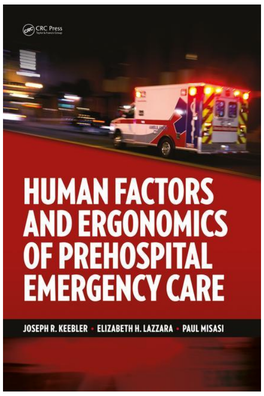

Human Factors and Ergonomics of Prehospital Emergency Care

Critical Essays in Human Geography

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Cognitive Factors in Emergency Medical Services

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A call comes in from a dispatch to the emergency medical services (EMS) post: “57-year-old female, unconscious.” The paramedics jump in the truck, leave the station, and head into traffic with lights on and the sirens blaring. The driver negotiates traffic as quickly as possible, sometimes driving on the left side of the road, sometimes on the right, proceeding through red lights while vigilantly scanning to make sure traffic is yielding to the ambulance. The partner pulls up the dispatch information, reads a description of the situation, and then switches over to a map to help navigate to the call location. Upon arriving at the scene, the paramedics are met at the door by the patient’s husband, who leads the team up to the second floor bedroom. By this time, the fire department’s first responders are also on the scene and five emergency personnel crowd into the small bedroom with the husband. The patient is not unconscious after all, but is lethargic and unable to rise from the bed. Her skin is cold and clammy to the touch, her heart rate is less than 50 beats per minute, and she reports feeling nauseous and faint. The lead paramedic on this call starts asking her questions. “What have you eaten today? How much have you had to drink? Are you on any medications?” Through the line of questioning, a picture starts to emerge about the situation. The paramedic is concerned about the slow heart rate, but the patient assures him that her heart rate is always slow. The team administers antinausea medication by estimating the weight of the patient and choosing the right dose after performing complicated mental calculations, taking into consideration her age and comorbidities that may affect the medication's safety. The medication dosage is cross-checked between the team members to make sure that they have calculated the dosage correctly. The team also starts to administer intravenous (IV) fluid since they have determined that one of the patient's problems is that she is severely dehydrated. After a few minutes, the patient is well enough to stand and is loaded into a chairlift for transport down the stairs and out to the ambulance. She gets out of the stair chair and onto the stretcher under her own power. On the way to the emergency room, the paramedic in the back with the patient continues to administer fluids and gives another round of antinausea medications, again after calculating the correct dosage. He hooks up a 12-lead electrocardiograph (EKG) to the patient to assess for myocardial ischemia or injury as a step in his process of confirming or disconfirming his suspected diagnostic hypothesis. He switches between entering patient information into a laptop, radioing ahead to the emergency room, and keeping up a dialogue with the patient to better understand her medical situation. Once at the hospital, the patient is transferred to the emergency department staff and the paramedic recaps all that he learned about the medical situation and the aid he provided up to that point. Finally, with the call over, the paramedics restock the truck and prepare for their next call.

The above scenario is typical of an emergency medical call and involves numerous cognitive activities. While driving, the paramedics must perceive the traffic situation, attend to the motion trajectories of the cars, remain vigilant for cars not yielding to the ambulance sirens, and search for street signs leading to the call location. All the while, the driver is being briefed on the upcoming call by his partner, who is multitasking by flipping back and forth between the call ticket and the city map on the laptop while also managing radio communication on the way to the scene. The paramedics form a set of expectations about how the call will go based on the description from the dispatch and their years of experience. Such expectations help them prepare for what they are about to face, but may also have an undue influence on their decision-making later. After arriving on the scene and evaluating for threats to personal safety, the paramedics must quickly assess the situation and determine which parts of the call description were accurate and which were not. They must be aware of not only their environment but also the visual symptoms of the patient—her complexion, coloring, clarity of speech, and movements. The paramedics must not be too influenced by the original description of the patient's illness from the dispatch lest it causes them to overlook important clues or head down the wrong diagnostic path. Rather, they ask questions to form a more detailed mental model of the patient's illness so that they can quickly stabilize her and prepare her for transport. In this system, medication doses must be calculated and cross-checked with other team members to avoid mental math errors. (The cross-check verification procedure is unusual at the national level, but has reduced medication errors in this county [Misasi, Lazzara & Keebler, 2014].) A paper printout of the patient's EKG is examined for telltale patterns indicating a heart attack, a visual pattern recognition task. Details of the patient's situation must be remembered to report to the hospital and to write up in the patient care report, often hours after the call is over—which is taxing on working memory. The paramedics must remember which supplies they used during the call so that they can restock at the hospital after the call is over. All the while, the emergency medical team must have a good bedside manner and maintain a calm presence to reassure the patient that everything will be OK—even if this is the end of their shift, they are fatigued, and the patient is uncooperative or abusive.

