**Chapter 10: Reasoning and Decision Making**

**Learning Objectives**

* Describe the common errors that people make in sylogistic reasoning and the cognitive con­straints that produce these errors.
* Explain the valid versus invalid forms of conditional reasoning and the cognitive factors caus­ing errors in such reasoning.
* Draw a graph representing the subjective utility curve and explain how it can be used to ac­count for risk aversion and framing effects in decision making.
* Compare the heuristics of representativeness and availability in estimating probabilities of outcomes in decision making under uncertainty and their relation to fast and frugal heuristics.

**Chapter 10: Reasoning and Decision Making**

**Brief Summary**

Human reasoning has been studied through examining how people evaluate syllogisms and conditional statements. Syllogistic reasoning involves evaluating whether a conclusion necessarily follows from two premises that are assumed to be true. Successful evaluation of a syllogism is constrained by a number of cognitive factors. According to the atmosphere hypothesis, people blindly accept the validity of the premise statements of a syllogism without careful consideration. Working memory limitations may restrict consideration of all possible combinations of the premises. The premises can also be misinterpreted as in illicit conversion or not considered at all as in belief bias when people accept any conclusions that fit their system of beliefs. Conditional reasoning involves evaluating involves deducing a valid conclusion from a rule in the form of an if-then statement. There are two valid forms of conditional reasoning. One form, known as modus ponens, involves affirming the antecedent. The second form, known as modus tollens, involves denying the consequent. People perform perfectly when applying modus ponens, but perform poorly when applying modus tollens. Performance is improved, however, when abstract statements are converted into concrete, lifelike situations. Cognitive factors also constrain the evaluation of conditional reasoning statements. Confirmation bias is the tendency to seek and evaluate evidence that confirms rather than rejects our prior beliefs. Myside bias refers to the fact that people seek and evaluate evidence in a biased manner that confirms their own prior political, religious, ethical, and economic beliefs and attitudes.

Human decision making does not follow the predictions of expected utility theory or the idea that people will select the course of action from among the possible alternatives that yields the greatest benefit. Instead, because people often must make decisions when faced with risk and uncertainty, peoples’ decisions are based on a model of subjective utility. When plotted on a graph, subjective utility shows a curvilinear relation to losses and gains. It is convex in the region of losses and concave in the region of gains. People are, thus, risk aversive because subjective utility drops faster with losses than it rises with gains. When making decisions under uncertainty, people rely on heuristics such as the representativeness heuristic and the availability heuristic. The rapidly emerging field of neuroeconomics considers human decision making to be a product of deliberative thought processes and affective processes. According to the somatic marker hypothesis, decision making is guided by bodily, visceral feelings based on the anticipated pain or pleasure of the decisional outcomes. Emotional processes also play an important role in moral decision making as these decisions have been found to recruit brain regions in the prefrontal cortex that are important for social emotions. The role of emotions in decision making also has important developmental implications as the brain areas involved in the cognitive-control network have been found to mature later than other brain structures. As a result, adolescent decision making may be prone to impulsivity due to a combination of a weakened cognitive-control network and a socioemotional brain network strengthened by elevated hormones. The effects of these underlying factors in adolescent decision making have important implications for policies establishing the age at which adult legal rights are granted.

**NOTE- If any of the links contained within are not working, please contact the publisher and an alternate resource will be found for you. In addition, an updated Chapter to this instructor’s manual will be uploaded to the companion website.**

**Chapter 10: Reasoning and Decision Making**

**Detailed Summary**

1. Syllogistic reasoning involves evaluating whether a conclusion necessarily follows from two premises that are assumed to be true. A valid deductive conclusion is *necessarily* true, given that the two premises are true. People identify valid conclusions about three quarters of the time. But they perform much worse with invalid conclusions, recognizing them as invalid only about a third of the time. The pattern of errors is very consistent. When the major premise contains the word *all* and the minor premise contains the word *some*, people regard a conclusion containing the word *some* as valid. When both the major and minor premises contain the word *no*, people regard a conclusion containing the word *no* as valid.

