EVOKED POTENTIALS

# Practice Pays When Undertaking Creative Action

In last month's issue of CLINICAL NEUROLOGY NEWS, we discussed how people formulate a strategic plan for acting on a creative idea. This month, we shall consider the next essential step, the action itself, or more precisely, factors that distinguish more-effective from less-effective action.

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Once the decision to act is made, the success of the creative endeavor will depend on the dexterity of its execution. With 3 seconds left to play, the fate of a team down by one point will differ drastically if the ball falls into the hands of a Michael Jordan versus a basketball wannabe like me. The research reported in our pages represents the dexterous execution of well-formulated experiments that further our knowledge and ultimately lead to treatments and cures of diseases such as Parkinson's disease, epilepsy, and diabetic neuropathy as highlighted at last month's annual meeting of the American Academy of Neurology. Yet, not all research successfully illuminates the questions it was designed to answer, and not all last second shots result in victory.

We differ greatly in our levels of dexterity in the performance of any given task. How can we explain such differences and, in particular, how can we explain the extraordinary dexterity of virtuoso musicians, elite athletes, and Nobel laureate scientists? Do these differences reflect how much of an impact nurture has on nature? Might it simply be that some individuals are just more practiced than others (nurture)? If so, this then begs the question of whether anyone of us could practice to the point of perfection. Or is that we are built differently (nature)? Might biological differences between us facilitate greater dexterity in the fortunate few, and if so, would this translate to all abilities or to just certain domains of skill (such as one of the multiple intelligences proposed by Howard Gardner that were described last month)?

Nurture, nature, and their interplay all contribute. Epigenetic alterations of genetic expression – the influence of nurture on nature – can occur at all levels of our physiology from DNA transcription to behavior: the social structure in which a child is reared, the expression of trigger-sensitive phenotypes, and the plasticity of hard wired neuronal circuits are just a few examples of their interplay (Ann. N.Y. Acad. Sci. 2003;999:451-60).

But, even in the case of a biologically influenced skill, environmental factors must play a role. For example, although just knowing how to play the piano is not sufficient to achieve virtuoso status, it is still a basic requirement even for a biologically determined musical prodigy. Therefore, let us examine nurture more closely.

Practice is part of everything we call learning and education: school, music lessons, rehearsal for a play, and so on. Learning to read requires a transition from an effortful, letter-by-letter phonetic strategy to a much less effortful whole-word semantic recognition strategy, and we find a similar pattern in learning a new skill. When we first begin to practice a new skill, many details are unfamiliar to us. Before a video gamer can reach the competitive level of the game itself, he must first learn how the controller works. Button A controlled jumps in the last game, but in the new game it controls gunfire. Even the layout of controls differs between PlayStation, Xbox, and Nintendo game systems. Learning how the controller works takes time and, until the controls are mastered, a player cannot be at his potential best. Acquiring any new skill requires overcoming these unfamiliar details during early practice stages so that, early in our practice trials, we pay close attention to these unfamiliar details. This is the attentional stage of skill learning. Attention and organization of the different steps of the skill are mediated by the prefrontal cortex and other regions that comprise the attentional network.

With repetition, these details become increasingly familiar. Later in our practice trials, these details and the skill itself become so familiar that the practiced action is nearly automatic. The transition from the effortful attention to each unfamiliar detail and stitching together of a series of skill fragments into a complete seamless action marks the beginning of the automaticity stage, and it is not until then that we can start down the road to virtuoso levels of skill. Functional brain imaging studies show that activation of prefrontal cortices during the early attentional practice stage diminish as the skill becomes automatic. With increasing task familiarity comes greater task automaticity and increasing performance dexterity (Proc. Natl. Acad. Sci. U.S.A. 1998;95:853-60). By the time we reach the stage of performance automaticity, our performance level plateaus. There are individual differences in how long it takes for a skill to reach the automaticity stage and the level of dexterity achieved by that time (although external rewards can influence this), but most people can reach this stage for most tasks.

