Aarhus University

Cognitive Science

Studium - Generale

Kristian Larsen - 7. Juni 2016

Supervisor:
Joshua Charles Skewes

AARHUS UNIVERSITET

“Science is what you know. Philosophy is what you do not know”
-Bertrand Russell,

Introduction:

Science is often considered equivalent to truth. Research in physics, chemistry and biology has provided the human race with laws of the universe. Gradually we have come to understand concepts such as the stars, planets, and the earth. More recently we have acquired profound knowledge about the human body – how to treat it and how not to treat it. In the last several decades we have lived in a revolutionary time in the history of science as we are starting to study, explore and understand the human mind. The human mind is a problematic concept to study; unlike plants or planets, which we can easily observe, the human brain is significantly complex as it contains approximately 100 billion neurons, which all may have as many as 10.000 neural connections. At the exit of the 19th century a lot of the pioneer work in psychology was initiated trying to establish a theory of the mind.

Currently and historically we find that research done by psychologists has often been criticized for being both non- and/or pseudo-scientific. This has been caused by the many experiments that have had a poor effect in reproducibility, which in most scientific contexts is not acceptable. At the moment psychology and related fields suffers from the pressure of - what has been called - the replication crisis that questions both the methodological and theoretical foundation of psychology. This is currently a very important issue as it questions to what degree psychology and related fields contribute with valid scientific knowledge. Owing to the technological development of the past several centuries’ deferent tools for brain-research have been developed. This has allowed researchers to study the concept of the mind as brain processes in an experimental structure comparable with the structure of the natural sciences. Human behavior, cognition and processes like memory, language and problem solving have been eagerly studied from different scientific perspectives trying to determine and establish a science of the mind – that is building a theoretical foundation from the things we know. Given the methodological and theoretical uncertainties encountered with the many facets and variables in human cognition, the philosophical aspects of the brain become important - that is encountering the things we do not know. As the complexity of the research increases so does the need for a medium that interacts and collects material from different areas of research. This is

where the interdisciplinary field of cognitive science emerges. Now the important questions are: What is the subject field of cognitive science and how does this contribute to the methodological and theoretical foundations of psychology and related fields? These questions are complex as they relate to a debate on the constitutional requirements for science and a discussion on what "good science" is and what "good science" has been.

I find that the interdisciplinary nature of cognitive science plays a unique role in current scientific contributions, both theoretically and methodologically. In order to address this matter I will make a three-part analysis trying to illuminate the most important aspects of this discussion. In the first part I am going to outline the methodological and theoretical aspects of psychology in a historical context. The second part will examine how cognitive science emerges, relates and segregates from psychology, methodologically and theoretically. In the last part of the analysis I will start discussing the impact from influential paradigms in cognitive science. Conclusively I will discuss the term "contributive science" and offer a suggestion on how cognitive science contributes in a unique way.

Part one: Psychology

1) A full analysis of the profound amount of different psychological movements is beyond the range of this thesis, but I will highlight some of the theoretical and methodological aspects, which have had a significant impact on both psychology and later on cognitive science.

Psychology is considered the study of the mind and behavior. Mind and behavior; this segregation between the internal and external events have had an important influence on the theoretical upbringing of psychology. Most of the groundwork has been made during the 20th century with different movements. Historically we find that the first scientific attempt to study the mind was attributed to William Wundt who believed that psychology should study consciousness. (Silverman&Gordon (2006). Wundt was inspired by chemistry and the idea of the periodic table. He wanted to create a similar table board explaining the fundamental elements of mental processes in their basic compounds. He used introspection as the scientific method for collecting the necessary data and believed that the best way to study the basic elements was to investigate experiences and break them down into components. Additionally William

Wundt investigated the concept of perceiving a combination of elements as a greater whole, which then later was further elaborated by the gestalt movement. Even though Wundt and introspection as a method suffered from a lot of criticism the overall movement was beneficial for psychology as it initiated the experimental study of the mind by creating a lab, collecting data from experiments and establishing a theoretical foundation. Thereby voluntarism was an important precursor for later movements in psychology and importantly I want to emphasize how the methodological initiation of psychology was driven by natural sciences like physics and chemistry.

Where voluntarism and later on structuralism were very interested in what the mind is there were other movements more concerned with what the mind does. Two influential movements in human behavior were functionalism and behaviorism. The brain was believed to be simply too complex to study and so the behavior became the main focus. Skinner, B. F. (1990) was very interested in "stimuli-response" a functional relationship he understood as analogous with "cause-effect". He believed that no human action was innate and that everything was learned through external stimuli. Importantly Skinner thought that by analyzing behavior it would be possible, not only to explain but also to predict and manipulate human behavior. Methodologically the important aspect of behaviorism is how they envisioned behavior to be studied objectively like natural phenomena. I want to emphasize the way in which Skinner believed behavior could be understood, predicted and manipulated is very similar to the way that natural sciences operate.

