options, whereas attitudes related to deliberate learning are more likely to reflect only part of that information.

Heuristics

Heuristics are general rules of thumb that people use in cognitive processing to reduce mental energy demands. While the general thinking has been that using heuristics reduces the accuracy of processing, evidence now suggests that in some situations heuristics can actually improve the accuracy of decisions. Heuristics include simple rules about how to search for more information, when to stop the search, and estimating the likelihood of an event. For example, the representative heuristic can lead a teenager to ignore warnings about smoking because the typical image is that people with lung cancer are old.

Why Understand Cognitive Decision-Making Processes?

Understanding the cognitive processing used can naturally provide several types of guidance in the field of medical decision making. It can help identify the specific challenges that make a particular decision difficult, which, in turn, clarifies how to make decision support interventions most effective. Understanding the cognitive processing also reveals important complexities in human behavior that should be considered when creating interventions. For example, sensitivity to environmental structure implies that how information is presented (not just what) can make a big difference in whether an intervention is helpful or not.

Understanding what and why people use particular processes can also help guide selection of outcomes that indicate good quality decisions. For example, people naturally aiming their decision processes to protect them from experiencing cognitive dissonance and postdecisional regret suggests that measures of value concordance and of regret are important quality indicators.

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See also Decision Making and Affect; Decision Rules; Regret; Values

Further Readings


COINCIDENCE

A coincidence is a random co-occurrence of two or more events that are perceived to be meaningfully associated with each other, even though there is no meaningful causal relationship linking them. A collision between an ambulance carrying an injured bullfighter and a cattle truck would constitute a coincidence, while internal bleeding following ingestion of broken glass would not. The need to distinguish true associations from coincidences is critical to good medical decision making, yet the human mind is ill equipped to make this distinction.

Co-occurrences of events can be perceived as meaningful when they happen along a number of dimensions, such as time (e.g., when a patient develops symptoms shortly after taking a drug), space (e.g., when multiple cases of a rare disease occur in the same town), or heredity (e.g., when several members of a family tree are found to have the same disorder).

While co-occurrences often indicate the existence of a direct causal relationship or a common underlying factor, many are simply the result of chance, and their constituent events should be considered independent of each other. However, determining whether a co-occurrence reflects meaningful
or random covariance is often difficult. In fact, research shows that the human mind is limited in its ability to distinguish meaningful associations from coincidences. People (even those with medical degrees) tend to commit predictable errors when trying to distinguish random chance events from meaningful causal processes. As a result, we often overreact to coincidences and underreact to co-occurrences that deserve our attention.

Some events are, by their very nature, especially likely to capture our attention and generate an emotional response. Accordingly, they are more likely to be initially encoded in memory and are later more accessible for recall. As a result, we tend to notice their co-occurrences much more and infer more from these than from co-occurrences of other events. For example, we are overly influenced by the probability of each event occurring on its own. The more unlikely each of the events is thought to be, the more surprising we find their individual occurrences, and this makes their co-occurrence seem all the more surprising and meaningful. Taking vitamins and experiencing mild stomachaches are both relatively common events, so their co-occurrence is likely to go unnoticed. In contrast, taking a new experimental drug and experiencing acute abdominal pains are both relatively uncommon events, so their co-occurrence is likely to raise suspicion of a causal link. Another closely related factor is the number of events co-occurring: The greater the number of events that co-occur, the more we tend to find this co-occurrence meaningful. A physician is more likely to suspect the presence of a disease when his or her patient shows five unusual symptoms than when the patient shows two unusual symptoms.

While these two factors can provide rational bases for judging the meaningfulness of co-occurrences (though not always), others are much less justifiable. For example, co-occurrences are perceived to be more indicative of a causal relationship when they are experienced firsthand than when they are experienced by others. This helps explain why patients and their loved ones are more likely to see, in the co-occurrence of symptoms, the threat of a serious medical condition, where the physician sees harmless coincidence.

The need to distinguish meaningful co-occurrences from simple coincidences regularly arises across a variety of medical decision-making contexts. Physicians and other medical professionals are often confronted with the difficult task of recognizing when co-occurrences are meaningful or coincidental: Does the simultaneous occurrence of certain symptoms imply the presence of a disease, or did it happen by chance? Does the apparent relationship between administration of a new medical drug and improved health signal effectiveness, a placebo effect, or a meaningless coincidence? Should a physician be concerned when his or her patient reports experiencing unpleasant symptoms following a medical procedure or is this mere happenstance? Are multiple outbreaks of a rare disease within a small geographic area the sign of a growing epidemic or just random clustering?

