The Frontal Lobes: Movement and Morality

Part II: Neuroanatomy and Neuropsychology Converge

Bob Caruthers, CST, PhD

In "The Frontal Lobes: Movement and Morality, Part I: Basic Anatomy and Function" (see March 1997 issue of the journal), a question was established: Why is the area of the brain most directly related to movement also considered responsible for moral and social action? Admittedly, the complex, interdisciplinary answer to this question does not affect the day-to-day activities of the surgical technologist. However, a broader understanding of brain function will help the surgical technologist and surgical first assistant comprehend functional neuroanatomy and the problems that affect patients who exhibit neurological symptoms. This two-part series is therefore intended to provide basic anatomical and functional information (Part I) and a broader neuropsychological understanding (Part II).

In Part I, specific movements were correlated with specific areas of the brain. However, subtle changes in movement type were not described. (For example, while damage to a particular portion of the motor strip may not render gross movement of the hand impossible, it may inhibit the ability to juxtapose the index finger and thumb, thereby restricting certain actions.) To some extent, Part II is directed to the CST/CFA or the specialist in neurosurgery—those who have more pre- and postoperative interaction with neurology patients. However, Part II also provides a discussion of the philosophical aspects of neurology, which should enhance appreciation of the clinical picture and understanding of neurological pathology for all surgical technologists.

Interdisciplinary knowledge—that gained from primate studies and human clinical observations—is required to comprehend the relationship between frontal lobe function and human voluntary actions, which include not only physical movement, but also moral and social actions. The reader should note that to reduce complexity in the following discussion of the relationship between frontal lobe injury and actions, areas such as the hypothalamus and hippocampus have not been addressed.

Frontal Lobe Syndrome

Patients with frontal lobe injuries are often said to be suffering from "frontal lobe syndrome"—a term that does not take into account the precise nature or location of a lesion or that patients often exhibit wide variations in their ability to perform specific tasks.[1] While the more basic definition of this syndrome has limited usefulness in clinical practice, it will prove helpful for the purposes of this article. The basic characteristics of frontal lobe syndrome include the following:[1]

- Decreased ability (or complete inability) to organize future operations
- Difficulty holding employment
- Presentation of an overly complimentary view of oneself
- Stereotyped manners
- Diminished ability to experience pleasure
- Diminished ability to react to pain
- Diminished sexual drive

- Diminished curiosity
- Lack of originality and creativity
- Decreased ability to focus attention
- Recent memory subject to interference
- Tendency toward inappropriate emotional reactions

The symptoms of frontal lobe syndrome described above can appear even when the following other functions occur within the normal range:

- General intelligence (relative to education, experience, and age)
- Movement
- Sensory distinctions
- Communication

Milner demonstrated that patients with frontal lobe injuries tend to perseverate (ie, "get stuck in a loop").[2] Once an action or answer has been selected, the patient stays with it even when the cues change. Petrides and Milner's studies of verbal and nonverbal action support the belief that the left hemisphere plays the major role in programming voluntary action.[3]

Synthesizing various studies of frontal lobe injury produces consistent, broad descriptions of frontal lobe syndrome manifestations. Specifically, patients (1) demonstrate a decrease in insight and foresight (ie, the loss of a master plan by which to select or evaluate actions) (orbitofrontal lesions), (2) lack appreciation of social rules (orbitofrontal lesions with bilateral or right-sided lesions more pronounced), and (3) present with various aphasias and motor deficits (depending upon lesion location). (Please refer to the reading list at the end of this article for a more comprehensive review.)

Patients with frontal lobe injuries are often said to be suffering from "frontal lobe syndrome"—a term that does not take into account the precise nature or location of a lesion or that patients often exhibit wide variations in their ability to perform specific tasks.

Cognitive Requirements for Moral and Social Action

Comparing the broad-based characteristics of frontal lobe syndrome (listed above) and the cognitive requirements for moral or social action (listed below) demonstrates why moral and social behavior can be accurately assigned to the frontal lobes—particularly the prefrontal area. To develop the cognitive requirements for moral and social action, I reinterpreted Pieper's Thomistic ethical scheme.[4,5,6] The resulting cognitive requirements include the following:

- Perception and storage of environmental data
- Reconstitution of memories based on environmental cues
- Appropriate adjustment of memories and environmental cues to allow for accurate interpretation of a given situation
- Appropriate planning based on memory and environmental cues
- Feedback
- Autonomous action

Philosophical Questions

Let's review for a moment: Thus far, we know that specific frontal lobe areas are involved in specific aspects of voluntary action (Part I) and that frontal lobe lesions cause deficits that affect moral and social actions (Part II). Two questions remain: (1) Do frontal lobe deficits affect voluntary action without regard to whether that action is moral or social? (2) How can we explain the connection between our ability to control movement and action, and our moral and social behavior?

To address these questions, I consulted Passingham, who summarized the literature on recognition and tasks related to cues from the external environment, which appear in the following list:[7]

- Perceptual recognition with a preselected standard response does not require prefrontal cortex activity (PET-scan demonstration).
- Perceptual recognition based on memory is not affected by a prefrontal lobectomy.
- Perceptual recognition when undertaking a conditional learning task activates Area 8 (See Figure 1 in Part I {March journal}).
- Perceptual recognition required to apply a rule to perform a task is affected negatively in cases of large dorsal prefrontal excisions.
- Perceptual recognition required to apply a complex rule to determine which task to perform is negatively affected in cases of prefrontal excisions.