2. One reason for our poor categorical reasoning performance is illicit conversion. People improperly assume that “If all A are B, then all B are A.” Another reason is that considering all possible combinations of what the premises mean places enormous demands on working memory. Not surprisingly, people simplify the task by considering only a few combinations and by considering only the combinations that are easily interpreted. In general, people reason in ways that are meaningful by constructing mental models. These models need not mirror the formal systems of logicians. One compelling example is the phenomenon of belief bias, whereby people accept a conclusion as valid if it fits their system of beliefs, regardless of the given premises.

3. Conditional reasoning involves deducing a valid conclusion from a rule in the form of “If P, then Q.” One way to draw a valid conclusion is to affirm the antecedent. By showing that P is true, it follows that Q is also true according to the conditional rule. The second valid form of reasoning is to deny the consequent. By showing that Q is false, it follows that P is also false. People reason virtually flawlessly when affirming the consequent. There is a strong tendency toward confirmation bias, or seeking evidence that confirms a conclusion. However, people rarely seek evidence that disconfirms the conclusion—denial of the consequent. Furthermore, people do not understand that denial of the consequent is a valid form of reasoning.

4. Making decisions under uncertainty implies that the probabilities of various scenarios must be estimated subjectively. Subjective probability generally tracks objective probability—except for low-probability events, which are overestimated. When reasoning under uncertainty, people rely on a variety of heuristics for making decisions. The representativeness heuristic assigns a high probability of occurrence to events that are judged to be typical of a class. According to the availability heuristic, an event is likely to occur if specific examples of the event can be recalled easily. Fast and frugal heuristics rely on minimal information and exploit evolved abilities and structures in the environment. For example, given two alternatives, people select the one that they recognize; human memory has evolved to process familiarity, and the recognizable alternative often is a good choice more than half the time or the level of chance.

5. Emotion affects reasoning and decision making and is a fast, automatic, effortless influence. The somatic marker hypothesis states that people experience bodily, visceral feelings that guide their decisions based on the anticipated pain or pleasure of the outcomes. Emotions are generated as different alternative courses of action are evaluated. The bodily states associated with these emotions (the somatic markers) assist with the process of making a decision. A region of the prefrontal cortex just above the eyes, called the orbitofrontal cortex, stores associations between events in the environment and the somatic markers that they generate. In weighing alternative courses of action, the orbitofrontal cortex activates the somatic markers, which in turn bias decision making. Some courses of action intuitively feel like good options while others are, at a gut level, bad ideas. Ventral regions of the prefrontal cortex also mediate social emotions such as empathy, embarrassment, and guilt. Moral intuition comes from the rapid and automatic influence of these social emotions in evaluating whether a course of action is right or wrong. Also, adolescents are especially prone to risk taking, because the network sensitive to social and emotional signals in decision making is more active relative to the cognitive control network in teenagers.

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**Topical Outline**

Syllogistic Reasoning

* Syllogistic reasoning involves evaluating whether a conclusion necessarily follows from two premises that are assumed to be true.

Syllogistic Forms

* + Evaluating syllogistic conclusions requires three steps: 1) Accurately considering all possible interpretations of the premises and the conclusion, 2) Consideration of all possible combinations of meanings of the major and minor premises, and 3) Determining whether all possible meanings of the conclusion are consistent with all possible combinations of the premises.

Common Errors

* People correctly identify invalid conclusions about one-third of the time.
  + When the major premise contains a universal affirmative (all) statement and the minor premise is a particular affirmative (some) statement, people overwhelmingly regard a conclusion containing the word some as valid.
  + When the major and minor premises both are universal negative statements, people often accept a conclusion that contains the word no.

