Chapter 1

The Psychology of Human Thought: Introduction

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The **psychology of human thought** deals with how people mentally represent and process complex information. For example, if you imagine an object rotating in space, you might represent the rotating object as an image of the object, or as a series of propositions that specify the characteristics of the object and its successive positions in space. A psychological scientist who studies human thought might investigate how people solve complex problems, or make decisions, or learn language, or use reasoning to decide whether the claims of a politician are true. Why do people find it easier to reason when the content of what they are reasoning about is familiar than unfamiliar, but why, at the same time, are they more likely to make an error in reasoning when the content is familiar? Why are people more afraid to travel in airplanes than in cars, even though, statistically, riding in a car is far more dangerous than riding in an airplane? Why do people view a robin or a bluebird as more "like a bird" than an ostrich or a penguin, even though all are birds? These are the kinds of questions that psychological scientists address when they study the psychology of human thought.

1.1 Goals of Research

Research in the psychology of human thought takes many forms, but it generally follows a particular form. We will illustrate this form with regard to the purchase of a new bicycle.

Suppose you are trying to figure out how people decide on a brand of bicycle (or anything else!) they would like to buy. How do they think about this problem? As a psychological scientist, you might start thinking about the issue by informally considering some of the ways in which people might make such a decision (see, e.g., Gigerenzer, 2015; Kahneman, 2013; Reyna, Chapman, Dougherty, & Confrey, 2011). Here are some strategies that a potential bicycle-buyer might use:

1. Weigh all the features of each bicycle (e.g., price, appearance, sturdiness, reputation, ease of use of gears, etc.) and decide which bicycle does best, considering all of those features.

2. Decide what features of a bicycle are most important to you—ignoring the rest—and decide on the basis of those features.

3. Decide what single feature of a bicycle is most important to you, and decide on the basis of that feature.

Of course, there are other possibilities, but suppose, for the purposes of this chapter, you consider just these three possibilities. You might then create a **theory**—an organized body of general explanatory principles regarding a phenomenon. For example, your theory might be that, in the end, people

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avoid complication and make their decisions only on the basis of the most important factor in a decision (see Gigerenzer, 2015). Then you might propose an **hypothesis**—a tentative proposal of expected empirical consequences of the theory, such as of the outcome of research. So here, your hypothesis is that if you offer people a series of bicycles, and know their preferences regarding aspects of a bicycle, their decision as to which one to buy will depend only on the single feature that is most important to them. Now you might design an **experiment**—a set of procedures to test your hypothesis (or hypotheses). In the experiment, you might ask people about the features that matter to them, how important each feature is, and then, which of several bicycles they would choose, assuming they had a choice. You then would do **data analysis**—statistically investigating your data to determine whether they support your hypothesis. You then could draw at least tentative conclusions as to whether your theory was correct.

One thing to remember is that many scientists believe, following Karl Popper (2002), that you only can falsify ideas through experiments, not conclusively prove them. That is, even if the results of an experiment are consistent with your theory, it does not mean that all possible experiments testing the theory would be consistent with the theory. More likely, some would be consistent but others would not be. However, if the results are not consistent with the theory, then perhaps you would want to move on to a new theory; or alternatively, you would want to see whether the theory is true only under limited sets of circumstances.

1.2 Underlying Themes in the Study of Human Thought

Theories and research in the study of human thought tend to recycle through a set of underlying themes. What are some of the main themes that arise again and again in the study of higher cognition, such as in the exploration of human thought? To understand the psychology of human thought, you need to understand how these themes recur, over and over again (see Table 1.1). In the text and table, we refer to the two aspects of the themes as potentially complementary rather than contradictory. For example, almost all behavior will result from an interaction of genetic and environmental factors, rather than resulting solely from one or the other. For consistency, we will show how seven themes arise in a single area of research, human intelligence.

1.2.1 Nature and Nurture

One major issue in the study of human thought is the respective influences on human cognition of nature, on the one hand, and nurture, on the other. Scientists who believe that innate characteristics of human cognition, those due to *nature*, are more important may focus their research on innate characteristics; those who believe in the greater importance of the environment, attributes due to nurture, may choose to focus on acquired characteristics.

