Problem Solving: Practical Examples and Additional Properties

Under a variety of circumstances, breaking down a problem or reducing it to its stimulus-based properties might seem easy, and as a result, a solution can be found very quickly. For example, once it is understood that solving the arithmetic computation of 82–38 requires the application of a procedure of regrouping numbers by "borrowing" and "carrying," finding the answer is simple. The exact same procedure is applied each and every time; only the content or numbers of the computation change. When learning how to read and spell, after it is understood that in the English language, the letters of the alphabet can take-on more than one sound and that these letters can be grouped together to generate additional speech sounds, the processes of reading and spelling become easier (which really means the rules of reading and spelling are learned) and in the future, for most of us, reading becomes automatic. The exact same "rules of reading" are applied to whatever we read. The same general concept about problem-solving is true for all circumstances imaginable. If the stimulus based properties of a problem can be found, they can be applied, and a solution can be generated and learned. Once the solution is learned, the application of that solution frequently becomes automatic or implicit, depending upon how often a similar situation is encountered. The process is applied without giving the matter a second thought.

This is very much analogous to a "Zen" story. When a centipede was questioned about how he was able to coordinate all of his numerous appendages without appearing clumsy or stumbling, the centipede said that he had never given it a thought! However, from that time on, the centipede was unable to move! The point is that we learn many adaptive, common skills throughout our lives; these skills become automatic and they are not easily accessible, and sometimes not accessible at all, to the processes of conscious cognitive recall [4, 5].

An experienced neuroradiologist will view an ambiguous MRI or CT scan and quickly determine whether an anomaly on an image is a small tumor or a benign finding [6]. An experienced chess player can look at a configuration of pieces on a chessboard and quickly determine if these pieces are arranged in a pattern for a potential checkmate; the stimulus-based controls, which consist of imagining various sequences

L.F. Koziol, *The Myth of Executive Functioning: Missing Elements in Conceptualization, Evaluation, and Assessment*, SpringerBriefs in Neuroscience
DOI 10.1007/978-3-319-04477-4_2, © Springer International Publishing Switzerland 2014

of moves, then leads to the proper move order to reach the goal [7, 8]. An automobile repairman uses a set of diagnostic tools to quickly determine why a car's engine will not start before making an attempt to repair it. A mover can look at a large piece of furniture and a doorway and then instantly determine, perhaps intuitively, the proper angle for moving that furniture through the opening, before "tinkering" with different angles and positions to see if the furniture fits. It is true that these examples might rely upon different learning systems, and that all of these systems will not be discussed in this book. However, in each and every one of these examples, the key issue concerns identifying the stimulus-based properties of the situation.

Similar problem-solving is involved in interpersonal situations. For example, since you know the preferences of your "significant other," you use that stimulus based information to make a pretty good guess as to whether or not they will like a present before you purchase it. This information about preferences allows you to *anticipate* their reaction. Therefore, this anticipation guides what you do. Without that type of information, your choice in decision-making can easily go wrong. For example, you might randomly decide to take your first date to a seafood restaurant. However, sitting together at a romantically arranged table, with the ambience of the restaurant seemingly perfect, your date reluctantly informs you about their allergy to shellfish and the fact that they simply are not partial to eating fish! At least you have acquired information about the other person's "reward" preferences, so that the next time you are faced with the problem of restaurant choice, you decide upon an eatery consistent with food preferences. You can at least use that information to point your thinking in a different direction. Taking these examples just a few steps deeper, this type of anticipation starts to suggest that empathy might develop from this process of anticipatory thinking. A variety of situations exemplify one simple principle: problem-solving requires people to discover stimulus-response based controls to guide behavior. This involves relying upon what a person has learned through experience and then applying that information to the current problem.

It is also obvious that problem-solving does not always proceed smoothly or easily. Thomas Edison "experimented" with many materials in trying to develop a light bulb; he was not successful after his first attempt. Alexander Graham Bell imagined that transmitting sound through wires was possible, but he, too, encountered repeated failures before finding the right materials for making a telephone. Thomas Salk worked with numerous chemical compounds before discovering a successful polio vaccination. The Wright Brothers (and many others before them) experienced repeated failures before a few successful, low and brief flights in 1903. All of these people demonstrated motivation on a persistent basis. They did not quit. Solving these problems must have been rewarding for them. The principles of flight became understood through application of "Bernoulli's principle." However, this principle was published in 1738 for the purpose of explaining fluid flow dynamics [9]. The principle simply states that when a fluid flows through a region of low pressure, it speeds up, and vice versa. Applying this principle to understand how it might be relevant to flight required a process of divergent thinking—using an idea in a manner for which it was never intended. The principle was applied to explain the flow of air, instead of fluid flow. But even with improved technology, there were still numerous failures in attempting to fly across the Atlantic Ocean until Lindberg's successful flight in 1927. Some aviators failed because of navigational problems; others ran out of fuel. However, none of these failures had anything at all to do with a lack of understanding of the principles of flight. Instead, flying across the Atlantic introduced additional stimulus-based features of a problem. These new features required identification through imagination or anticipation; innovation was required to implement ideas that might lead to a solution. While the list goes on and on, even just these few examples illustrate another important point about problem-solving: it is not always easy to find solutions and when failure occurs, this typically means that *all of the stimulus-based characteristics of the problem have not been accounted for, discovered or are not yet fully understood*. A program for traveling to Mars is under consideration. Considerable information about living in outer space has been gathered from "shuttling" astronauts back and forth, spending time in space for many months before returning home, in the international space station project. However, how does one keep a human alive, traveling in space, for 3 years? What are all the necessary environmental characteristics about Mars that must be known before embarking upon such a risky endeavor? Without a doubt, NASA's Rover missions are providing answers to many of these questions, but numerous other problems must be anticipated, simulated and solved before such a spaceflight. Without drawing from an appropriate knowledge base, and without the ability to anticipate, how does a person even imagine the potential problems?