Imaging we drew a very distinct line completely separating the movements mentioned above into two; One that only study the mind (voluntarism, structuralism) and one that only study behavior (functionalism, behaviorism). The interesting aspect here is how the methodological ambition is comparable. Both movements seem inspired by the work of early positivists. The main principles of positivism, which state that any social science should be conducted using the same method as natural sciences (Wacquant, Loic. 1992.), seem to have influenced the methodological conviction of early psychology. Aspiring to uncover laws of causality with objectivity and rationalism, William Wundt and Skinner initiates from a similar methodological basis, a basis where science provides objective, authentic and reliable knowledge. Even though introspection was criticized for not being objective, the ambition was scientific objectiveness. Here I want to make a distinction between methodological foundation, which is how we have determined the way movements operated looking

back; and the methodological ambition, which was the methodological drive of the movements. William Wundt's methodological ambition was experimental objectivity, though we later have defined introspection as not being objective. I will return to the subject and discuss the influence of positivism later on. Conclusively I want to mention some early work of the psychoanalytic psychology. This work differs significantly from the movements mentioned above. Sigmund Freud[1] was concerned mainly with the subject, not the objective observations. The theoretical foundation was based on notes from therapy sessions, which was qualitatively analyzed and operationalized into a terminology. The approach also served a clinical purpose, not only a scientific one; this is a very important theoretical criterion for a psychologist, that the single person is highly relevant in the subject field. In that way the methodological foundation of the psychoanalytics was very different from e.g. Behaviorists. The final point I want to make is that even though the groundwork of Sigmund Freud was criticized for its methods it was still very beneficial to clinical therapy and further research.

Conclusively I will emphasize that psychology contains a very broad spectrum of theory and that the methodological obstacles of studying the mind is still an issue.

Part 2: Cognitive science

Also concerned with mind and behavior, Cognitive science emerged around the 1950's. Cognitive science is thought to be influenced by, and influential on, many different faculties including philosophy, linguistics and of cause psychology. Some refer to the field of study as a plurality: "cognitive sciences" because the subject field is too broad to be considered one area of research. It has been argued that cognitive science was a counter-revolution to behaviorism, which had overlooked the influence of internal processes for decades. (Silverman&Gordon (2006). The nature of this counter-revolution is very important to the emergence of cognitive science. In this analysis I will operate with some of Thomas Kuhn's thoughts on the structure of a revolutionary science, and apply these to the emergence of cognitive science. Kuhn believed that scientific theory has evolved, not merely from scientific accumulation, but also and most importantly from scientific revolutions i.e. paradigmatic changes in the history of science. (Kuhn, Thomas (1962). An example of a radical paradigm shift

[1] Most well-known founder of psychoanalytic psychology

could be when scientists discovered that the sun was the center of our galaxy, not the earth. However, Kuhn's criteria for a revolutionary science are more flexible than this. Let me approach some of the primary aspects involved with a paradigmatic change trough an example.

Imaging you had just had a nice late-night walk home from a friend's house. You reach your door and realize that you dropped your keys. Even though you are quite sure you did not loose your keys beneath the light-pole this is still the first place you will look. Why? You look under the light-pole because it allows you to break down your issue structurally and apply conditions for a solution. 1) My keys are here. 2) My keys are not here. Operationally the light-pole permits you to address your issue with certainty. Looking in the dark will not allow you to conclude anything, as you will not be able to see if you passed your keys. Intuitively the obvious solution would be to add more light. What would happen then, if we lit up the entire walk? This would be an accumulation of light (correspondingly knowledge), and then you would be able to determine whether your keys are lost completely or not. However, this might not be the best solution. Another pedestrian might have stepped on the keys pushing them under the surface. Then maybe a metal-detector, a gps-signal or x could be the solution. The paradigmatic change emerges as you address the problem differently and with a different paradigm consider structural circumstances under which your issue (the lost keys) can be illuminated. By that logic a revolutionary phenomenon may emerge without interfering disparagingly on its forerunners; thus both the accumulated light and the metal detector will increase the likelihood of you finding your keys. Kuhn emphasizes this point in his work "The structure of social sciences" and so will I for later discussion. In order to define cognitive science as a paradigm change I will place the emergence of cognitive science in Kuhn's theory of scientific phases. I suggest that cognitive science emerges as a revolutionary science to psychology - in Kuhn's third phase. I will not describe the phases in full but emphasize that a lot of the methodological and theoretical groundwork in cognitive science was already established by psychology and related fields in the first 2 phases in Kuhn's terminology.