- The ability to make associations in a temporary or contextual setting, which is required when one experiences insufficient perceptual recognition, is negatively affected by prefrontal lesions.
- Tasks requiring selective attention are poorly performed by patients with frontal pathology.

While developing the list above, Passingham concerned himself with recognition of external cues and tasks related to recognition. Passingham also considered the relationship between frontal lobe activity and internal cues and tasks. That is to say, what happens when we ask for a mental response? He addressed this relationship in the following list of specified, conditional tasks that do not involve developing an action plan:

- Mental rehearsal of finger movements activates the medial premotor cortex but not the motor cortex.
- Mental rehearsal of a walk, which includes directional changes, activates the dorsal prefrontal cortex.
- Mental arithmetic and word selection from rhymes learned previously activates the dorsal prefrontal cortex.[7]

Passingham's studies clarify that human mental activity involves selection of both learned responses and responses from internal cues.[7] However, the lists above do not address the cognitive functions involved in developing an action plan. The three aspects of a planned action (noted by Passingham) include preparation, planning, and acting on the plan. Preparation occurs when an action is identified—but before it would be appropriate to act. It involves activation of the medial premotor cortex and is common to both primates and humans. The major difference is that humans have the ability to activate the preparatory set at any time or choose to inhibit the action. Primates, on the other hand, cannot create multiple theoretical plans. The hypothetical plan is abstract—under condition X, action 1 is appropriate. However, taking action simply involves fulfilling the plan. While normal human beings can perform purely mental trial-and-error tasks, the ability to do so is clearly diminished in patients with frontal lobe lesions or excisions. Studies of patients with frontal lobe lesions indicate subtle changes in their ability to prepare, plan, and act (as compared to the norm):

- They can identify but tend to break rules.
- They tend not to override interference (ie, tend not to inhibit other options).
- When left anterior lesions are present, patients are less successful at solving problems that involve a series of moves.
- When frontal lesions are present, the ability to compare and select the best plan is inhibited.

The cumulative effect of the above information demonstrates that human beings can perform purely mental trial-and-error tasks. This ability is greatly diminished in patients with frontal lobe lesions or excisions.

Conclusion

General characteristics of the frontal lobes that are subtly hidden in this mass of information include the following:

- IQ is not affected by frontal lobe lesions.
- Memory is not affected by frontal lobe lesions.
- The frontal lobes are more active during new movements while habituated actions arise from the temporal lobe.
- The frontal lobes provide significant inhibitory control over movement, which allows for movement to be refined.

This quick introduction to frontal lobe function facilitates understanding that the frontal lobes are primarily responsible for movement. Moreover, it demonstrates that the frontal lobes, when damaged, can cause an individual to exhibit morally or socially dysfunctional behavior. For example, a patient who cannot override interference—that is, cannot inhibit other options or cues—will not be able to appropriately adjust memories and cues that would enable him or her to give accurate meaning to a specific situation. According to Pieper, the inability to accurately define a situation renders prudent action impossible.

This leads us back to the original question: Why are movement and morality linked in the brain? The answer to this question is actually very simple: Moral action is a variant of any other action—including movement. It receives the qualifier "moral" only because of the evolutionary experience of the human species. Actions are evaluated according to their effect on the individual and the social group, and actions that produce positive results tend to be repeated. With enough repetition, these actions become habituated. On the other hand, actions that produce negative responses, such as pain, tend to be discarded.

Over time, the social group begins to categorize actions. Positive results are termed "good," and negative results are termed "bad." With experience, these

categories are expanded and more elaborate categories and rules are developed. Ultimately, individual acts that produce positive results are incorporated into formal statements such as, "Do unto others as you would have them do unto you."

As neuroanatomy and neuropsychological studies continue to converge, our knowledge about our essential selves will burgeon. Surgical technologists whose patients exhibit neurological difficulties will benefit—both personally and professionally—from this knowledge. Δ

References

1. Heilman KM, Valenstein E. *Clinical Neuropsychology*. 2nd ed. New York, NY: Oxford University Press; 1985.
2. Milner B. Effects of different brain lesions on card sorting. *Arch Neurol.* 1963;9:90-100.
3. Milner B, Petrides M. Deficits on subject-ordered tasks after frontal- and temporal-lobe lesions in man. *Neurospsych.* 1982;20:249-262.
4. Caruthers B. *Perceptions of Care Received During Childhood: A Constraint on Moral Stage Attainment.* Austin, Tex: University of Texas; 1995. Dissertation.
5. Pieper J. *The Four Cardinal Virtues.* South Bend, Ind: Notre Dame University Press; 1964.
6. Aquinas T; McDermott T, ed. *Summa Theologiae: A Concise Translation.* Westminster, Md: Christian Classics; 1989.
7. Passingham RE. *The Frontal Lobes and Voluntary Action*. New York, NY: Oxford University Press; 1993.

Suggested Reading

Calvin WH. *The Cerebral Symphony.* New York, NY: Bantam Books; 1989.

Edelman GM. *The Remembered Present.* New York, NY: Basic Books Inc; 1989.

Kandel ER, Schwartz JH. *Principles of Neural Science*. New York, NY: Elsevier/North Holland Publishers; 1981.

Bob Caruthers, CST, PhD, is AST's professional development manager. He previously served as surgical technology program director at Austin Community College (Austin, Tex) and has been a consultant to AST for many years.