitive abilities," *Developmental Science*, 2007.

¹⁴ Jack Naglieri and J.P. Das, "Planning, Attention, Simultaneous, Successive (PASS) Theory: A Revision of the Concept of Intelligence." In *Contemporary Intellectual Assessment: Theories, Tests and Issues*, Guilford Press, New York, 2005.

¹⁵ David Uttal, et. al., "The Malleability of Spatial Skills: A Meta-Analysis of Training Studies," *Psychological Bulletin*, June, 2012. Advance online publication. doi: 10.1037/a0028446.

¹⁶ Sarah Abitbol Avtzon, "Effect of Neuroscience-Based Cognitive Skill Training on Growth of Cognitive Deficits Associated with Learning Disabilities on Children Grade 2-4," *Learning Disabilities, A Multidisciplinary Journal*, 2012.

¹⁷ Multiple studies at www.mybrainware.com/safari/research.

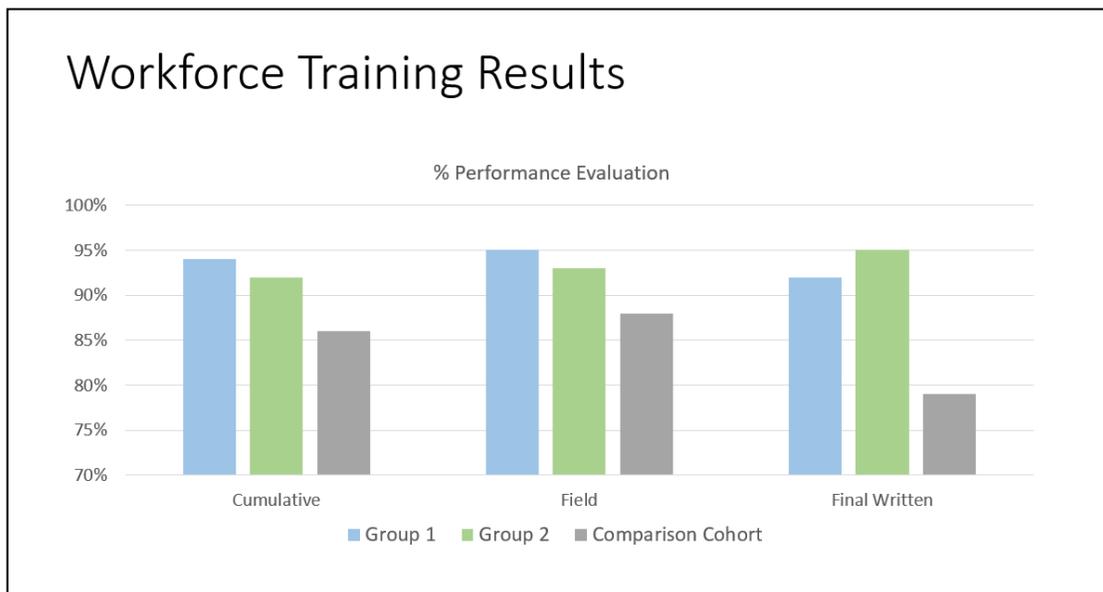
¹⁸ Don Helms and Sara Sawtelle, "A Study of the Effectiveness of Cognitive Therapy Delivered in a Video Game Format," *Optometric Vision Development*, 2007

¹⁹ Shari Caudron, *Workforce Magazine*, January 2000.

the workplace? How automatic are their responses in a workplace situation in recalling the information needed? And how effectively do they apply it in the right situations?

Training in workplace content relies on learned curriculum (reading, math, etc.), but it also assumes that workers have the underlying cognitive skills that will enable them to take in process, absorb, retain, and recall the information the organization wants them to know. If it were possible to improve underlying cognitive skills and thereby improve understanding, memory, retrieval ability and retention, then that would suggest that we could expect better retention of information/content contained in training programs by building stronger cognitive skills.

Results from a pilot program in 2011 suggest that inclusion of cognitive skills training on the underlying skills that correlate with workplace performance can improve overall results of an intensive new-hire training program. Two cohorts of trainees used a computer-based cognitive skills training program called BrainWare SAFARI as part of a 6-week training program to learn to be console operators in an oil refinery. The trainees exhibited significant improvement in cognitive performance as measured by self-ratings and by performance on the GAMA (General Adult Measures of Abilities), with 86% of the group who took the test improving their calculated IQ score following their use of the program. Most important, the two groups whose training included cognitive skills training performed dramatically better on all three components of their final evaluation criteria than a previous cohort that whose training did not include cognitive training, as shown in the chart at the top of the next page. As a consequence, all but one of the 50 members of Groups 1 and 2 met the standards to be hired by the corporation where a drop-out/failure rate of 4 to 6 would be expected.



Soft Skills and Leadership Skills

Now we turn our attention to some of the most prized skills in organizations – those underscored by the previously referenced Conference Board report as essential for success in this millennium – creativity, problem-solving, critical thinking and leadership. Managers sometimes refer to these as “soft skills,” largely because they are harder to measure than factual knowledge. But another view holds that these skills are in some ways “harder” than factual knowledge. These skills are even more fundamental, as they might even be considered structural; they are, in essence, how the brain works through its neural connections. These too are part of and rely on the

infrastructure of cognitive capacity that employees bring to the workplace or that the workplace is able to help them develop there. Creativity, problem-solving and critical thinking all rely on basic cognitive skills – the ability to see patterns, to see things from a different point of view, to coordinate the activities of multiple areas of the brain at the same time, to hold several ideas in the mind while thinking about them, and so forth.