The technological development and the invention of the computer had a huge impact on the foundation of cognitive science. The idea of the mind as an input-output agent

was not unfamiliar, as B.F Skinner (1990) introduced it in the early 20th century. However, the assumption that the mind is a computer and the fast growing use of machines in research was a radical change and let to this paradigmatic change. It allowed researchers to investigate the internal processes, which had been considered a "black box" by the behaviorists. Kuhn's philosophy on science also relates to the ideas of positivism mentioned earlier. These ideas have impacted the methodological foundation of cognitive science too. The counter-revolution to behaviorism is mainly theoretical, not methodological, as behaviorism and cognitive science are methodologically quite similar. Not only are they both influenced by the methodological aspects of the natural sciences, cognitive science also seem to success from functionalism as it investigates the mind in terms of how the mind processes or in other words what the mind does. However, the interdisciplinary nature of cognitive science holds different views, which I now will address.

One important methodological conviction in cognitive science is what Loic Wacquant (1992) terms the instrumental positivism. This I believe is quite adequate in describing what has been, and what still is influential to the methodological conviction of cognitive science. The approach is an equivalent to quantitative research, which finds reliability in empirical generalizations, objectivity and replicability. This aspect is very important for the methodological and thereby also the theoretical foundation of cognitive science. It places the object (3.person data) in favor of the subject (1.person data). Remember my statement that parts of psychology center the individual (1.person data) in relation to therapy. This could have been a clear methodological distinction between psychology and cognitive science; however, cognitive science has developed quite a lot since the 1950's. The implementation and necessity of first person data has been discussed in the past several decades. Raymond Boudon (1991) argues that quantitative research is only concerned with identifying causal effects, and not understanding the meaning of them. David Chalmer (2010), an Australian philosopher, argues that only by combining first- and third-person-data we will be able to answer fundamental questions about the human mind. This argument introduces a very important debate on the diversity between paradigmatic viewpoints in cognitive science.

Part three: influential paradigms

The interdisciplinarity of cognitive science is highly relevant in the discussion of paradigms. The influence from other disciplines makes the subject field of cognitive science hard to determine categorically. I will try to describe and discuss the main characteristics of cognitive science looking at some different paradigms and their qualities. As mentioned above cognitive science emerges both influenced by the behaviorists, but also as a counter-revolution to them. The methodological similarities, which were inspired by positivism, affected a major paradigm in cognitive science: "computationalism" or "the computational theory of mind". The computational theory of mind argues that the mind is a computational system and is considered a traditional paradigm in cognitive science. Wilson and Foglia (2016).

Even though the idea that the mind is a computer seems innovative, the argumentation behind is slightly vague. "Computation" could be a metaphor for basically all systems. If the only condition to a computation is the construction of an output from an input, then all processes are computations and the argument is very unclear. On the other hand, if the explicit analogy between mind and computer is simply accepted, then computationalism becomes a very interesting explanatory tool for the cognitive system. This was defiantly the incentive to computationalism, which historically has impacted cognitive science a lot. Historically the paradigm is also strongly connected to artificial intelligence. Allan Turing (1950) provided a very clear notion on intelligence. He defined an intelligent machine as a machine that would execute cognitive tasks. He created a test, which he believed would be able to determine intelligent machinery, the so-called "Turing test". If the computer "won" the test Turing identified the machine as intelligent because it would be able to execute functions equivalent to the human mind. McColluch and Pitts (1943) suggested the evidential groundwork for the computationalists in an article. They presented, what they called, the logical calculus for nervous activity, which offered a logical explanation of how neurons act in the all-or-none fashion. This has later been criticized as being an oversimplification. An important characteristic of computationalism is the fact that the brain is the independent agent of the mind. The critics contest this notion as they suggest that the mind is an exceedingly dynamical system, which is interactive with the body. This linking leads to another paradigm in

cognitive science, embodied cognition. Here proponents suggest that the body is an important part of cognition, a notion that has been overlooked or considered unimportant by computationalism.