Prehospital medicine is delivered in fast-paced, high-stakes environments in which cognitive and perceptual factors may determine the difference between life and death. Paramedics and emergency medical technicians assess a scene upon arrival and make quick diagnostic decisions that need to be accurate and hold up to scrutiny. Misreading a medication label, miscalculating a medication dose, or misdiagnosing a medical problem can all result in adverse outcomes for a patient. The domains of these types of errors—perception, attention, memory, and decision-making—are all studied by cognitive psychologists. Findings from these and other domains in cognitive psychology are relevant to practitioners and may help them better understand the mental demands of emergency medicine. The purpose of this chapter is to provide an overview of the field of cognitive psychology, talk briefly about its origins and major concepts, and describe how they may relate to prehospital medicine.

HUMANS AS LIMITED INFORMATION PROCESSORS

The field of cognitive psychology started in the 1950s and 1960s in an attempt to explain human mental phenomena such as problem-solving, language, memory, perception, attention, and reasoning (Gardner, 1985). At that time, the behaviorist approach was the dominant theoretical perspective in psychology and limited experimental investigations to only observable data, such as clearly identifiable stimuli and responses. This theoretical perspective constrained the sorts of topics that could be studied, and psychologists grew frustrated with behaviorism's inability and unwillingness to address the complexities of human thought, which is not directly observable. At the same time, psychologists were compiling a number of findings that could not be explained using the tools of behaviorism, setting the stage for a revolution in the field of psychology (Neisser, 2014). The cognitive revolution used the newest technology of the day—computers—as a way to help conceptualize the machinations of the human mind and became wildly successful by doing so (Gigerenzer & Goldstein, 1996).

The core of the cognitive approach is conceptualizing humans as information processors. Information comes into the human mind through the senses, is represented and processed in myriad ways, and then is transformed into thoughts, memories, decisions, or behaviors performed by the individual (Neisser, 2014). Furthermore, information is interpreted by the individual, based on their knowledge, expertise, and life experiences. Much of cognition is an active process, in terms of both acquiring information from the world and thinking about that information. A person might observe a certain set of symptoms in a patient, search for other related symptoms, think about what those symptoms mean, come to a conclusion about the diagnosis, and then act on that diagnosis to administer proper aid. Such behaviors impact the world, are observed perceptually, are interpreted cognitively, and lead to further behaviors that impact the world, and then the cycle repeats.

Cognitive psychology further recognizes that the mind is a *limited-capacity* information-processing system (Miller, 1956; Tsotsos, 1990). Why limited in capacity? One way to understand this is to consider that the world contains an essentially unlimited amount of information but the human mind has only a limited number of neurons. Therefore, it is computationally *impossible* for humans to process all of the information available to them (Tsotsos, 1990). Consequently, the human mind must take shortcuts when processing information, such as selecting only certain streams of information to process instead of others or making educated guesses rather than laborious calculations. In support of this notion, Miller (1956) famously proposed that humans are limited to about 7 ± 2 "chunks" of information that they can maintain in working memory at any given time (where a chunk can be thought of as a group of tightly associated pieces of information, such as the single term *EMS* rather than the three words *emergency*, *medical*, and *services*). Broadbent (1958) proposed that we limit the amount of information we process at any given time by filtering out irrelevant bits. By accepting processing limitations of humans as a given, cognitive psychology concentrated on how humans overcome those limitations through various mental strategies such as chunking and filtering. Such a perspective gives insights into not only what humans cannot do but also what they can do by using efficient strategies. Despite their limited cognitive resources, humans typically perform remarkably well in complex tasks such as prehospital medicine, mainly because they have adopted strategies to make the most use of the information that they can process.

