Integration of Cognitive Training for Performance Optimization: Creating Experts through Understanding Cognitive Functions

by CPT Aaron B. Price

It's important to explore the Army's current training methodology to identify areas where scientific research and performance experts can be leveraged to help leaders increase efficiency in achieving or maintaining an objective "T" (trained). The current "one size fits all" approach to training results in wasted time and energy and does not take into account that every Soldier is different.

To solve this, we hope to create a shared understanding of how individuals learn and what makes an individual "a novice" or "an expert" at a specific task. The ability to identify novices and experts in our formations will allow leaders to tailor their training approach to each individual Soldier. We can then create empowered team leaders, armed with scientific knowledge and assisted by performance experts, who can minimize the time it takes to achieve expertise at the individual level.

Background

For example, to train paratroopers, sustained airborne training (SAT) is conducted before every airborne operation. SAT is comprised of pre-jump, static-line control, activation of the reserve parachute onboard the aircraft, red-light procedures (including amber-light procedures), jump refusals and exiting procedures (SARJE), mock-door training and parachute-landing falls (PLF). The intent of SAT is to allow individual jumpers to rehearse the actions they will take during the airborne operation with an emphasis on safety. SAT is currently conducted *en masse*, with little consideration given to the experience level of individual jumpers and in conditions that are not conducive to true understanding (large groups, poor acoustics and multiple distractions). A possible reason for the "one size fits all" approach to SAT is our lack of a true assessment methodology for airborne proficiency.

Figure 1. Troops head out on their fifth and final jump from 1,200 feet in a C-130 before earning their wings during the Airborne School's Jump Week at Fort Benning, GA. *(Photo by Susanna Avery-Lynch)*

A typical assessment methodology for individual expertise is based on the number of jumps, whether or not the individual is jumpmaster-qualified and, to a lesser extent, the individual's time on airborne status. An apparent

issue with this approach is that many individuals spend large amounts of time out of the airborne community and then return to the airborne community years later. If an individual jumps 64 times as a young trooper, moves on to another unit, and then years later returns to airborne status and executes one jump, he or she could potentially reach the prerequisites to become a master-rated parachutist. However, in the time the individual was not on airborne status, equipment, training, techniques and procedures may have changed dramatically.

Also, airborne proficiency degrades over time if not exercised frequently. The result is an individual who is wearing the symbol of expertise (the Master Parachutist Badge) but who may not truly be an expert.

Role of memory

Cognitive scientists describe memory as having multiple components, including procedural, declarative and working memory. Procedural memory is commonly referred to as “muscle memory,” and it generally operates outside of conscious thought.

Declarative memory is responsible for the recall of facts or events. For example, jumpmasters use declarative memory to recite pre-jump verbatim.

Both procedural and declarative memory can be likened to different forms of information stored on the hard drive of a computer. These memory systems are where all our knowledge, skills and abilities are stored, ready for use if we need them. While skills stored in procedural memory can be retrieved automatically (without conscious thought), information stored in declarative memory must be retrieved and used by an additional memory system called working memory. Working memory is responsible for temporarily holding, processing and manipulating information that we retrieve from declarative memory.

An analogy for working memory would be random-access memory (RAM) in a computer. RAM is used by computer programs to temporarily store information required to execute a specific function. Like RAM, working memory is finite, so attempting to process too much information in working memory can overload you, reducing your ability to react quickly to changing circumstances.

When acquiring a new skill, people rely heavily on their declarative memory system. For example, a paratrooper first learns how to exit the paratroop door in the Basic Airborne Course through mock-door training, exiting the 34-foot tower and eventually exiting actual aircraft. At this stage of training, the paratrooper must consciously (use working memory) think about making eye contact with the safety, hand off his or her universal static line, turn 90 degrees into the door and conduct a vigorous “up six inches and out 36 inches” exit. As the paratrooper becomes an “expert,” this information transitions into the procedural memory system; the paratrooper no longer needs to hold each step in mind while executing the task. Building procedural memory for a specific task requires repetition and time and must be supported by declarative memory to achieve expertise.