Cognitive Constraints

* The atmosphere hypothesis presumed that people do not attempt to evaluate the conclusion logically, but blindly accept the validity of the premise statements without careful consideration.

Working Memory

* + Working memory limitations may cause people to fail to consider all possible combinations of the premises.

Illicit Conversion

* + Illicit conversion occurs when people misinterpret the premises.

Meaning and Knowledge

* + Illicit conversion can be eliminated by stating the premises in meaningful ways.
  + Belief bias refers to people accepting any and all conclusions that happen to fit with their system of beliefs.

Conditional Reasoning

* Conditional reasoning involves deducing a valid conclusion from a rule in the form of “If P, then Q.”

Valid and Invalid Conditional Reasoning

* + The first valid form of conditional reasoning is known as modus ponens or affirming the antecedent.
  + The second valid form of conditional reasoning is known as modus tollens or denying the consequent.
  + Two invalid forms of conditional reasoning are denying the antecedent and affirming the consequent.

Common Errors

* People perform perfectly in applying modus ponens, or affirmation of the antecedent, but perform poorly with modus tollens, or denial of the consequent.

Cognitive Constraints

* Wason and Johnson-Laird (1972) used a four-card selection task to study how people evaluate conditional statements.
* The results showed that few participants solved the task by denying the consequent in the conditional rule.

Meaning and Knowledge

* People may misrepresent the Wason and Laird (1972) card task as a biconditional rule.
* Reasoning about a concrete, lifelike situation reduces these errors.

Confirmation Bias

* Confirmation bias is the tendency to seek and evaluate evidence that confirms rather than rejects our prior beliefs.
* Myside bias refers to the fact that people seek and evaluate evidence in a biased manner that confirms their own prior political, religious, ethical, and economic beliefs and attitudes.

Decision Making

* Expected utility theory assumes that people make decisions by assigning a utility to various outcomes, give weight to those utilities based on their probability of occurring, and then choose the course of action that yields the largest sum.

Subjective Utility

* + Expected utility theory does not capture the way people make decisions under risk and uncertainty.
  + Kahneman and Tversky (1984) found that people are risk aversive because subjective utility drops faster with losses than it rises with gains in money.
  + Subjective utility shows a curvilinear relation to losses and gains. It is convex in the region of losses and concave in the region of gains.
  + The framing effect refers to making a different decision depending on where people perceive themselves to be in relation to the curvilinear subjective utility function.

Heuristics for Decision Making

* When making judgments under uncertainty, people rely on a limited number of heuristics which sometimes lead to reasonable judgments and sometimes lead to systematic errors.

Representativeness

* + When using the representativeness heuristic, people assign a high probability of occurrence to events that are representative or typical of a class.
  + The law of small numbers, also known as the gambler’s fallacy, is when people expect small samples to appear random and mirror the probabilities obtained with large samples.

Availability

* The availability heuristic suggests that if relevant samples can readily be retrieved from memory, then the class of events must occur with a high probability.
* Hindsight bias refers to the fact that people confidently judge that they knew an event would occur after it occurs.

Fast and Frugal Heuristics

* A fast and frugal heuristic is a cognitive process that searches for minimal information and consists of building blocks that exploit evolved abilities and structures in the environment.

Analogies

* An analogy heuristic looks for similarities between a current problem and one solved in the past.

Means-End Analysis

* Means-end analysis refers to comparing one’s current state to the goal state and then finding a means or an operator to reduce the difference.

Emotion and Thinking

* The rapidly emerging field of neuroeconomics recognizes that human decision making involves an interaction of deliberative thought processes and affective processes.

Somatic Marker Hypothesis

* The somatic marker hypothesis suggests that people experience bodily, visceral feelings that guide their decisions based on the anticipated pain or pleasure of the outcomes.
* Somatic markers are stored in a region of the orbitofrontal cortex just above the eyes, plus the adjacent ventromedial prefrontal cortex.
* The role played by somatic markers on emotional decision making has been studied using the Iowa Gambling Task.