The field of human factors adopted the notion of humans as limited-capacity information processors capable of making mistakes and added a systems perspective, which conceptualizes work environments as complex, interacting systems instead of collections of individuals (e.g., Dekker, 2014; Holden et al., 2013). Given that humans make mistakes, it is important to have resilient and redundant systems to catch those mistakes and to frame information and tasks in ways that humans process more naturally. User-centered design, information visualization, and cognitive engineering all depend on knowing the human mind's capacities and limitations so that technologies and work systems can be designed to minimize errors and maximize performance.

For a long time, the expectation in the medical community was that providers should deliver care with no mistakes. When mistakes did occur, especially when they resulted in injury or death, the individual care provider was held to account and punished for the transgression (the "bad apple" theory; Dekker, 2014). Much of this dynamics is still present in healthcare today, although thankfully a more system-level approach is being adopted by the community (e.g., Carayon et al., 2006; Holden et al., 2013). Under the systems perspective, when an error occurs, it is more useful to examine the overall situation and environment surrounding the incident to determine what went wrong (Strauch, 2002), rather than to blame the healthcare provider and stop there. The notion is that nobody sets out to harm a patient, so if an error happened, it must have seemed like the logical action to take at the time, given the information that was available to the worker. Therefore, errors must be understood within the context of the information available and decisions that healthcare workers must make (Dekker, 2014).

A watershed moment for the healthcare community in terms of how to conceptualize and correct medical errors happened when the Institute of Medicine issued its famous report *To Err Is Human* (Kohn, Corrigan & Donaldson, 2000). The report documents the vast number of medical errors that actually occur nationwide and proposes various steps to correct them. More importantly, the report represents a shift by the medical community toward conceptualizing medical providers as limited-capacity information processors and recognizing that medical errors will happen, especially when redundant error-checking systems are lacking.

While the healthcare field has just started to conceptualize humans as error-prone organisms, the field of cognitive psychology has considered humans to be limited information processors from its very founding (e.g., Miller, 1956). Such a perspective may be useful for the field of medicine in general and EMS in particular since cognitive psychologists have been cataloging the variety and extent of humans' mental limitations for over half a century.

Overall, the cognitive approach conceptualizes humans as having finite mental resources that can lead to errors under the right (or wrong) circumstances. The question is not whether humans will commit errors—they will—but rather, *why* do people make the errors they do? On the other hand, what mental operations support accurate performance and decision-making? Understanding the limitations and boundaries of human cognition and performance allows us to make systems that are robust to the errors that humans inevitably commit. Once the inevitability of human error is accepted, the focus then turns to both understanding when such errors will happen and building systems and processes that identify and correct potential errors before they happen. To understand when errors will occur, we must first understand the limits of human cognition.

COGNITIVE FACTORS IN EMERGENCY MEDICINE

The following sections offer a brief overview of some domains of cognitive psychology that are relevant to human factors in emergency medicine. Although they are not an exhaustive list, the topics discussed should provide some insights into the various ways that cognitive psychology topics may be applied to EMS scenarios.

Attention

As mentioned previously, there is more information available in the world than we can process with our limited cognitive resources. Therefore, some information must be processed at the expense of the rest (Broadbent, 1958). Such differential processing is *attention*. The processed items are attended; the unprocessed items are ignored. Knowing which things to pay attention to and which can be safely ignored is a key element of expertise (Ericsson & Lehman, 1996).

There are many ways in which attention is used in emergency medicine. Even the most basic task of restocking a vehicle at the beginning of a shift involves a visual search for items either low in inventory or out of stock. The worker knows what the items look like and where they belong, and they direct their visual attention toward those aspects of the truck that they are restocking. When driving to a scene under lights and sirens, one needs to monitor traffic and shift their attention around to ensure that other vehicles are not going to come through the intersection.