Figure 2. Students at Fort Benning's Airborne School complete mock-door training at Fryar Drop Zone in October 2014. Students must have five successful airborne jumps from 1,250 feet to earn their wings. *(Photo by Patrick Albright, Maneuver Center of Excellence Public Affairs Office photographer)*

During a rapidly changing and dangerous task, like jumping out of an airplane, an individual must be able to physically execute the task without consciously thinking about it (procedural memory) and be able to recall the actions necessary to respond rapidly to changes in the environment (declarative memory). If the individual is a novice, instead of using his or her procedural memory to jump out of the aircraft, it's necessary to shuttle information out of declarative memory using working memory, which is a finite resource and can be seriously affected by stress or other factors.

Dr. Joe Moran of Natick Soldier Research, Development and Engineering Center (NSRDEC) tells us that "the basic differences between expert and novice skill performance are that experts are able to use procedural memory for a skill, which means that performance requires less access to declarative memory." In other words, experts "just do it."

In addition, Dr. Caroline Davis, also from NSRDEC, said "experts can rapidly and flexibly transition between procedural and declarative memory systems" in response to unexpected stimuli. Therefore, an expert paratrooper will activate his or her reserve parachute very quickly after realizing something is wrong with the main parachute because he or she can rapidly transition from the muscle memory required to jump to the declarative memory required to recall what to do in response to a malfunction. Novices, on the other hand, need to consciously access the steps for the task from declarative memory and move it to working memory. In other words, novices need to think about it.

Figure 3. A U.S. Army paratrooper with 1st Brigade Combat Team, 82nd Airborne Division, jumps out of an Air Force C-17 Globemaster III aircraft June 27, 2013, during Joint Operational Access Exercise (JOAX) 13-03 at Fort Bragg, NC. JOAX is designed to enhance cohesiveness between Army, Air Force and allied personnel, allowing the services an opportunity to properly execute large-scale heavy equipment and troop movement. JOAX is an example where Soldiers could be expected to transition between procedural and declarative memory systems.
(Photo by Senior Airman James Richardson)

The impact is that experts can detail the specific steps to a task easily but have less ability to recall each individual time they used that expertise. Novices, meanwhile, tend to be able to recall specifics about the last time they did the task but cannot describe how to do the task in general with as much clarity or detail.

Recommendations

Questionnaire. Our collaboration with the cognitive-science team at NSRDEC led to a deeper understanding of basic learning and memory processes, giving us the intellectual toolkit needed to improve current training practices. For example, in addition to the current methodology for assessing expertise at airborne operations, something as simple as a questionnaire aimed at determining what an individual can retrieve about jump standards will provide leaders insight as to the level of expertise of their paratroopers.

Experts within our formations should be able to accurately describe specific steps in great detail, while novices will be able to describe the steps in very general terms. For example, an expert may respond to the airborne questionnaire's question "describe what you do when you receive the command hook up" by stating that they would hook the static line snap hook to the appropriate anchor line cable, ensuring that the spring opening gate is facing toward the skin of the aircraft and then form a four in the hand, two below bite, ensuring the double-sewn portion of the static line is left free for the safety.

A novice answer may be as generic as the individual stating that he or she would hook up the static line to the anchor line cable. The airborne questionnaire compares responses to the performance steps outlined in the 82nd Airborne Standard Operating Procedures and Technical Communication 3-21.220.

The questionnaire could be validated by administering it to a control group of jumpmasters (known experts) and brand-new paratroopers (known novices) to confirm that the results differentiate the two groups. Additional validation could be achieved by increasing the sample size and by using "blind raters" to sort individuals based on their results. If the accuracy in sorting experts from non-experts is high, we would have a potentially useful tool. Then leaders could place their jumpers into ability groups based on the results of the questionnaire. During SAT, jumpers in the novice ability group would receive pre-jump, SARJE and PLF instruction in small groups (three to five personnel per group) with jumpmasters and expert jumpers, ensuring novice jumpers achieve complete understanding.

Combination of procedural and declarative learning. To achieve expertise (the objective "T") at a task, we must teach Soldiers with a combination of procedural learning (repeating a task over and over) and declarative learning (acquiring information one can speak about). Then we must test both procedural memory related to the task as well as declarative memory.

Many senior leaders in the Army already employ this strategy using the crawl-walk-run methodology. For example, to train a fire team to "react to contact," a leader first holds a class to explain the basic steps (the crawl phase) and continues to teach the basic steps until an individual can recall them and show comprehensive understanding. Next, the leader talks through the steps of "react to contact" while combining it with a half-speed walk-through of the physical tasks necessary. This is generally conducted in an environment with minimal complexity or distractions (e.g., a parade field), while continuing to enforce and test each individual's ability to recall the steps of the task verbally.