Perhaps nowhere has this issue played out more than in the study of human intelligence (see, e.g., Sternberg & Grigorenko, 1997). Intelligence researchers have argued for many years regarding the respective roles of genes and environment in intelligence, and two researchers with opposing points of view even wrote a book about their opposing stances (Eysenck & Kamin, 1981). At the time of their book, hereditarian and environmental viewpoints were viewed as in opposition to each other.

Today, scientists recognize that the picture is more complex than it appeared to be at that time. Most likely, genetic effects are not due to some "intelligence gene", but rather due to many genes, each having very small effects (Tan & Grigorenko, in press). The genes that have been identified so far as possibly contributing to intelligence are of small effect and their effects are sometimes difficult to replicate. It appears that environment plays an important role, often in conjunction with genes (Flynn, 2016). Some effects may *epigenetic*, meaning that aspects of the environment may turn certain genes "on" and "off", either resulting in their commencing or ceasing, respectively, to affect development.

1.2.2 Rationalism and Empiricism

Rationalist investigators tend to believe that one can learn a lot about human behavior through reflec-

Table 1.1: Major Themes in the Study of Human Thought.

Number	One Emphasis	Other Emphasis
1	Nature	Nurture
2	Rationalism	Empiricism
3	Structures	Processes
4	Domain Generality	Domain Specificity
5	Validity of Causal Inferences	Ecological Validity
6	Basic Research	Applied Research
7	Biological Methods	Behavioral Methods

tion and self-introspection. *Empiricist* investigators believe in the necessity of data collection. The rationalist tradition dates back to the Greek philosopher Plato, whose ideas are discussed further in Chapter 2,"History of the Field of the Psychology of Human Thought".

In *The Theaetetus*, one of the Platonic dialogues, *Theaetetus* imagines that there exists in the mind of man a block of wax, which is of different sizes in different men. The blocks of wax can also differ in hardness, moistness, and purity. Socrates, a famous Greek philosopher, suggests that when the wax is pure and clear and sufficiently deep, the mind will easily learn and retain and will not be subject to confusion. It only will think things that are true, and because the impressions in the wax are clear, they will be quickly distributed into their proper places on the block of wax. But when the wax is muddy or impure or very soft or very hard, there will be defects of the intellect (*Great Books of the Western World*, 1987, 7, 540).

Plato's view of intelligence in terms of a metaphorical ball of wax is the product of a rationalist approach: Obviously, he did not do any kind of formal experimentation to derive or test this point of view. Aristotle, another early Greek philosopher, in contrast, took a more empirical approach to understanding intelligence:

In the *Posterior Analytics Book I*, Aristotle conceived of intelligence in terms of "quick wit":

> Quick wit is a faculty of hitting upon the middle term instantaneously. It would be exemplified by a man who saw that the moon has a bright side always turned towards the sun, and quickly grasped the cause of this, namely that she borrows her light from him; or observes somebody in conversation with a man of wealth and defined that he was borrowing money, or that the friendship of these people sprang from a common enmity. In all these instances he has seen the major and minor terms and then grasped the causes, the middle terms. (*Hutchins: Great Books of the Western World*, 1952, Vol. 8, p. 122).

Although in Aristotle's times, no one did formal experiments, notice that Aristotle gives a genuine real-world example, presumably derived from his past experiences, whereas Plato's discussion in *The Theaetetus* was obviously hypothetically derived (or contrived).

Today, psychological scientists studying intelligence use an empirical approach. But rationalism still plays an important part. Many theories, when originally posed, are derived largely from the thinking processes of scientists. After the theories are proposed, they then are tested empirically, usually on human subjects, but sometimes by computer simulations or by other means. In the modern-day study of human thought, both rationalism and empiricism have a place.