When examining a patient, a paramedic directs their attention toward their instruments or the patient's body to gather information for a diagnosis. They might look at the patient's coloring, pupils, and heart rate or look for signs of wounds or cardiac arrest. Each of these tasks involves selecting a subset of the world to process while withdrawing processing of the rest of the world. Visual searches of these sorts involve systematic deployments of attention to stimuli in the world to gather information and form a mental representation of the situation (Custers, Regehr & Norman, 1996).

One interesting phenomenon related to attention and search is known as *satisfaction of search*. When performing a visual search for a target, there is a tendency for one to stop searching after a single target is found and therefore miss other targets that might be relevant (Berbaum et al., 1990; Tuddenham, 1962). In one famous example, radiologists examining a chest X-ray were able to find the tumor but failed to notice that the clavicle had been removed from the image (Potchen, 2006). Therefore, when assessing a situation, it is important to remember that just because one problem has been identified, that does not mean that there are no other problems that should be addressed. It is important to be thorough when arriving on scene and assessing a patient's injuries.

Another important aspect of attention for EMS is multitasking, which is having two (or more) active tasks you are trying to accomplish at once (Poposki & Oswald, 2010). During such occasions, we split our attention between the tasks—or, more accurately, we rapidly shift our attention back and forth between the tasks (Pashler, 1994). When driving to a scene, one must not only drive but also negotiate traffic, monitor radio chatter, strategize with one's partner, and navigate to the call location. When transporting a patient, the paramedic in the back of the truck must attend to the patient, accurately dose and deliver drugs, monitor vitals, and coordinate with the hospital. Since attention is split or constantly redirected while multitasking, it is easy to make mistakes. Some multitasking is unavoidable in EMS, but whenever possible, tasks should be completed one at a time with full attention to avoid the possibility of medical errors.

Schemas

Since humans cannot process all of the information available in the world, they usually do not even try. Instead, they look for patterns in the environment and draw conclusions from partial evidence. Some cognitive psychologists talk about this sort of pattern processing in terms of *schemas*, which are structured knowledge representations with default assumptions built in (Bartlett, 1932). For instance, if your friend tells you that they recently adopted a golden retriever, you instantly make a number of assumptions about their new dog without being consciously aware of doing so.

For instance, you may assume that the dog has four legs, long yellow hair, and a pleasant disposition. You have expectations about the size of the dog, its intelligence, the amount of grooming it requires, and whether or not it would play fetch. The point here is that we are constantly making assumptions and filling in information about objects, people, and events that we actually know very little about.

Schemas come into play when EMS personnel respond to a call. The dispatch gives a description of the situation, which may lead to assumptions about how the call will go. However, until EMS arrives on the scene, it is not clear what is really happening. If the description of the patient's symptoms is inaccurate, workers may go down the wrong diagnostic path due to assumptions from the dispatch's description. For instance, if you are told that you are heading to a scene to treat a 55-year-old male experiencing chest pains and shortness of breath, you might automatically assume that it has something to do with their heart when it could instead be an allergic reaction or adverse drug interaction. Similarly, when treating a patient in their early 20s who is having slurred speech and weakness on the right side of their body, you might be less willing to diagnose them as having a stroke as you would if they were in their 70s. The assumptions we make is that older people tend to have strokes, not younger people. While this is typically true, it is not always true, and it is important to be aware of any hidden assumptions one is making while treating a patient.

Memory

Memory is one of the most widely studied and well-understood topics in cognitive psychology. Many people tend to think of memory as a single resource—like a hard drive or a digital recorder—that stores experiences in a way that can be faithfully read out later. In reality, there are many types of memory and they work almost nothing like digital recording devices do. Memory is selective, biased, associative, and fragile. Without extensive training and practice in memory techniques, we have very little control of what we remember, as anyone knows who has forgotten the name of somebody they have just met. The following section will review several major types of memory resources, briefly describe their capacities and limitations, and then talk about the aspects of memory relevant to EMS.