Once understanding is reached in the physical walk-through and verbal talk-through, leaders have Soldiers execute the task at full speed (run), testing the physical actions through observation and the declarative understanding through questions (why are you doing what you are doing?) in a much more complex scenario (a squad training exercise lane or a live-fire exercise). At this point, we can validate that the objective "T" was either attained or if

further training is necessary, whether declarative (the individual did not know what to do) or procedural (the individual didn't know how to physically execute).

Using performance experts

The Army has been using this crawl-walk-run methodology to one extent or another for many years. The concept behind it is not new; however, it is not executed for every task we must conduct. Throughout this process, it is important to leverage the expertise of performance experts before, during and after testing. Their ability to teach techniques to reduce anxiety and stress as well as obtain the focus to transition between different forms of memory can enable a more efficient use of time when training Soldiers to master a task.

Basic Army training uses the crawl-walk-run methodology to train Soldiers, but once an individual arrives at a unit, he or she typically stays in the "run" phase. Unfortunately SAT (as it is conducted now) is not really training; instead it's a rehearsal of the actions a jumper is about to execute. That may be true as applicable to other Army branches.

A novice jumper will eventually acquire expertise through repetition, though the number of repetitions required varies greatly among individual paratroopers. Therefore we can gain greater efficiency when creating expert jumpers by identifying novice jumpers early by using the methods described. Then leaders can apply the crawl-walk-run methodology to train novices to become expert jumpers. Leaders can place more emphasis on declarative memory by giving classes that cover the fundamentals of jumping out of an airplane and then testing that knowledge through verbal or written exams. Leaders can train procedural memory by conducting mock-door training in small groups initially. Then both procedural and declarative memory can be trained by conducting walk-through, talk-through training in the mock door where individuals describe and perform the necessary actions under the guidance of an expert jumper.

The "run" phase of airborne training is actually conducting airborne operations. Efficient time spent before airborne operations will likely result in jumpers who are able to achieve expertise more quickly, with fewer repetitions. It will also reinforce that every paratrooper is a professional who is expected to know the job, regardless of rank.

Figure 4. Paratroopers from 82nd Airborne Division jump from a C-17 Globemaster at Fort Bragg, NC, during Exercise Joint Forcible Entry in April 2005. The "run" phase of airborne training is conducting airborne operations like this one. *(Photo by Scott F. Reed)*

Jumpmaster School creates expert jumpers by training and testing both declarative and procedural knowledge. We can do the same in our formations by creating true understanding using similar methods. One way to increase efficiency in achieving an objective "T" for a task is to ensure that leaders at all levels:

- Are experts at the tasks they are training;
- Understand the need to train and test both the declarative memory and procedural memory to achieve expertise; and
- Understand how to determine whether a Soldier has mastered the material.

The takeaway from all this is that we must arm our team leaders with the understanding that every Soldier is different; some may need more emphasis in training their declarative memory (knowledge) instead of training their procedural memory (skills), or vice versa. This can happen when we empower team leaders with appropriate background knowledge by leveraging performance experts and NSRDEC scientists. This will allow team leaders to tailor training methods to individual Soldiers to reach a shared understanding and mastery for the collective group.

Leaders at all levels must understand the science behind the crawl-walk-run methodology and the need to train and test both declarative and procedural memory to create true experts who can react to changes in their environment by quickly accessing the appropriate type of memory to execute their tasks with adaptability and agility.

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Figure 5. SSG David Harp prepares paratroopers with 1st Brigade Combat Team to jump from a UH-60M Blackhawk helicopter at Fort Bragg, NC. Harp, the noncommissioned officer in charge of airborne operations, is assigned to 82nd Airborne Division's 2nd Battalion, 325th Airborne Infantry Regiment, 2nd Brigade Combat Team. Leaders like Harp can place more emphasis on declarative memory by giving classes that cover the fundamentals of jumping out of airplanes/helicopters and then testing that knowledge through verbal or written exams. *(Photo by SGT Michael J. MacLeod)*

Figure 6. SPC Ronald Turner, 325th Airborne Infantry Regiment, provides security for fellow Soldiers who are searching for insurgents and weapons in Mianashin, Afghanistan. Soldier reaction time in critical situations can be reduced via rapid access to procedural memory. *(U.S. Army photo)*