1.2.3 Structures and Processes

Structures here refer to the contents, attributes, and relations between parts of the human mind. *Pro-*

cesses refer to the actual operations of the human mind. Much of early research on human intelligence was structural. Theorists of intelligence argued, and to some extent, still argue about structural models of intelligence. For example, Charles Spearman (1927) believed that human intelligence can be characterized structurally by one general factor of the mind permeating our performance on all cognitive tasks, and then specific factors particular to each cognitive task. Louis Thurstone (1938) believed that there are seven primary mental abilities: verbal comprehension, verbal fluency, number, spatial visualization, inductive reasoning, perceptual speed, and memory. Today, theorists of intelligence still disagree, to some extent, about these structures. Two prominent models are the CHC (Cattell-Horn-Carroll) model (McGrew, 2005), which argues that there is a general factor of intelligence at the top of a hierarchy of abilities, and two strata below it, including fluid abilities (ability to deal with novel stimuli) and crystallized ability (world knowledge); and the Johnson-Bouchard (2005) g-VPR model, arguing instead that the three main abilities beneath general intelligence are verbal, perceptual, and image rotation. So even today, there are disagreements today about the structure of intellectual abilities and the resolution of these disagreements is an active area of research.

Many of the issues today, however, revolve around process issues. Are there basic processes of intelligence, and if so, what are they?

In the latter part of the twentieth century, Earl Hunt (e.g., Hunt, 1980) proposed what he called a *cognitive correlates* approach to studying the relationship between intelligence and cognition—one would study typical cognitive tasks, such as the time an individual takes in naming a letter, and then look at the correlation between that time and scores on psychometric tests. In this way, Hunt thought, one could understand the basic cognitive building blocks of intelligence.

Sternberg later proposed an alternative *cognitive components* approach (Sternberg, 1983, 1985), whereby intelligence could be understood in terms of components not of simple tasks, like identifying whether two letters are the same as each other, but rather more complex tasks similar to those that appear on intelligence tests, such as analogies or syllogistic reasoning.

Today, many of the discussions regarding processes underlying intelligence concern working memory (Conway & Kovacs, 2013; Ellingsen & Engle, in press; Kane et al., 2004). Working memory appears to play an important part in processes of intelligence, and is highly related to fluid intelligence (discussed above). Originally, it appeared that working memory is a, or perhaps the crucial component of fluid intelligence (Kyllonen & Chrystal, 1990). But in their recent work, Engle and his colleagues have argued that working memory and fluid intelligence may in fact work separately but in conjunction—with working memory helping us remember what we need to remember but fluid intelligence helping us forget what we need to forget (Ellingsen & Engle, in press).

By the way, one of the first information-processing accounts of intelligence was offered by the same scholar who offered the theory of general intelligence (Spearman, 1923). Charles Spearman certainly was one of the most versatile as well as brilliant psychologists of the early twentieth century!

1.2.4 Domain-Generality versus Domain-Specificity

The concept of *domain-generality* refers to the notion that a cognitive skill or set of skills might apply across a wide variety of domains. The concept of *domain-specificity* refers to the notion that a cognitive skills or set of skills might apply only in a specific domain, or at most, a small set of domains. Of course, there is no uniformly agreed upon definition of what constitutes a "domain." Is verbal processing a single domain, or are reading, writing, speaking, and listening separate domains?

Spearman (1927) suggested that the aspect of intelligence that we know best, general intelligence or what he called "*g*", is what matters most to people's ability to adapt to the environment. In extreme contrast, Howard Gardner (2011) has suggested that intelligence is highly domain-specific, indeed, that there are eight distinct and independent "intelligences"—linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, naturalist, interpersonal, and intrapersonal. He believes that any general intelligence is merely an artifact of the independent intelligences being used in conjunction in a multitude of tasks.

An intermediate information-processing perspective is taken by Sternberg (2011), who has argued that the basic information-processing components of intelligence are the same in all tasks—for example, recognizing the existence of a problem, defining the problem, mentally representing the problem, formulating a strategy to solve the problem—but that how well these processes are performed depends on the domain. That is, how well one can execute a given process depends on the domain in which the process is exercised.