**For most people, the performance of a task becomes nearly automatic with enough practice, but biological differences do exist in how soon the level of performance plateaus.**

Cerebral activation patterns for subsequent practice stages differ between sensorimotor and cognitive tasks (Cereb. Cortex 2005;15:1089-102). Sensorimotor tasks are defined as those that involve repetitive movements of a specific body part, for example, the left fingers of a violinist. Ongoing repeated fingering movements enhance horizontal synaptic connectivity within the finger homunculus. Consequently, there is enhanced cortical activation of that region with the fingering movement because of the greater number of neurons recruited for that task's performance (Science 1995;270:305-7). Cognitive tasks, in contrast, rely upon the integration of multiple brain regions that are geographically distant and serve different functions. With practice, the relative activation of all these different areas diminishes perhaps because they become physiologically integrated into a functional network that requires less effort expenditure from each component region.

Practice effects powerfully influence the level of dexterity any normal human brain can attain. However, biological differences do exist among us and also influence dexterity levels, as we shall consider next month. ■

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# Applicable to Wide Range

**Parkinson's** *from page 1*

chines). The study participants exercised three times a week for 3 months and were supervised by exercise physiologists at the Baltimore Veterans Affairs Medical Center.

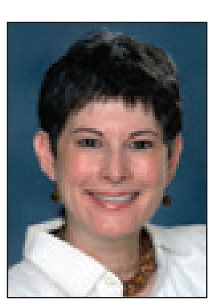
Baseline pre- and posttraining measures included the 6-minute walk; 10-meter and 50-foot gait speeds; peak oxygen consumption; and the UPDRS, which evaluates disease symptoms such as tremor, rigidity, loss of dexterity, slowness, walking, and balance.

The mean age of patients was 66 years and 75% were male. Dr. Shulman reported that at the end of 3 months, all modes of exercise improved distance on the 6-minute walk, with significant improvements in the low-intensity treadmill group and in the stretching/resistance group, and a trend toward significance in the high-intensity treadmill group. The greatest improvement was seen in the low-intensity treadmill group, in which patients walked 11% further over 6 minutes, a distance equivalent to half a city block.

Both groups that used the treadmill significantly improved their 10-meter fast gait, but the low-intensity treadmill group demonstrated greater improvement on the 50-foot fast gait. Both treadmill groups improved peak oxygen consumption.

Only patients in the stretching/resistance group experienced significant improvements in the motor component of the UPDRS, the key measure of Parkinsonian motor symptoms.

"The fact that the low-intensity treadmill group had more consistent benefit in terms of gait and mobility was surprising," Dr. Shulman said. "Our main interest was improvement in gait and mobility, because those are the most disabling symptoms of Parkinson's disease. A key fact is that it wasn't necessary to greatly increase the intensity of walking to achieve benefit. That means that more people with a greater range of disability can benefit from exercise in Parkinson's disease."



**It was surprising that the 'low-intensity treadmill group had more consistent benefit in terms of gait and mobility.'**

**DR. SHULMAN**

The positive impact of stretching and resistance exercise was also surprising, she said. "People with Parkinson's who have rigidity tend to develop a stooped posture; they tend to lose their range of motion and general mobility because they're stiff and slow," Dr. Shulman said. "One possibility is that the stretching and strengthening exercises in that group relieved symptoms of loss of range of motion and stiffness over time."

She acknowledged certain limitations of the study, including the fact that outcomes were evaluated only at 90 days and that it was a single-blinded (not a double-blinded) analysis. "There isn't any way to get around that, since patients in exercise trials are aware of their exercise training," she noted. "It's ironic that all of our patients were hoping that they would be assigned to the high-intensity treadmill group. They all wanted to be in that group because it was clearly the most strenuous group. When they were assigned to the low-intensity group or to the stretching/resistance group, they were somewhat disappointed, yet those were precisely the groups that were most effective."

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Dr. Shulman said that she had no relevant financial conflicts to disclose. ■