Separating coincidence from causality is a problem that also confronts patients and nonmedical professionals: Are feelings of nausea following a dining experience the first signs of serious food poisoning, which calls for a trip to the emergency room, or are they unrelated? Are the higher rates of surgical death associated with a particular hospital the result of malpractice or bad luck? Even when medical professionals are able to recognize coincidences, they must confront the objections of patients and loved ones who are quick to see meaningful associations in the co-occurrence of significant events (e.g., two family members dying from a rare disease) and resistant to the possibility that these could happen by chance alone.

A number of real-life examples illustrate the importance of distinguishing causation from coincidence. One striking case is the controversy that erupted in a number of Western countries, when many parents were convinced, by anecdotal evidence, that vaccination for measles, mumps, and rubella (MMR) caused autism. A number of studies were carried out in response to the resulting public outrage, with the majority of them finding no association between MMR vaccination and the occurrence of autism. As it turns out, children tend to be diagnosed with autism around the time they turn one, which also happens to be when they are administered the MMR vaccine. As result, a number of children who would have been diagnosed with autism, even without the vaccine, received this diagnosis shortly after receiving the MMR vaccine, leading many parents to perceive a direct link between the two.

Because of biases in human probabilistic reasoning, medical professionals and their patients
are subject to misunderstanding coincidental occurrences as causally related. For this reason, teaching medical professionals to be aware of these biases is a prerequisite for good medical decision making and effective communication with patients.

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See also Biases in Human Prediction; Causal Inference in Medical Decision Making; Judgment; Probability Errors

Further Readings

Complexity

Complexity science is the study of systems characterized by nonlinear dynamics and emergent properties. In contrast, simple mechanical systems are describable by sets of linear equations lending themselves to conventional scientific methods. But living systems and systems composed of living things display and adapt to changes in unpredictable ways. Complexity science studies systems as complete wholes instead of components or subsystems to effectuate better decisions that are more realistic for clinical and policy decisions.

Complexity is a term that describes how system components interact with one another. For instance, conventional medical science may be less able to predict which patients will experience unanticipated side effects from a new drug. Likewise, healthcare delivery and its many elements are not likely to respond predictably to policy or reimbursement changes.

As knowledge of health and illness progressed through the 20th century, Cartesian notions of a mechanical and predictable universe were inadequate to describe some natural phenomena. Multi-faceted and complex findings associated with the health sciences might benefit from more advanced or comprehensive frameworks than the mechanical ones typically employed. A science of complexity was sought to improve predictability and quality of medical decision making with the use of specialized scientific methods.

Healthcare interventions draw on the accumulated knowledge and wisdom of disease—formalized as science—processes to prevent, ameliorate, or cure conditions. Given that diseases, treatment options, and patients are often complex and unpredictable systems, perhaps clinical decision making could benefit through a deeper understanding of the system dynamics impinging on individual patients to a greater or lesser degree. For instance, complex patient ecologies include in addition to physiology, the cultural, local community, social, psychological, genetic, emotional, and relational domains, all of which can augment or impede treatment.

A science of complexity is attractive because of a potential to describe and predict systems phenomena more congruently with what is known about actual living system attributes and behaviors. For instance, the inputs, processes, and outputs associated with living systems are often described as nonlinear since system inputs yield unpredictable outputs. Furthermore, system behaviors may be deterministic, stochastic, or random responses to environmental challenges and changes; and all types of system responses may appear similar. Also, describing the “essence” of a given system through conventional repeated sampling methods of system outputs may never converge on fixed system parameters. Furthermore, living whole systems are logically irreducible to description and prediction by simple “reductionist” methods. Slicing a system conceptually or literally for study has limits. At some threshold, the emergent and nonlinear properties of a whole system cease to function normally, and the subject of inquiry is lost.

Important too is the tendency for conventional scientific tools that tend to favor group responses over individual or idiographic ones. Emergent or unexpected clinical or policy system behaviors are