1.2.5 Validity of Causal Inferences and Ecological Validity

The advantage of laboratory-based research with carefully controlled experimental conditions is that they promote *validity of causal inferences*, that is, the extent to which scientists can establish causal bases for scientifically observed phenomena. Because scientists in the laboratory often can carefully control independent as well as confounding variables (i.e., variables that are not relevant to an experiment but that might affect the results, clouding conclusions to be drawn), the scientists can ensure, to the extent possible, that experimental effects are due to the variables they are supposed to be due to. But the potential disadvantage of laboratory experiments is that the conditions of testing may be rather remote from the conditions observed in everyday life. One of the most famous scientists to point this out was Ulric Neisser (1976), who argued that many of the results obtained in the laboratory do not apply well to real-world phenomena. *Ecological validity* refers to the generalizability of conclusions to the everyday contexts in which behavior of interest occurs.

Most formal research on intelligence is done in laboratories. The results tell us, for example, that most cognitive tasks tend to correlate positively with each other, meaning that if a person does well on one of them, he or she also will tend to do well on others. But Sternberg et al. (2001) found that, under circumstances, an important adaptive cognitive task (procedural knowledge among rural Kenyan children of natural herbal medicines used to combat parasitic illnesses) correlated negatively with some of the cognitive tasks used in laboratories and classrooms to measure general intelligence. The point of the research was not that, in general, general intelligence correlates negatively with adaptive procedural knowledge (i.e., knowledge of how accomplish tasks in real-world environments). Rather, the point was that the correlation depends on the circumstances—that we may be too quick to draw general conclusions from experimental contexts that are somewhat limited. Because the Sternberg et al. (2001) study was a field experiment conducted under challenging circumstances in rural Kenya, it would be difficult if not impossible to draw causal conclusions from the research. But the research might have a certain kind of ecological validity lacking in the more "sterile" environment of the psychologist's laboratory or even a carefully controlled classroom administration of a standardized test.

1.2.6 Basic Research and Applied Research

Basic research attempts to understand fundamental scientific questions, often by testing hypotheses derived from theories. It does not concern itself with how the research is used. *Applied research,* in contrast, seeks to apply scientific knowledge to problems in the world, often with the goal of solving those problems to make the world a better or at least a different place.

Human intelligence is an area that historically has had a lively mix of basic and applied research, not always with the most admirable of outcomes. The research that has yielded some of the theories of intelligence described above, such as *g* theory or the CHC theory, is basic. Applied research has often been in the form of research on intelligence testing, research following in the tradition of Alfred Binet and Theodore Simon (Binet & Simon, 1916), researchers who invented the first "modern" intelligence test. The legacy of this research is mixed. On the one hand, Binet was hopeful that his work on intelligence could be used to create a kind of "mental orthopedics" that would help those who performed at lower intellectual levels to improve their performance. On the other hand, much of the applied research in the early years of the twentieth century was at least in part pejorative, seeking to demonstrate that people of some socially defined races or ethnicities were inherently more intelligent than others (see Fancher, 1987; Gould, 1981; for reviews), usually according with some prior hypothesis about the superiority of the "white race" over other groups.

That said, there has also been applied research attempting to show that intelligence is at least, in some measure, modifiable in a positive way. For example, Feuerstein (1980) presented a program called *Instrumental Enrichment* that his data suggested could help improve the intelligence of those who were intellectually challenged by the kinds of tasks found on standardized intelligence tests. Sternberg, Kaufman, and Grigorenko (2008) presented a program, based on research originally done in Venezuela, for helping people improve their intelligence. Jaeggi et al. (2008) showed that at least some aspects of fluid intelligence might be susceptible to positive modification.

These various efforts show that applied research can serve either more or less positive purposes. Applied research is a useful way of putting science into practice, but it can either create electric bulbs that light up the world, or nuclear weapons that potentially can destroy that same world.

