Commentary

Optimizing client and student learning from the brain's perspective

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Educating clients and veterinary students can be both rewarding and frustrating. In the clinic, even the best and most dedicated clients may, at times, not understand or follow our instructions for the care of their animals. In the classroom, even the most passionate and academically gifted veterinary students may perform poorly some days. Although clients and students are ultimately accountable for their own actions, understanding resource allocation in the brain and how it affects learning may help clinicians and professors more effectively obtain the desired results when educating clients and students.

Resource Allocation in the Brain

During physical activity, additional energy resources are provided to skeletal muscles as a result of increased blood perfusion rates.[1] In contrast, the effects of brain activity on the hemodynamics of the brain are not as well understood. Increases in local blood flow within the brain are associated with areas of higher neural activity and, presumably, reflect the larger energy demands of those segments.[2–4] However, these modest local increases in blood flow do not impact total cerebral blood flow, which remains relatively fixed at 750 to 950 mL/min or 50 to 65 mL/100 g of brain tissue in normotensive adult humans, even during intense cognitive activity.[3,5,6]

Kahneman[7,8] postulated that the brain functionally reallocates energy resources to the areas of most need. For example, energy resources are shifted to the prefrontal cortex during cognitive activities and to the more reflexive centers of the brain during physically demanding activities. The result is that during physically demanding activities, performing at a high level cognitively is often difficult because the brain simply does not have sufficient energy resources for both areas.[7,8] Similarly, Hockey[9] has suggested that cognitive tasks are performed at the expense of fundamental needs such as eating, resting, or expressing emotion. The upshot is, for example, that after a long day during which you expended substantial cognitive energy, you might find yourself in a senseless argument not because you are particularly angry, but because your brain does not have the energy to inhibit lower reflexive behaviors, increase resources to the prefrontal cortex, or allow you to realize the basis for the argument is ridiculous.

Allocation of effort within the brain is much like allocation of energy. Both cognitive and motor tasks consume mental effort. And, although the total amount of mental effort can fluctuate, if clients or students are expending considerable mental effort on a particular task, they may not have sufficient mental effort to devote to another one. In the clinic, for example, a client who is preoccupied with thinking about missing a deadline at work or being late to pick up the children might not be able to put sufficient mental effort into good decision making or following your directions. In the classroom, students who expend substantial mental effort studying for a test might find that they do not have sufficient mental effort remaining to perform as well on the test as anticipated.

The Three Phases of Learning

Fitts and Posner[10] described three phases of learning: the cognitive (or explicit learning[11]) phase, the associative phase, and the autonomous (or implicit learning) phase. Briefly, the cognitive phase occurs when an individual is first attempting to understand a task and the basic skills needed to accomplish that task. This is a very active process during which the prefrontal cortex is tending to multiple cues while also attempting to process the new information,[10] and is associated with a high energy cost.[12]

During the associative phase of learning, skills are refined and errors are reduced as the individual practices the task.[10] Control of the task is shifted to the lower centers of the brain as the individual becomes more proficient, reducing the brain energy expenditure.

Finally, during the autonomous phase, the individual uses the new information that has been learned to complete the task reflexively, with execution of the task primarily controlled through the lower centers of the brain.[13,14] This requires less processing and, therefore, less cognitive control and energy, meaning that the individual can complete the task efficiently[15] despite environmental distractions or other concurrent cognitive activities.

Components Affecting Learning

Three important components affect humans' capacity to learn: the environment, the person, and the task.[16,17] First, the environment determines context, and context, in turn, determines learning capacity. In the simplest terms, the ability to learn a complex task or understand complex instructions will typically be different in a quiet environment than it is in a crowded, noisy environment. Second, the capacity to learn depends on the individual's ability to receive and process new information while inhibiting reflexive defensive behaviors that prevent focusing on the new information. Third, complex tasks involving multiple steps will be more difficult to learn than simple, well-defined tasks.

The environment

Complex behavior, which includes learning behavior, depends on how well the CNS can regulate the autonomic state. However, although we can influence the autonomic nervous system, control is not conscious. The autonomic nervous system is in a parasympathetic state when there are no environmental demands and the brain is focused on internal recovery and restoration. As external environmental demands increase, the brain must mobilize energy. Porges[18] coined the term "neuroception" to describe how the brain determines whether a situation is safe or threatening. Briefly, the default response to a new environment is for the brain to feel threatened and trigger defensive strategies before we are cognitively aware of any danger.[18] During this default reaction, the brain transitions to a sympathetic state and focuses resources to the lower centers, where the limbic system controls the initial, reflexive, defensive response.[19,20] This reflexive response is, however, inhibited if the brain determines there is no threat, and resources shift to the prefrontal cortex to initiate a movement, learning, emotion, social interaction, or another appropriate response.[18,19]

During learning, we do not want the brain to allocate all resources to the prefrontal cortex, because then overanalysis would occur as the brain was attempting to process each and every sensory cue received. We also do not want the brain to allocate all resources to the lower centers where the reaction would be solely reflexive.