Some approaches to training acknowledge the underlying cognitive processes involved in their training, rehearsal and mediation,²⁰ while others focus on developing familiarity with processes and techniques that are likely to leverage the brain's metacognitive abilities, to enable one to think integratively, rather than to make either/or trade-offs.²¹

In 2001, Dr. Patricia Wolfe published one of the first books that explained to teachers how to apply some of the most important principles gleaned from neuroscience research to the teaching and learning process.²² More recently, the applicability of those findings to management and leadership has become the subject of more extensive academic work. In "Your Brain at Work," Waytz and Mason identify four brain networks involved in creative thinking, rewards, decision-making and cognitive control and self-regulation.²³

Each of these areas depends to some degree on or interacts with areas of cognitive processing that are malleable and can be developed, including foundational cognitive skills and executive functions. Just as educational practice is embracing the dual benefits of strengthening both the cognitive capacity of the learner and the teacher's effectiveness in using more brain-compatible instructional practices, the new neuroscience of leadership is beginning to show the same dual effects in a workplace setting. In this arena, one current practical application would be the development of these skills in Millennials to facilitate their transition to leadership roles.

Life-Long Learning

While life-long learning applies to all workers, one top-of-mind issue is that, as baby boomers reach retirement age and birth rates in the developed world fall, employers are increasingly concerned about a shrinking workforce. Labor shortages are bringing greater competition for skilled workers and older employees are increasingly motivated to remain in the workplace, whether to sustain their sense of self-worth or for financial reasons.

While older workers generally have many advantages, including experience, loyalty, institutional memory, and a strong work ethic, productivity can become an issue.²⁴ Organizations have a compelling interest in ensuring that these workers retain the mental acuity and agility to perform optimally in their roles. Moreover, as discussed above, we can count on those roles changing. In an era of rapidly advancing technology, older workers will have to learn new things in order to be effective, not just in the jobs they know, but in the jobs that have yet to be invented.

Indeed the changing nature of jobs will affect all workers, not just those over a certain age. However, older workers do have some particular characteristics worth considering. For example, while many factors contribute to older workers' job satisfaction, one key is ongoing professional development.²⁵ Continuing to find one's job interesting is important to older workers. According

²⁰ Donalee Markus, *Retrain Your Business Brain: Outsmart the Corporate Competition*, Dearborn Trade Publications, 2003

²¹ Roger Martin, "How Successful Leaders Think," *Harvard Business Review*, June 2007

²² The second edition was published in 2010, Patricia Wolfe, *Brain Matters: Translating Research into Classroom Practice*, ASCD.

²³ Adam Waytz and Malia Mason, "Your Brain at Work," *Harvard Business Review*, July-August 2013.

²⁴ Rainer Strack, "Managing Demographic Risk," *Harvard Business Review*, February 2008

²⁵ Barbara Jaworski, "Aging workers, changing values: employers that want to benefit from aging workers' changing value will need to show they are committed to their ongoing development and respectful of their unique needs," *The Journal of Employee Assistance* 2005

to an AARP poll, 87% of workers who say they plan to work in retirement will do so because of a desire to remain mentally active, and 50% because of a desire to learn new things.²⁶

While staying active through work may, by itself, help deter the cognitive decline associated with aging, targeted training to sustain cognitive well-being, especially in the areas of attention, memory and processing speed may enable older workers to be even more effective even later in life. Indeed, brain fitness has the potential to become an integral part of corporate wellness programs.

Recent research documents the explosive growth in corporate wellness programs around the world and one trend places more emphasis on technology to enable greater personalization.²⁷ Indeed, just as organizations focus on preventive health programs to support physical well-being (and lower health care costs), it is expected that they will add preventive brain health to their initiatives.²⁸

Conclusion

Cognitive skills underlie the ability to learn and perform in the workplace. New tools and techniques have been developed that enable cognitive skills to be developed, rapidly and dramatically. Improved cognitive skills can help organizations address key workforce issues including:

- Remediating Deficiencies in Workforce Readiness
- Developing the Cognitive Capacity for Workplace Problem-Solving
- Improving the Effectiveness of Training Initiatives
- Enhancing Productivity of Older Workers
- Improving the Skills Good Leaders Need
- Improving the Learning Capacity of All Workers

It is becoming increasingly clear from neuroscience research that intelligence is not fixed and that the component skills that make up intelligence and learning capacity can be trained, at any age. This means that there is reason to hope that ill-prepared entry-level workers will be able to make significant improvements in their ability to meet workplace requirements and to benefit from corporate training programs. It means that all workers can enhance their higher-order thinking and communications skills in a very short time. It means that older workers can be effective longer and grow in their roles. In other words, it is possible today to train skills such as attention, visualization, working memory and auditory processing. It is possible to develop social and emotional intelligence as well as job skills and overall cognitive capacity.

If our employees are deficient in some of these skills, those deficiencies can often be remedied. If they are strong, they can become stronger. Indeed, by developing the underlying cognitive skills that allow employees' minds to function more effectively, we should be able to develop a nation of workers at significantly more advanced levels of functioning and achievement. What is required is that organizations begin to train the skills they need rather than bemoaning the lack of skills in those they hire. Today there is a blueprint for developing the 21st century worker, with neuroscience as the architect and with a strong and flexible mind as its foundation.

²⁶ AARP, *Staying Ahead of the Curve*, 2003

²⁷ Buck Consultants, *Working Well, A Global Survey of Health Promotion and Workplace Wellness Strategies*, 2007

²⁸ Sharp Brains, Inc., *The State of the Brain Fitness Software Market*, 2008