The first distinction cognitive psychologists make is between short-term and long-term memory. *Short-term memory* contains the current items one is thinking about at any given time, which must be rehearsed to be maintained and can be easily lost (Baddeley, 2003). *Long-term memory*, on the other hand, is a vast storehouse containing events, facts, and skills, which is much more robust to loss and interference than short-term memory (Schacter & Tulving, 1994). Interestingly, items in long-term memory may be stored but momentarily irretrievable, depending on the current context and cues available (Bjork & Bjork, 1992). Understanding the nature and limits of human memory can help EMS workers avoid errors and maximize performance.

Short-Term/Working Memory

Short-term memory contains the conscious thoughts a person is currently considering. The terms *working memory* and *short-term memory* are often used interchangeably, although the former implies manipulation of items, whereas the latter does not necessarily. With regard to working memory, Baddeley (2003) proposed that there are several subsystems: a *visuospatial sketch pad* for mental imagery, a *phonological loop* for verbal items, an *episodic buffer* for remembering the temporal ordering of events, and a *central executive* for managing interactions between the previous three systems. An EMS worker may use the visuospatial sketch pad when imagining how to position a patient on a gurney or thinking about where to place equipment for optimal use. The phonological loop may be used to repeat a list of items mentally so that they can be maintained long enough to be written down. The episodic buffer may be used when listening to a patient describe the series of events that led up to their injury, which may be reported in a different order than they were actually experienced and thus need to be rearranged to form a proper narrative. The central executive, meanwhile, coordinates all of these activities and determines which working memory resources should be used when and to what effect.

A major feature of short-term/working memory is that it is limited in capacity, meaning that only a certain number of items can be maintained at once. Miller (1956) famously estimated the human memory span to be 7 ± 2 items, and while there have been different estimates over the years, the general notion that short-term memory has a limited capacity is widely accepted. One of the consequences of the limited nature of short-term memory is that items need to be transferred to a more permanent form of storage—either written down or transferred to long-term memory—to prevent them from being lost.

Long-Term Memory

Whereas short-term memory is limited in capacity, long-term memory is essentially unlimited and, like a scaffolding, the more knowledge one has in a certain domain, the more they have the capacity to learn (Bjork & Bjork, 1992). Long-term memory can be broadly divided into *declarative* and *nondeclarative* types (Schacter & Tulving, 1994). Declarative memories, sometimes called *explicit memories*, are the sorts of things you can say out loud to another person, such as what you ate for lunch or the capital city of France. Declarative memory can be further subdivided into *episodic* and *semantic types* (Squire & Zola, 1996). Episodic memories are memories of previous events that you have experienced and include information about the particular time and place at which the event happened. For instance, writing a narrative description of an emergency call after the fact relies heavily on episodic memory for the places and events experienced. Semantic memories, on the other hand, are memories of facts that you know, but which are not tied to a particular time and place. For instance, knowing that there are four chambers in the human heart or 12 pairs of cranial nerves does not depend on remembering the particular day in school that you learned that information.

Another interesting form of explicit long-term memory that cognitive psychologists have studied is *prospective memory*, which is the intention to remember to do something later (Brandimonte, Einstein & McDaniel, 2014). There are many tasks in EMS that require prospective memory. For instance, there is not always time to write down patient information, especially in emergencies, so one may make a mental note to tell the hospital about a patient's drug allergy. If certain supplies are used up on a call, you might have to remember to restock before the next call. If there is a delay in treatment because another treatment needs to be executed first, then remembering to do the original treatment is a prospective memory. In all of these cases, there is the intention to remember something later, which may or may not happen. Some of the keys to successful prospective memory retrieval are having both distinctive and specific retrieval cues at a later date, which can help recall one's original intentions (McDaniel & Einstein, 2000).

Nondeclarative memory, also called *implicit memory*, stores information that is harder to verbalize (Schacter & Tulving, 1994). For instance, knowing how to play an instrument, drive a car, or insert an IV tube with a gentle touch are all motor-based skills that are difficult to learn and hard to explain without mentally or physically simulating the process. Another interesting form of nondeclarative memories is habits, which are learned sequences of behavior that do not require explicit recall to perform (Squire & Zola, 1996). Anyone who has left the house to run an errand and accidentally started to drive to work because their mind was wandering can attest to the power of habits. In EMS and all safety-critical fields, it is important to establish good habits so that the correct procedures will be followed even in the face of distraction. Whether it is taking blood pressure, starting an IV, or hooking up equipment, the more times you have rehearsed doing something the smoother that the process goes. Furthermore, being able to perform the physical tasks of EMS smoothly reduces cognitive load, which in turn frees up mental resources for other items. Considering the fundamentally limited nature of human information processing, it is important to reduce cognitive load whenever possible.