Without question, one of the most impressive feats of problem-solving concerns the spaceflight of Apollo 13; the explosion of an oxygen tank when traveling towards the moon, a problem that had never, ever been *simulated* or *imagined* previously, generated a cascade of problematic circumstances, with a chain of problems unfolding, with one problem leading to another. Even though the spacecraft was designed with numerous "back-up systems," an oxygen tank was venting out into space, essentially making these contingency systems useless. The loss of oxygen threatened life support systems; it threatened the generation of electricity necessary for maintaining each and every vital system required for spaceflight, such as computer and navigation systems, communication between earth and the space vehicle, the fuel for using engines for course correction, temperature regulation, and so on and so forth. Each problem had to be solved correctly by "improvisation," by directly *interacting* with it, as these issues developed; other problems had to be quickly anticipated in order to take appropriate proactive steps immediately, because the nature of the circumstances did not allow the luxury of repeated problem-solving attempts [10]. The stimulus-based properties of the problems that arose had to be determined "on the spot," without overlooking a clue, because literally, "failure was not an option." However, many people, even including top-level NASA engineers, knew and feared it was clearly a distinct possibility [11, 12]. All sorts of practical matters had to be *anticipated*, such as how to conserve fuel, electricity, limited battery power, and oxygen; how to navigate correctly and change course appropriately without the luxury of a computer; how to conserve other supplies, etc; the list of issues is too long to mention here, but the point is obvious; problem-solving, and decision-making, involve the anticipation of outcomes. The "bottom line" is the kind of anticipatory thinking that should tell us, "*If I do this,* *than that should happen.*" So anticipation is inherent in solving problems; behavioral controls always predict or "look ahead."

Also, the engineers at NASA did not have the privilege of living in today's world of competitive academia in which they could receive the special accommodation of "extra time" in order to find the correct answer to a test question. The fact of the matter was that time was an extremely critical issue. Factual knowledge was one important variable. However, applying that information quickly, efficiently, and effectively, by directly interacting with the problem and *anticipating* the outcome was at the heart of the matter. In many if not most situations, *interacting with the problem in* the "*real time*" of the moment is a critical factor that is frequently dramatically revealed in problem-solving and behavioral control. The world we live in requires us to interact.

Speed of response is frequently critically important. Captain "Sully" did not have "extra time" to determine how and where to land a commercial jetliner in the Hudson River after the plane's engines failed [13]; an "ER" physician or "triage team" does not have much time to identify, prioritize, and treat an unconscious patient's injuries when the person is wheeled into the emergency room of a hospital after being in a motor vehicle accident. It should come as no surprise to anyone that pilots and those in "first responder" professions frequently train in simulation drills to make certain responses become *familiar, routine, and automatic.* This allows them to respond quickly and implicitly, even outside of conscious awareness, without giving certain matters a second thought. This then provides the opportunity to attend to the *novel* or more unique characteristics of the situation in question. Perhaps any job that initially prepares a person through "on the job training" serves a similar purpose.

Even these "quick action" features of behavior are also seen in a simple way at a very practical level; as you approach an intersection while driving and the light turns from yellow to red, there is little time to decide to brake; you are then glad you did when you see a "semi" speeding through the intersection from the opposite direction, or perhaps out of the "corner" of your "round" eye, you see a person who prematurely began to cross the street. Fortunately, we have learned a response to these situations! The ability to make certain choices and decisions automatically after we have sufficient practice is another critical feature of problem-solving. As noted by Richer and Chouinard [14] the best way to evaluate the efficiency of the fronto-striatal system is to observe its functioning under time pressure, and this is one of the "vertically organized" neural systems involved in behavioral control.

So, what is the point of reviewing so many wide-ranging examples? It is remarkable what problem-solving situations have in common, from making seemingly simple choices to the most advanced phenomenon, because inherent in all problem-solving is decision-making. In a sense, understanding decision making behavior is at the heart of this paper. It is truly remarkable what can be learned about decision-making by merely examining the obvious. Problem-solving is evident *everywhere, and these examples were chosen intentionally to illustrate different aspects of decision making, or different aspects of behavioral control.* These examples will be revisited later in order to examine subtle but significant differences and the cognitive networks that need to be flexibly recruited to function in these situations.

http://www.springer.com/978-3-319-04476-7

The Myth of Executive Functioning
Missing Elements in Conceptualization, Evaluation, and Assessment
Koziol, L.F.
2014, XI, 127 p. 5 illus., Softcover
ISBN: 978-3-319-04476-7