1.2.7 Biological and Behavioral Methods

There are many methods through which psychological scientists can investigate the psychology of human thought. Two classes of methods are *biological*, which involves studies of the brain and central nervous system, using methods such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) to study the brain; and *behavioral*, which typically presents people with problems or questions for them to address. We have discussed behavioral research throughout the chapter. What does biologically-based research look like?

Some of the earliest biological research emphasized the analysis of hemispheric specialization in the brain. This work goes back to a finding of an obscure country doctor in France, Marc Dax, who in 1836 presented a little-noticed paper to a medical society meeting in Montpelier. Dax had treated a number of patients suffering from loss of speech as a result of brain damage. The condition, known today as aphasia, had been reported even in ancient Greece. Dax noticed that in all of more than 40 patients with aphasia, there had been damage to the left hemisphere of the brain but not the right hemisphere. His results suggested that speech and perhaps verbal intellectual functioning originated in the left hemisphere of the brain.

Perhaps the most well-known figure in the study of hemispheric specialization was Paul Broca. At a meeting of the French Society of Anthropology, Broca claimed that a patient of his who was suffering a loss of speech was shown postmortem to have a lesion in the left frontal lobe of the brain. At the time, no one paid much attention. But Broca soon became associated with a hot controversy over whether functions, particular speech, are indeed localized in the brain. The area that Broca identified as involved in speech is today referred to as Broca's area. By 1864, Broca was convinced that the left hemisphere is critical for speech. Carl Wernicke, a German neurologist of the late nineteenth century, identified language-deficient patients who could speak but whose speech made no sense. He also traced language ability to the left hemisphere, though to a different precise location, which now is known as Wernicke's area.

Nobel Prize-winning physiologist and psychologist Roger Sperry (1961) later came to suggest that the two hemispheres behave in many respects like separate brains, with the left hemisphere more localized for analytical and verbal processing and the right hemisphere more localized for holistic and imaginal processing. Today it is known that this view was an oversimplification and that the two hemispheres of the brain largely work together (Gazzaniga, Ivry, & Mangun, 2013).

More recently, using positron emission tomography (PET), Richard Haier discovered that people who perform better on conventional tests of intelligence often show less activation in relevant portions of the brain than do those who do not perform as well (Haier et al., 1992). Presumably, this pattern of results reflects the fact that the better performers find the tasks to be easier and, thus, invoke less effort than do the poorer performers. P-FIT (parieto-frontal integration) theory, proposed by Rex Jung and Richard Haier (2007), proposes that general intelligence is associated with communication efficiency between the dorsolateral prefrontal cortex, the parietal lobe, the anterior cingulate cortex, and specific temporal and parietal cortex regions.

Again, it is important to emphasize that biological and behavioral methods are not opposed to each other. In Haier's research, as in most contemporary biologically-based research, participants perform some kind of cognitive task and their behavior is recorded. What is different is that, while they perform the task, biological measurements are made, for example, by an fMRI machine in which the participants are embedded. So even biological research and behavioral research can combine in powerful ways to yield insights about human cognition.

1.3 Seven Themes Applied to Problem Solving

We believe that the seven themes are universal issues within a psychology of human thought. We have presented these themes in the context of intelligence but to illustrate the usefulness of these distinctions in another exemplary domain, we choose the field of problem solving (see Chapter 9, "Problem Solving", for more details). We will go through the seven dichotomies and see if they are useful in that domain too.

(1) *Nature – nurture*. This distinction plays not so important a role as it does in the context of intelligence. One reason could be that there are no controlled twin studies comparing problem solving. The dependent variable of interest was always intelligence, not problem solving. Therefore, a lack of research data forestalls conclusions.

(2) *Rationalism – empirism*. As has been said before, rationalists see an advantage in the use of theories, empirists rely more on data. In problem solving research, we need both: a strong theory that makes predictions about behavior, and good experiments that deliver reliable data.