Moral Decision Making

* Moral decision making is the study of how people make decisions with ethical implications and requires theory of mind capabilities.
* Moral decision making recruits brain regions in the default network and the ventral regions of the prefrontal cortex that are important in social emotions.

The Teenage Brain

* + - Poor decision making among adolescents may arise from impulsivity due to an immature brain network for governing self-regulation.
    - The cognitive control network of the brain involves the dorsolateral prefrontal cortex, the anterior cingulate, and posterior regions of the brain in the parietal cortex.
    - Research on adolescent decision making has important implications for establishing the age at which adult legal rights are granted.

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**Key Terms**

syllogistic reasoning

valid deductive conclusion

atmosphere hypothesis

illicit conversion

belief bias

affirming the antecedent

denying the consequent

denying the antecedent

affirming the consequent

confirmation bias

decisions under risk

decisions under uncertainty

framing effect

representativeness heuristic

law of small numbers

gambler’s fallacy

availability heuristic

hindsight bias

fast and frugal heuristic

somatic marker hypothesis

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**Discussion Questions**

Discussion Question #1

How are reasoning and decision making distinct processes? How are they similar?

Discussion Question #2

Many mental illnesses are first identified during adolescence when the prefrontal cortex is still maturing and the socioemotional network of the brain is strongly active due to hormonal increases. How do the features of the adolescent brain make them more vulnerable to the effects of mental illness?

Discussion Question #3

Provide an example of a recent moral decision that was made based on reports in the world news and evaluate the quality of this decision. Do you think a good or bad decision was made? Why?

Discussion Question #4

Explain how neuroeconomics affects one’s decision to purchase a car as well as the car salesperson’s decision to sell it. Is it possible for the final outcome to satisfy both the buyer and the seller?

Discussion Question #5

List three examples of personal beliefs that you would have a difficult time changing. For each of these examples, identify the reasons you hold strongly to these beliefs and what evidence you would consider appropriate to change these beliefs. How do you think possessing these beliefs has affected your thinking?

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**Questions for Thought**

Consider the conditional rule: “If I study hard, then I will do well on the final exam.” How would you confirm this rule as valid using the form of reasoning known as denial of the consequent? Why would it not be helpful in testing the rule to see what happens if you do not study hard?

Can you think of cases in which you used the heuristics of representativeness and availability? What about fast and frugal heuristics?

Give an example of when you used your “gut instincts” or felt emotion to make an important decision. Describe your decision-making process in this instance in terms of the somatic marker hypothesis.

Cognitive neuroscience has demonstrated that the adolescent brain is not fully mature, particularly in the prefrontal regions known to be important in decision making. Do you think such evidence should be taken into account in judging the guilt of a 16-year-old in a criminal trial? How should such evidence be taken into account in formulating public policy?

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**Web Resources**

[**Representiveness Heuristic**](http://cat.xula.edu/thinker/decisions/heuristics/)

Click on the link for the Representativeness Heuristic to participate in an interactive demonstration.

[**Availability Heuristic**](http://cat.xula.edu/thinker/decisions/heuristics/)

Click on the link for the Availability Heuristic to participate in an interactive demonstration.

[**Gambler’s Fallacy**](http://cat.xula.edu/thinker/decisions/heuristics/)

Click on the link for the Gambler’s Fallacy to participate in an interactive demonstration.

[**Cognitive Psychology**](http://www.it.uu.se/edu/course/homepage/hcinet/ht06/lectures/lecture5)

On the main page scroll down to *Test 1: Confirmation Bias* and follow the instructions for the card task.

[**Iowa Gambling Task Demo**](http://www.millisecond.com/download/library/v3/IowaGamblingTask/IowaGamblingTask.web)

An interactive demonstration of the Iowa Gambling Task.