One way to improve memory and cognition is to off-load those processes onto physical artifacts that support decision-making. Specifically, procedures and cognitive aids (e.g., checklists) can help ensure that processes are being done correctly and relevant information is being considered (Gawande, 2010). They provide structure to support reasoning and alleviate cognitive workload, especially under times of stress and limited cognitive resources. A second way to improve performance in the field is to practice procedures by using high-fidelity simulation (Salas et al., 2008). Such exercises create opportunities for implicit habits to be learned in realistic environments and explicit recall to be aided using the memory cues provided by the simulation.

Judgment and Decision-Making

Many of the mentioned examples have to do with gathering information and making decisions in the face of uncertainty. The branch of cognitive psychology that studies such processes is known as judgment and decision-making. It is probably not too controversial to say that humans do not always reason objectively and rationally about information. We do not think through all possible courses of action, weigh them, and then choose the optimal path in a dispassionate, systematic way (Klein, 2008). Rather, we typically use shortcuts in thinking—*heuristics*—to help us make decisions and we have biases in the ways that we consider information (Kahneman, 2011). While these heuristics and biases often work, they are not guaranteed to work and can cause humans to make poor decisions (Kahneman, Slovic & Tversky, 1982). Furthermore, the less time we have or the more stress we are under while making a decision, the less deliberative we are in the process (Cannon-Bowers & Salas, 1998). There are several heuristics and biases that are relevant to EMS and can impair optimal decision-making.

Anchoring and Adjustment

One heuristic people use when estimating quantities and magnitudes is *anchoring and adjustment*. When estimating some quantity, we tend to become anchored to an initial number and then adjust our estimate away from the anchor. This seems like a reasonable strategy except for two problems: (1) we tend to underadjust away from an anchor (Slovic & Lichtenstein, 1971) and (2) just about anything can serve as an anchor, whether it is relevant to the situation or not (Tversky & Kahneman, 1974). For instance, Tversky and Kahneman (1974) had participants spin a roulette wheel that had been rigged to stop at either 10 or 65. After spinning the wheel and having it land on a low or a high number, the participants were asked to estimate the percentage of African countries in the United Nations. People who spun a low number estimated a significantly lower percentage of African countries in the United Nations (25%) than did those who spun a high number (45%). What did the numbers on the wheel have to do with estimating the number of African countries in the United Nations? Nothing! But the mere fact that an arbitrary number was in the participants' heads when they made their estimate was enough to significantly influence their estimates.

In the realm of EMS, it is important to examine the anchors one is using when reasoning about quantities and magnitudes. For instance, if you are estimating the weight of a patient to calculate a drug dose, an initial incorrect guess about the weight might have a profound influence on the final weight used in the dosage calculation. When asking a patient how many pills they have consumed or drinks they have had, offering an initial estimate may inadvertently bias their report (e.g., "How many pills did you take? 10?"). It is important to be aware of the anchoring and adjustment bias in order to guard against it.

Availability

Another bias that can influence decision-making in EMS is *availability*, in which examples that more easily come to mind are judged to be more frequent. Tversky and Kahneman (1974) reported an example in which groups of participants heard a list of male and female names, some of whom were famous (e.g., Richard Nixon) and some of whom were less so (e.g., Lana Turner). One group heard a list with more famous male names and another heard a list with more famous female names. The participants were then asked to recall whether the list contained more men or more women. Despite the lists being the same length, participants judged the lists to contain more names of the sex that was more famous. The ease with which the famous male or female names came to mind during the recall phase caused the participants to think that there were more males or females on the list, respectively.

