

Definition of cognitive psychology

“The scientific study of the mind.”

1. Usually means normally functioning minds, studying normal minds directly, and/or through studying abnormal minds, and/or animal studies, and/or computer models.

e.g. **Warrington and Shallice** studied four brain damaged patients who were impaired when it came to recognising living things - a **category-specific impairment**. One patient, JBR, could only name 6% of living things when shown a picture, but 90%+ of non-living things. **Hillis and Caramazza** later produced similar research that shows some people have the opposite impairment.

Suggests that **in normal cognition**, categories of living and non-living things are either represented and/or processed differently. **Warrington and Shallice** suggest that living things are represented through **sensory properties vs non-living things represented by functional properties**. May help to explain why JBR showed impairments to food and musical instruments as well.

2. Can also be defined as referring to activities in areas like cognitive neuropsychology, cognitive neuroscience and perhaps even linguistics and artificial intelligence. There is no easily defined boundary between disciplines.

3. Cognitive psychology uses many different methods of investigation - e.g. experiments, models, neuropsychological investigations, brain scans.

e.g. **Devlin et al** used both experimental and neuroimaging methods to investigate category-specific impairments. Lexical decision task used (participants needs to decide if a combination of letters is a word or not.) Judgement and response time recorded. Semantic categorisation task also used - three words belonging to one category followed by a fourth - does

Chapter1 - Foundations of cognitive psychology

the fourth word fit the category or not. For both tasks, participants brain scanned using PET. A separate group performed the semantic categorisation tasks with pictures and fMRI brain scanning was used. Conclusion was that no differences between the active regions of the brain were found in either PET or fMRI scans - so casting doubt on the explanation offered by **Warrington and Shallice** when studying category-specific impairments in impaired participants.

Greer et al used a connectionist n/w that assumed living and non-living things were not represented in distinct ways, but that difference between living/non-living things occur because living things share properties that are strongly correlated - e.g. all mammals have eyes, breathe etc. Representations were distributed over the units of the n/w. “Lesioning” the n/w gave the result that shared properties of living things were more resistant to damage than those of non-living things.

Von Eckardt - Assumptions of the cognitive approach

1. Capacities can be partitioned and studied in isolation from one another (e.g memory vs language.)
2. Focus is on the individual and their environment - social /cultural aspects are de-emphasised.
3. Cognitive capacities are autonomous from non-cognitive ones - e.g. affect, motivation.
4. It is useful/meaningful to distinguish between normal and abnormal cognition.
5. It is possible to talk of a “typical” cogniser and generalise as adults are sufficiently alike to ignore any individual differences.
6. Answers to empirical questions can be given in terms of information processing.

7. Answers to empirical q’s should be justified on empirical grounds.

8. Neuroscience constrains answers to empirical questions.

History of Cognitive Psychology

Introspectionism - work of Donders, Fechner & Helmholtz led to **Wundt** establishing a lab in Leipzig in 1879. Study of **consciousness** was his focus - as observation of physical phenomena is mediated by conscious experience. **Introspection** used as a research method - in the belief properly trained individuals could use this in a similar way to other scientists making observations of the physical world. Experiments designed with adequate controls and replicable results. Focus on measures of performance such as reaction time and why these varied - explanations sought as to why one conscious experience led to a different reaction time to another. Was **not** concerned with the unconscious processing involved in responding to a single stimulus - considered these to be caused by physiological features rather than psychological ones.

Wurzberg school (**Kulpe**) - argued consciousness did not arise from the construction of ‘bottom up’ sensations like Leipzig school, instead contents of consciousness determined ‘top down’ from the particular task focus.

Despite introspectionism falling out of favour in first 20 years of C20, their elaborate classifications of conscious experience is now starting to attract the attention of C21 psychologists.

Gestalt psychology

Built on the work of the Wurzberg school. **Wertheimer** - pure movement can be perceived directly and does not have to be inferred from changes of an object’s position - e.g. wind through grass.

Perception of stimulus patterns to our conscious experience - e.g. a tune played on a piano remains the same if played on a guitar or in a different key. Therefore must be more to a tune than just the auditory sensations - it is perceived in the relationship between the notes - their patterning.

Functionalist psychology

James - similar in concept to evolutionary psychology - our ways of feeling/thinking are what they are because of their utility in shaping our reaction to the world. Functions of the mind, not the contents of consciousness, should be the focus of psychology.

Behaviourism

Watson - behind the movement of psychology out of the lab 'into the real world'. Interested in how people act and how they can be influenced. Psychological knowledge should be applied - e.g. education, advertising, health ... Psychology should therefore be scientific, objective and be publicly observable. Later behaviourists, e.g. **Skinner** sought to explain behaviour only through reference to stimuli. [However, there are many objective scientific disciplines, e.g. physics, that do reference the unobservable through necessity - e.g. you can't see gravity directly, but can observe and explain its effects.]