To achieve effective learning, therefore, we must provide an environment where clients and students are not in reflexive mode and not constantly thinking and analyzing. This means that our clinics and classrooms should be places where clients and students feel comfortable and supported. The clinic and classroom environment should be welcoming and inclusive, with the pictures on the walls, the behaviors of staff and faculty, and the physical layout friendly to and inclusive of clients and students of all races, ethnicities, sexual orientations, gender identities, and physical abilities. Clients and students don't have the capacity to learn if their brains perceive the environment as threatening.[21]

The person

Once the environment is suitable, we need to place people in a state where they can optimally learn new things. The term neutrality is used by the Postural Restoration Institute to emphasize optimal states for executing physical behaviors.[22] Hartman redefines neutrality as a state of brain activity essential for inhibiting an individual's default negativity bias or defensive state to allow the reception and processing of new information for any form of learning. Neutrality occurs when the prefrontal cortex is focused on meaningful, novel, and nonthreatening stimuli, thereby inhibiting reflexive or defensive behavior. A person in a state of neutrality is in a position to take in new information and execute desired outcomes. Maximal neutrality is not necessary to teach someone something new, but the probability of success likely increases with increasing neutrality. A state of neutrality can only be reached when the brain appraises both internal and external stimuli and deems it to be advantageous to survival to learn something new.

Clients and students won't find neutrality if their brains perceive their educator as intimidating or threatening. This means that clinicians and professors should maintain a nonthreatening appearance and supportive demeanor. A smile is a simple way to engage the prefrontal cortex and put students and clients at ease.[23]

The task

Learning can begin when there is a suitable environment and the individual is in a state of neutrality where the prefrontal cortex can process new information. The last component in learning relates to the task itself.

Intuitively, simple tasks are easier to learn than are complex tasks that involve multiple steps. Often, the veterinarian or professor is in the autonomous phase of learning with respect to the task, while the client or student is just entering the cognitive phase of learning. Therefore, the veterinarian or professor might have difficulty estimating the complexity of the task or the ease with which a client or student should be able to achieve success. Expectations for proficiency should be realistic and based on the background and experiences of the clients or students.

Learning for clients and students can be facilitated by using simple, well-defined tasks within controlled parameters so that their brains can allocate more energy to cognitive centers. The complexity or intensity of the task can be increased as the student or client reaches the phase of learning where sufficient options are available to meet the demands of the task regardless of complexity, intensity, environment, or context.

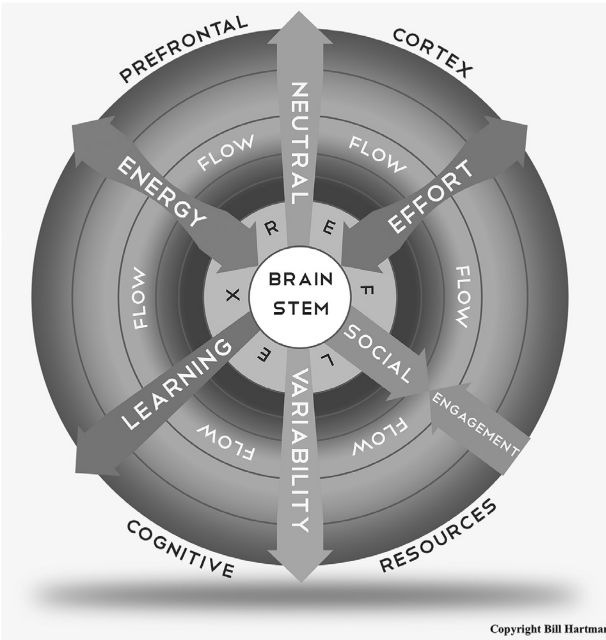

Figure 1—Hartman's Behavioral Onion. This representation of the brain depicts the lower or reflexive portions centrally and the higher cognitive portions in the outer layers. Arrows that point away from the center represent processes that require increasing cognitive resources. Arrows pointing to both the central and outer layers represent processes that require a shifting of resources. The arrows that point to each other indicate an optimum balance of resources.

Additionally, learning of the task may be facilitated when the professor or clinician targets the cognitive style or learning preference of the client or student. The cognitive style determines if the client or student learns best using pictures or words, which are processed using different areas of the brain.[24,25] When information is presented in the nonpreferred style, the brain will expend effort reprocessing the information through the preferred route.[25] To facilitate understanding of resource allocation in the brain for visual learners, the authors offer Hartman's Behavioral Onion **(Figure 1)**.

Summary

In summary, to improve learning of a task, the environment in which the task is taught can be changed, the individual can be encouraged to be in a state of neutrality, or the complexity or intensity of the task can be varied.[16] Educators cannot treat all clients and students exactly the same because everyone has had different experiences and will interpret things differently. The key to successfully teaching clients and students new tasks is to provide situations that allow the brain to allocate maximal resources to learning until the desired behavior becomes reflexive. To do this, we need to take a human-centered approach.[26] We need to get to know our clients and students so that we can understand what their needs are and provide them with optimal learning environments.

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