In the realm of EMS, if by happenstance a worker has experienced several rare cases in a row, she might be biased toward thinking that those cases are more common than they really are, which could affect her diagnostic decisions. Or, for example, if the city is in the middle of a heat wave and it is being reported all over the news, then one might be biased toward thinking that a patient who is nauseous and faint is experiencing heat stroke rather than some other cause. However, it would be prudent to consider other symptoms that could *disprove* the diagnosis of heat stroke rather than just those symptoms that are consistent with it, which brings us to our next decision-making bias.

Confirmation Bias

Confirmation bias is the tendency to consider only information that is consistent with a hypothesis or one's point of view rather than also considering information that might disprove it (Baron, 2000). In a famous example by Shafir (1993), two groups of participants evaluated a hypothetical scenario in which two parents were suing for the sole custody of their child. Both groups read the same descriptions of the parents: parent A had average income, health, and working hours; an average relationship with the child; and a relatively stable social life, while parent B had an above-average income, minor health problems, long working hours, an extremely close relationship with the child, and an extremely active social life. When one group of participants was asked, "To which parent would you *award* sole custody?" they picked parent B 64% of the time. Interestingly, however, when the other group was asked, "To which parent would you *deny* sole custody?" they also tended to pick parent B 55% of the time. In other words, Parent B was both awarded and denied custody of the child, depending on how the question was framed. Why would this preference reversal happen? When the participants considered reasons to award custody, they tended to concentrate on the positive aspects of parent B to confirm their decision, but when they considered reasons to deny custody, they concentrated on the negative aspects of parent B in the same vein. In other words, the participants tended to concentrate on information that was consistent with the decision they needed to make, rather than considering all of the information as a whole.

The confirmation bias reflects the tendency of people to frame their evaluation of information with regard to their goals or current hypotheses. People tend to seek out confirming information for their points of view and do not consider disconfirming information as readily. In the realm of EMS, the way a call is first described by the dispatch may influence the diagnostic decisions of the medical team. There may be a bias to frame one's thinking relative to the information reported rather than by considering other alternatives.

Due to many reasons already listed earlier—the dispatch's description of a call, recent calls that one has experienced, and assumptions about people based on their age, appearance, etc.—one might have a quick hunch as to the diagnosis of a patient upon arriving on the scene. The danger of the confirmation bias is that the EMS worker might only seek out information that would confirm their current hunch rather than also seek out information that might disconfirm it. It is important to not be locked into a conclusion quickly and to consider alternative explanations of how a patient presents.

CONCLUSION

The cognitive perspective is useful for thinking about emergency services and prehospital medicine. It recognizes that humans are limited in their information-processing abilities and biased in the ways they consider information. It recognizes that humans will make errors. Cognitive psychology can help to understand the information processing demands of tasks and the thinking and cognitive resources available in emergency medicine and can help to specify the sorts of measures and countermeasures that might be deployed to improve performance.

REFERENCES

Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience*, *4*(10), 829–839.

Baron, J. (2000). *Thinking and deciding*. New York: Cambridge University Press.

Bartlett, F. C. (1932). *Remembering: An experimental and social study*. Cambridge, UK: Cambridge University.

Berbaum, K. S., Franken Jr., E. A., Dorfman, D. D., Rooholamini, S. A., Kathol, M. H., Barloon, T. J. et al. (1990). Satisfaction of search in diagnostic radiology. *Investigative Radiology*, *25*(2), 133–140.

Bjork, R. A. & Bjork, E. L. (1992). A new theory of disuse and an old theory of stimulus fluctuation. *From learning processes to cognitive processes: Essays in honor of William K. Estes*, Vol. 2, pp. 35–67.

Brandimonte, M. A., Einstein, G. O. & McDaniel, M. A. (2014). *Prospective memory: Theory and applications*. Oxford: Psychology Press.

Broadbent, D. (1958). *Perception and communication*. London: Pergamon Press.

Cannon-Bowers, J. A. & Salas, E. E. (1998). *Making decisions under stress: Implications for individual and team training*. Washington, DC: American Psychological Association.