The decline of introspectionism meant behaviourist thinking was taken up enthusiastically - in the US but then more widely. Internal mental events (e.g. conscious experiences) either did not exist or *might* have existed (**Skinner** argues they were forms of covert behaviour) and should be avoided in a scientific psychology. Even complex phenomena were explained as learned responses - for example, the behaviourist view of language production was a chain of stimulus-response pairs - the next word being uttered in response to the preceding stimulus word.

Behaviourism did not offer accounts of higher mental processes - planning, problem solving, attention etc.

Return of the Cognitive

Lashley - 'The problem of serial order in behaviour' (Hixon symposium, 1948) illustrated the problems with behaviourist accounts of complex actions where one segment that was supposedly a stimulus for another segment was separated by many intervening segments. Language production is a good example of this - some words in a sequence depend on far earlier words so the simple view that each word acts as a stimulus for the following word cannot be correct.

Also, argued that many sequences are executed too quickly for feedback from one segment to act as a trigger for the next - e.g. piano playing, typists, tennis players.

View later (1957) reinforced by **Chomsky's** review of Skinner's book on verbal behaviour. Argued cannot be a set of learned responses as:

(a) Children acquire native language too effortlessly c.f. acquiring a language in adulthood

(b) If behaviourists correct, exposing children to ungrammatical and impoverished language environments should inhibit grammatical language production - but there is no evidence for this.

Chomsky proposed language as being rule-based - learning a language is about acquiring these rules, not by learning how to respond to particular stimuli. (a throwback to the idea of patterning in Gestalt psychology.)

Classical (Newtonian) explanations of physical phenomena are cast in terms of cause and effect - the action of gravity on an object causes it to fall to earth. So called purposive or teleological explanations (e.g. the stone falls 'in order to' reach its resting place) were out of favour - hence the move by behaviourists to explain psychology in terms of stimulus and response. However, more complex mechanical systems (e.g. heating) rely on feedback mechanisms -

Information about the (mis)match between a desired state and an existing state. The functioning of a heating system is not localised to any one component - but is a property of the whole system. Similarly, servomechanisms in anti-aircraft systems - **Weiner** - cybernetics.

Any function/behaviour can be analysed in terms of feedback loops from wholly non-conscious to fully conscious and intended behaviour. **Miller** - the concept of TOTE (Test-Operate-Test-Exit) units. i.e. If discrepancy, then operate, then test again, if eliminated, exit (otherwise execute TOTE again.)

Conceived as an advance on the conditioned reflex of **Pavlov** or the condition response of **Watson/Skinner** - both of which can be thought of as TOTEs. Allows the possibility of purposive behaviour and unobservable goals while providing a link to the scientific rigour of behaviourist approaches.

N.B. - TOTEs can be nested in hierarchies - e.g. "start the car" nested in "drive to the shops" nested in "buy a present": allows the conceptualisation of how behaviour can be completely structured. Similar to the concept of a "flow of control" in a computer program.

Computers and the mind

Turing machines - 1936 (an abstract specification for a machine that could compute and computable function) eventually realised in stored program computers (e.g. Pilot ACE, Manchester Mk I).

Turing test - a machine could be said to be intelligent and therefore think if it was indistinguishable in its responses from that of a human to a series of questions.

Cognitive psychology inherits some behaviourist concerns with scientific method; rejects an exclusive focus on what is observable and uses computers to understand the mind - to control experiments, as a research tool (e.g. model the mind) and as 'thinkers'.

Science, models and the mind

Being scientific while invoking unobservable theoretical entities.

1. When accounting for observational data (e.g. force fields, electron energy levels, genes, cognitive operations.)

2. To specify a model of the relationship between the construct and the behaviour being explained (e.g. Newton's equations modelling the effect of gravity on an object.) Cognitive psychology has to proceed in the same way - detailed observations of language require explanations that invoke unobservable, theoretical constructs in the mind. Modelling is not easy (and computer models can help) as:

(i) They can become very complicated very quickly - so computers are helpful in similar ways as in meteorology - complex phenomena are almost impossible to model without them.

(ii) Predictions of a model can be difficult to work out. Simulation within a computer model - "what if" - can be used to see if particular conditions in the model lead to correct predictions of behaviour in humans.

(iii) Difficult to determine internal consistency of models. Programming into a computer makes this simpler - inconsistent models lead to unhandled exceptions in programs (and potentially to crashes.)

3. Advent of techniques of brain imaging suggests mental processes may be observable - e.g. fMRI showing which parts of the brain are active when a particular task is performed.