[**The Wason Selection Task**](http://www.philosophyexperiments.com/wason/)

An interactive demonstration of the Wason Selection Task.

[**Thinking & Decision Making**](http://www2.fairmontstate.edu/users/ffidura/cogpsy/cpthnkng.html)

Scroll to the bottom of the page and click on the demonstrations of the framing effect.

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**SAGE Journal Articles**

Steginga, S.K. & Occhipinti, S. (2004). [The application of the heuristic-systematic model to treatment decision making about prostate cancer.](http://mdm.sagepub.com/cgi/reprint/24/6/573?ijkey=4dzf7fN1OaBrE&keytype=ref&siteid=spmdm) Medical Decision Making, 24, 573-583.

1. In their article, the authors discuss two modes by which individuals can arrive at a decision: heuristic processing and systematic processing. How do these modes of processing differ?

2. How do the authors define the “expert opinion heuristic?” According to the authors, in what situations are men diagnosed with prostate cancer more likely to rely on the expert opinion heuristic?

3. In the conclusion of their article, the authors point out that their model incorporated elements of the availability heuristic. What are some of the differences between the authors’ expert opinion heuristic and the availability heuristic?

4. People often seek second opinions from medical doctors concerning their conditions. What are some of the factors that prompt people to seek a second opinion? What are some other situations where a second opinion is sought?

Fellows, L.K. (2004). [The cognitive neuroscience of human decision making: A review and conceptual framework.](http://bcn.sagepub.com/cgi/reprint/3/3/159?ijkey=FXfpxBszsbxCI&keytype=ref&siteid=spbcn) Behavioral and Cognitive Neuroscience Reviews, 3, 159-172.

1. Fellows’ review article introduces readers to a task used to study decision making known as the Iowa gambler’s task (IGT). The IGT is designed to examine the relationship between risk, reward, and punishment in human decision making. What is the procedure for the IGT?

2. Contrast the IGT performance of normal individuals without brain damage to those with ventromedial frontal lobe (VMF) damage. According to the article, why do the VMF patients perform differently than the normal participants?

3. Fellows introduces a three-stage model of the components of human decision making. Describe the three components of this model and indicate the brain areas that are most strongly associated with each of these components?

4. Use Fellows’ three-stage model to contrast the differences in decision making for impulsive and non-impulsive individuals.

Carli, L.L. (1999). [Cognitive reconstruction, hindsight, and reactions to victims and perpetrators.](http://psp.sagepub.com/cgi/reprint/25/8/966?ijkey=c8L.VIQsByLyI&keytype=ref&siteid=sppsp) Personality and Social Psychology Bulletin, 25, 966-979.

1. According to the author, how are memory reconstruction processes and hindsight bias similar?

2. The author discusses how hindsight bias leads observers to derogate victims. What are some of the factors the author mentions for why hindsight bias would lead to victim derogation? What are the implications for the role of hindsight bias in jury decisions?

3. Based on the results of the author’s research linking memory reconstruction and hindsight bias, what steps can be taken to minimize the role of these factors in real-life decisions?

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**Recommended Readings**

Gigerenzer, G., et al. (1999). *Simple heuristics that make us smart*. New York: Oxford University Press.

Haidt, J. (2008). Morality. *Perspectives on Psychological Science, 3*, 65–72.

Hastie, R. (2001). Problems of judgment and decision making. *Annual Review of Psychology, 52,* 653-683.

Loewenstein, G. F., Rick, S., & Cohen, J. D. (2008). Neuroeconomics. *Annual Review of Psychology, 59*, 647–672.

Markman, A. B., & Gentner, D. (2001). Thinking. *Annual Review of Psychology, 52,* 223-247.

Shafir, E., & LeBoeuf, R. A. (2002). Rationality. *Annual Review of Psychology, 53,* 491-517.

Stanovich, K. E.(1999). *Who is rational? Studies of individual differences in reasoning*.

Mahwah, NJ: Erlbaum.