Carayon, P., Hundt, A. S., Karsh, B. T., Gurses, A. P., Alvarado, C. J., Smith, M. et al. (2006). Work system design for patient safety: The SEIPS model. *Quality and Safety in Health Care*, *15*(1), i50–i58.

Custers, E. J., Regehr, G. & Norman, G. R. (1996). Mental representations of medical diagnostic knowledge: A review. *Academic Medicine*, *71*(10), S55–S61.

Dekker, S. (2014). *The field guide to understanding "human error."* Surrey, UK: Ashgate.

Ericsson, K. A. & Lehmann, A. C. (1996). Expert and exceptional performance: Evidence of maximal adaptation to task constraints. *Annual Review of Psychology*, *47*(1), 273–305.

Gardner, H. (1985). *The mind's new science: A history of the cognitive revolution.* New York: Basic Books.

Gawande, A. (2010). *The checklist manifesto: How to get things right*, Vol. 200. New York: Metropolitan Books.

Gigerenzer, G. & Goldstein, D. G. (1996). Mind as computer: Birth of a metaphor. *Creativity Research Journal*, *9*(2–3), 131–144.

Holden, R. J., Carayon, P., Gurses, A. P., Hoonakker, P., Hundt, A. S., Ozok, A. A. et al. (2013). SEIPS 2.0: A human factors framework for studying and improving the work of healthcare professionals and patients. *Ergonomics*, *56*(11), 1669–1686.

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Macmillan.

Kahneman, D., Slovic, P. & Tversky, A. (1982). *Judgment under uncertainty: Heuristics and biases.* Cambridge, UK: Cambridge University Press.

Klein, G. (2008). Naturalistic decision making. *Human Factors*, *50*(3), 456–460.

Kohn, L. T., Corrigan, J. M. & Donaldson, M. S. (2000). *To err is human: Building a safer health system.* Washington, DC: National Academies Press.

McDaniel, M. A. & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology*, *14*(7), S127–S144.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*(2), 81.

Misasi, P., Lazzara, E. H. & Keebler, J. R. (2014). Understanding multi-team systems in emergency care, one case at a time. In Salas, E., Rico, R. & Shuffler, M. (Series Eds.), *Research on managing groups and teams*: *Vol. 17—Pushing the boundaries: Multi-team systems in research and practice.* Bradford, UK: Emerald.

Neisser, U. (2014). *Cognitive psychology: Classic edition*. New York: Psychology.

Pashler, H. (1994). Dual-task interference in simple tasks: Data and theory. *Psychological Bulletin*, *116*(2), 220–244.

Poposki, E. M. & Oswald, F. L. (2010). The multitasking preference inventory: Toward an improved measure of individual differences in polychronicity. *Human Performance*, *23*(3), 247–264.

Potchen, E. J. (2006). Measuring observer performance in chest radiology: Some experiences. *Journal of the American College of Radiology*, *3*(6), 423–432.

Salas, E., Wilson, K. A., Lazzara, E. H., King, H. B., Augenstein, J. S., Robinson, D. W. et al. (2008). Simulation-based training for patient safety: 10 principles that matter. *Journal of Patient Safety*, *4*(1), 3–8.

Schacter, D. L. & Tulving, E. (1994). *Memory systems*. Cambridge, MA: MIT Press.

Slovic, P. & Lichtenstein, S. (1971). Comparison of Bayesian and regression approaches to the study of information processing in judgment. *Organizational Behavior and Human Performance*, *6*(6), 649–744.

Squire, L. R. & Zola, S. M. (1996). Structure and function of declarative and nondeclarative memory systems. *Proceedings of the National Academy of Sciences*, *93*(24), 13515–13522.

Strauch, B. (2002). *Investigating human error: Incidents, accidents, and complex systems*. Burlington, VT: Ashgate.

Tsotsos, J. (1990). Analyzing vision at the complexity level. *Behavioral & Brain Sciences*, *13*(3), 423–469.

Tuddenham, W. J. (1962). Visual search, image organization, and reader error in roentgen diagnosis: Studies of the psycho-physiology of roentgen image perception. *Radiology*, 78, 694–704.

Tversky, A. & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131.