(3) *Structures – processes*. Problem solving is *per definitionem* more relevant to processes than to structures but in fact, most studies using problem solving measures (like those used for the worldwide PISA problem solving assessment of 15-year old students; see Csapó & Funke, 2017) rely on performance evaluation in terms of solution quality. There are not many indicators for processes. With the advent of computer-based assessments of problem solving, log-file analyses have become new data sources for process evaluation (Ramalingam & Adams, 2018).

(4) *Domain-generality – domain-specificity*. This is an important distinction in problem solving research. Heuristics (rules of thumb) are differentiated with respect to their generality: there are general-purpose strategies like means-ends analysis (i.e., considering the obstacles that prevent the direct transformation from an initial problem state to the goal state; formulating subgoals to overcome the obstacles) and there exist domain-specific solution strategies, like finding a bug in a software program that can be used only under certain circumstances.

(5) *Lab studies – ecological validity*. There is a group of researchers in the field (see Lipshitz, Klein, Orasanu, & Salas, 2001; summarizing: Klein, 2008) that uses the label of "naturalistic decision making" (NDM). They claim that NDM relies on (1) the importance of time pressure, uncertainty, ill-defined goals, high personal stakes, and other complexities that characterize decision making in real-world settings; (2) the importance of studying people who have some degree of expertise; (3) the importance of how people size up situations compared to the way they select between courses of action. They criticize lab studies for their missing ecological validity. As it turned out recently, the differences between the two sides seem to be less than thought (Kahneman & Klein, 2009).

(6) *Basic research – applied research*. Most of the current research in problem solving is focused on basic issues. But the field for applications is wide open. Especially with complex problem solving (i.e.,

complicated ill-defined problems), political and economic problems come into the research focus. For example, Dörner and Güss (2011) did an analysis of Adolf Hitler's decision making style and identified a specific strategy of the dictator for solving political problems.

(7) *Biological methods – behavioral methods*. Recently, there have been some studies conducted with fMRI methods (Anderson, Albert, & Fincham, 2005; Anderson et al., 2008). But the use of biological methods is still lacking in large portions of the research arena of problem solving. One reason for this lack of research is the complexity of higher cognitive processes.

Summarizing, we can say that the application of the seven themes to the field of problem solving research does work. The themes can be found here, too. It is likely that these topics will be found throughout the chapters of our book, some of them more clearly, others of them less so.

1.4 Conclusion

Human thought is a fertile field for investigation. Almost all the problems we solve and decisions we make depend on human thought. We have argued that seven themes pervade much of research on human thought. We have used human intelligence and problem solving as examples of how these themes are pervasive.

There is no one "best" method for studying human thought. Rather, one wants to use a variety of *converging operations* (Garner, Hake, & Eriksen, 1956)—different methods that converge upon the same substantive results—to understand human thought. This book will show you the astonishing number of different ways converging operations have been used to help us all learn how we think and use that thought to adapt to and shape the world in which we live.

Summary

This chapter introduces the psychology of human thought. It opens by considering what the field encompasses, and at a general level, how investigations of human thought proceed—through theories generating hypotheses leading to experiments for which data can be analyzed. The chapter then considers seven themes that pervade research in the psychology of human thought, giving as an example, research on human intelligence, where all seven themes have permeated research ever since the field began. The seven themes are nature and nurture, rationalism and empiricism, structures and processes, domain generality and domain specificity, validity of causal inferences and ecological validity, basic and applied research, and biological and behavioral methods. The chapter concludes that the psychology of human thought is best investigated through a melding of *converging operations*, that is, by multiple kinds of methods that one hopes will yield mutually confirming results.

Review Questions

1. Why is there no single "best" method for studying human thought?
2. Can you explain some of the major underlying themes for studying human thought?
3. How are human intelligence and human problem solving related?

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Glossary

data analysis Statistically investigating your data to determine whether they support your hypothesis. 4

experiment A set of procedures to test your hypothesis (or hypotheses). 4

hypothesis A tentative proposal of expected empirical consequences of a theory, such as of the outcome of research. 4

psychology of human thought Deals with how people mentally represent and process complex information. 3

theory An organized body of general explanatory principles regarding a phenomenon. 3