Such studies can be criticised as they only help a function to be localised to a region of the brain - they don't help to directly improve theories of cognition. However, they can provide a contribution - e.g. theoretical deductions, improved confidence in existing theories (e.g. in the way seeing genes has led

to advances like genetic engineering.

The Cognitive Approach

Representation

While arguing cognitive psychology is scientific, researchers like **Fodor** argue it should be regarded as a special science, due to the complex relationship between the mind and the physical world.

Two competing intuitions - one being that the mind transcends the body - for example, being in love is more than a particular body or brain state. The second is that the mind ought to be an explicable part of the natural world - i.e. it is difficult to say what a psychological state is if it is not physical in nature.

The property of aboutness is difficult to explain with the natural sciences. E.g. a book is more than just molecules - it is about a topic. Similarly with mental processes - their aboutness involves representations - our thoughts represent possible states of affairs; perceptions represent our immediate environment.

Brentano believed mental states consisted of acts and contents. E.g. Belief that x is lazy comprises of an act (of believing) and a content (x is lazy.) So two different mental states would be involved in the belief that x is lazy and that everyone is lazy. Same act, but states differentiated by their content. He concluded that psychology needs to consider not only the internal features of the mind, but also what these features are about.

Cognitive psychology is therefore studying something that is intrinsically relational - it spans what is in the mind and what it relates to in the (physical) world.

Computation

Marr - "if vision is an information processing task, then I should be able to make any computer do it".

If information processing is what the mind is about, then the mind is computational at some level, as well as representational.

Von Eckardt - two assumptions involved in deciding the mind is computational.

1. A linking assumption - if the mind is computational, its capacities are therefore computational. This serves to link minds (not well understood) with computers (well understood.)

2. The system assumption - computers are systems which represent information, input, store, manipulate and output representations. They operate according to rules.

These two assumptions work together to provide a framework for understanding (the unknown) minds.

The form of the model is one of debate - two main proposals put forward.

(i) Symbol systems

The mind is computational means that the mind embodies computational mechanisms for manipulating symbolic representations of mental states - e.g. x is lazy. This manipulates the symbol for x and the symbol for laziness.

Newell and Simon - (i) Symbol systems consider a basic set of symbols that can be combined to form larger symbol structures. (ii) They contain processes to operate on the symbols to produce new structures. (iii) Symbols are about objects.

In other words, they claim that all cognitive processes (underlying language, perception, memory ...) manipulate symbols.

Could be tested by developing models of symbol systems and comparing them with empirical data. Disagreement would not disprove - it may just be that

a different symbolic model may agree better with the data. Lots of empirical evidence will therefore be needed to determine this proposition one way or the other.

(ii) Connectionism

Draws inspiration from the known features of the brain - e.g. that of neurons being highly interconnected and that they pass information on by being inhibited or enhancing the activity of connected neurons. They also process information in parallel. This approach builds models of cognition out of building blocks that replicate these properties in computer programs.

A symbolic model would attempt to understand the representations involved in understanding language and then construct a computer program to encode the representations and manipulate them in accordance with the rules of grammar. Whereas a connectionist model would represent information in neuron-like computing units and understand it in terms of what neurons are physically capable of.

Connectionist models are good at generalising from just a few examples - like humans - e.g. the typical UK Prime Minister is like ...

Level-dependent explanations

Cognition can be understood on three different levels - Marr, 1982.

Level 1 - The Computational Level

Specifies what a computational system computes and why it computes it. E.g. the mapping of a set of inputs to their outputs - the plus function with inputs 2,2 would result in the output 4. Why the (plus) function is the correct function for a specific task should also be specified.

Level 2 - The Algorithmic Level

Specifies how a computation is achieved. E.g. to add 2 to 3, the numbers may be represented as dots and the dots on the left are moved to join the dots on the right one dot at a time. The number of possible algorithms becomes even greater when considering how someone might play chess. Therefore difficult for cognitive psychologists to work out which is the 'right' algorithm for a given situation. Why are particular representations chosen (e.g. for language) rather than any other?

Level 3 - The Implementational Level

How algorithms and representations are realised physically. For language, this would have to make reference to neural circuitry and their actual activities while processing language - very difficult! Such an explanation of language exceeds current understanding.

Therefore, cognitive psychologists focus their work at levels 1 and 2 in explaining cognition - i.e. functional accounts (level 1) and process accounts (level 2). But there are relationships between all three levels.

Conclusions

Cognitive psychology has a long history and makes connections with many other disciplines. It may be a special science - between a social and a natural science.

Many topics are not fully understood, even though cognitive psychology has been a productive approach to date. Attention and perception have shown significant successes; consciousness and emotion still present very real challenges.