

# Methods of Cognitive Psychology

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Cognitive Psychology has unifying theoretical ideas, but we have to appreciate the diversity of outlooks and methods that researchers in different fields bring to the study of mind and intelligence. Although cognitive psychologists today often engage in theorizing and computational modeling, their primary method is experimentation with human participants. People, usually undergraduates satisfying course requirements, are brought into the laboratory so that different kinds of thinking can be studied under controlled conditions. For example, psychologists have experimentally examined the kinds of mistakes people make in deductive reasoning, the ways that people form and apply concepts, the speed of people thinking with mental images, and the performance of people solving problems using analogies. Our conclusions about how the mind works must be based on more than "common sense" and introspection, since these can give a misleading picture of mental operations, many of which are not consciously accessible. Psychological experiments that carefully approach mental operations from diverse directions are therefore crucial for Cognitive Psychology to be scientific.

Although theory without experiment is empty, experiment without theory is blind. To address the crucial questions about the nature of mind, the psychological experiments need to be interpretable within a theoretical framework that postulates mental representations and procedures. One of the best ways of developing theoretical frameworks is by forming and testing computational models intended to be analogous to mental operations. To complement psychological experiments on deductive reasoning, concept formation, mental imagery, and analogical problem solving, researchers have developed computational models that simulate aspects of human performance. Designing, building, and experimenting with computational models is the central method of artificial intelligence (AI), the branch of computer science concerned with intelligent systems. Ideally in Cognitive Psychology, computational models and psychological experimentation go hand in hand, but much important work in AI has examined the power of different approaches to knowledge representation in relative isolation from experimental psychology.

While some linguists do psychological experiments or develop computational models, most currently use different methods. For linguists in the Chomskian tradition, the main theoretical task is to identify grammatical principles that provide the basic structure of human languages. Identification takes place by noticing subtle differences between grammatical and ungrammatical utterances. In English, for example, the sentences "She hit the ball" and "What do you like?" are grammatical, but "She the hit ball" and "What does you like?" are not. A grammar of English will explain why the former are acceptable but not the latter.

Like cognitive psychologists, neuroscientists often perform controlled experiments, but their observations are very different, since neuroscientists are concerned directly with the nature of the brain. With nonhuman subjects, researchers can insert electrodes and record the firing of individual neurons. With humans for whom this technique would be too invasive, it has become possible in recent years to use magnetic and positron scanning devices to observe what is happening in

different parts of the brain while people are doing various mental tasks. For example, brain scans have identified the regions of the brain involved in mental imagery and word interpretation. Additional evidence about brain functioning is gathered by observing the performance of people whose brains have been damaged in identifiable ways. A stroke, for example, in a part of the brain dedicated to language can produce deficits such as the inability to utter sentences. Like Cognitive Psychology, neuroscience is often theoretical as well as experimental, and theory development is frequently aided by developing computational models of the behavior of groups of neurons.

Cognitive anthropology expands the examination of human thinking to consider how thought works in different cultural settings. The study of mind should obviously not be restricted to how English speakers think but should consider possible differences in modes of thinking across cultures. Cognitive Psychology is becoming increasingly aware of the need to view the operations of mind in particular physical and social environments. For cultural anthropologists, the main method is ethnography, which requires living and interacting with members of a culture to a sufficient extent that their social and cognitive systems become apparent. Cognitive anthropologists have investigated, for example, the similarities and differences across cultures in words for colors.

With a few exceptions, philosophers generally do not perform systematic empirical observations or construct computational models. But philosophy remains important to Cognitive Psychology because it deals with fundamental issues that underlie the experimental and computational approach to mind. Abstract questions such as the nature of representation and computation need not be addressed in the everyday practice of psychology or artificial intelligence, but they inevitably arise when researchers think deeply about what they are doing. Philosophy also deals with general questions such as the relation of mind and body and with methodological questions such as the nature of explanations found in Cognitive Psychology. In addition, philosophy concerns itself with normative questions about how people should think as well as with descriptive ones about how they do. In addition to the theoretical goal of understanding human thinking, Cognitive Psychology can have the practical goal of improving it, which requires normative reflection on what we want thinking to be. Philosophy of mind does not have a distinct method, but should share with the best theoretical work in other fields a concern with empirical results.

In its weakest form, Cognitive Psychology is just the sum of the fields mentioned: psychology, artificial intelligence, linguistics, neuroscience, anthropology, and philosophy. Interdisciplinary work becomes much more interesting when there is theoretical and experimental convergence on conclusions about the nature of mind. For example, psychology and artificial intelligence can be combined through computational models of how people behave in experiments. The best way to grasp the complexity of human thinking is to use multiple methods, especially psychological and neurological experiments and computational models. Theoretically, the most fertile approach has been to understand the mind in terms of representation and computation.