How does the brain coordinate our actions and interactions with objects in the environment? How do we learn the many complex skills that make up our daily activities, such as drinking a cup of coffee without spilling it or playing the piano? Revealing the fundamental principles that underlie skill learning and retention in the healthy nervous system is a necessary basis to understand neurological dysfunction and to develop intervention. Recent research of my lab has examined three motor skills: the discrete task of throwing a ball to hit a target, the rhythmic task of bouncing a ball, and the continuous task of carrying a cup filled with coffee. Key concepts that drive our inquiry into changes with practice are variability and stability. Characteristic for our approach is to start with a mechanical model of the task and render it in a virtual environment. As such, the human interacts with a known task environment. Based on stability analyses of the dynamical model, we study how the neuro-mechanical system develops robust solutions to meet the task demands. Using the three model examples, we show that developing skill means 1) finding the most error-tolerant strategy and channeling sensorimotor noise into task-irrelevant dimensions, 2) exploiting solutions with dynamical stability, and 3) optimizing safety margins and predictability of solutions. Based on these insights into healthy function, we started to test new intervention techniques that facilitate learning and relearning of motor tasks.