Imagine a teacher who has to grade a paper. Is the output (the teacher's opinion on the paper) solely created by the input (the writing itself), or is the teachers opinion affected by his/her physical state – amount of sleep, coffee, back pain, hemorrhoids etc.? Despite the fact that embodied cognition is a more recent paradigm, there has been made a quite firm establishment of the phenomenon. Wilson and Foglia (2016) present some of the main characteristics for embodiment cognition e.g. body as constraint, body as distributor and body as regulator. These characteristics explore and assess the involvement of the body in cognition. I will not describe these in full, but continue to the overall impact embodied cognition has had on cognitive science and the philosophy on mind. If the mind is embodied and not indistinctively bound to the skull, then the methodological procedure may have to changes. The subjectivity becomes a necessary interest in understanding the processes of the mind. David Chalmer (2010) believes that there exists an explanatory gab between the physical (thereby measurable) processes, and the conscious experience of the individual. Some believe that this will be illuminated through an accumulation of brain-function-knowledge (computationalism), but according to Chalmer (2004) it requires the use of qualitative research methods if we want to understand and explain this explanatory gap. Owing to functional research we know a lot about what certain brain parts do and what they correlate with. However, this is the "easy" problem when trying to understand the complexity of the mind – how the brain functions. In order to fully understand the very nature of the mind, we need to address the concept of individual consciousness (David Chalmer (2004). According to Chalmer this is the "hard" problem. As mentioned in 'part 2' Chalmer suggests that the combination of first- and third person data is essential to understand the philosophy of mind and consciousness. Though there has not been established a complete paradigm Chalmer initiates a paradigmatic debate on the importance of first-person data in cognitive science. This illustrates how the paradigmatic viewpoints of cognitive science are flexible as they are constantly challenged in the interaction with other scientific disciplines. This is an important character for cognitive science. In the following discussion, I will address this interdisciplinary flexibility, which I think makes cognitive science contributive to psychology as well as related fields.

Closing discussion:

The purpose of the discussion will be to identify how the interdisciplinary subject field of cognitive science makes contributions to scientific knowledge. I will discuss the main points from the analyses in context to the knowledge-constitutive interests presented by Jürgen Habermass. (Vanessa, 2012). This will include a debate on how research is subject to a political discourse and how this relates to the replication crisis. Open Science Collaboration (2015).

If we want to determine how cognitive science contributes to its related fields we need to determine the criteria of a contributive science? Like I stated in the first line of the introduction, science is often considered equivalent to truth. I want to discuss this concept of truth. According to positivism a researcher's job is to discover all the phenomena that already exists in the world, phenomena that are just waiting to be discovered. Through the analysis we see how psychology, cognitive science and related fields historically have been influence by positivism and this notion of true objectivity. Does this mean that objective (quantitative) research is the only true and contributive science? With the knowledge-constitutive interests Habermass introduces an important systemic dimension to this discussion. The term interest is central in the discussion as it holds a strategic facet; it allocates the purpose of science. Habermass defines this as a value-attribution to science. The argument holds that scientific knowledge first exists in a pre-scientific state, where the purpose of science is subject to interests. In that case is science subjective before it can turn objective. (Vanessa Sonne-Ragans (2012). Correspondingly I find that the notion of science as a truth is an oversimplification. For instance is the primary purpose of the natural sciences not to discover all universal truths but to subjugate nature so we can exploit, manipulate and utilize the natural resources to the best of our ability. This is when a natural science provides the most beneficial knowledge and thereby is most contributive. Habermass finds that the natural sciences are united under one category; the technical/rational interests. The pre-scientific subjectivity is the strategic interest in using the natural sciences for our benefit; the objectivity is the methodological conviction – that is the quantitative, empirical and objectifying research, which aims to provide universal laws. Habermass operates with 3 categories. For the purpose of this discussion I will only address the first – mentioned above - and the second: the

practical interests. Here we find the humanities or hermeneutic sciences. The methodology is qualitative, interpretative and seeks to understand and interpret the social facets of humans. I find this second interest very important. Practically, the human specie attributes a lot of value to this social understanding. It is tied closely to social interaction and the understanding of humans in everyday life, which in everyday life is important. Here I will make my first point: a science that contributes to social understanding is a contributive science. Then we have to answer an important question: Is there a conflict of interests connected to how we access this social understanding? When science is subject to knowledge-constitutive interests, researchers have to follow dominant political discourses of science – what are the interests? Such discourses are highly influenced by the historical aspects of science. The history of science has suggested a theoretical and methodological separation between the natural and the interpretative sciences. This sharp division between the first and second interest is also highlighted by Habermass as an obstacle. It problematizes a methodologically interdisciplinary research. The sharp division makes it easy for critics to distinguish and outline exact criteria for sciences. This is one of the main reasons why the replication crisis (2015) becomes relevant to discuss. At the moment we live in a time where the knowledge-constitutive interest is highly affected by systemic perspectives. An important political trend like efficiency-improvement is exceedingly connected to the technical interests. This is one reason why we see the huge influence of positivism on all aspects of science to day. Statistically evidence-based knowledge is in high demand. This makes the technological interest exceedingly influential. However, at the same time the practical interest in individuality is more centered in research than ever. Is this a conflict of interests? I find that the political trend is a guarantee or certainty; a certainty that most people will benefit from the acquired knowledge under many different circumstances. This is the main criticism in the investigation of reproducibility in psychology (2015). One of the main points from the research states that: *"Potentially problematic practices include selective reporting, selective analysis, and insufficient specification of the conditions necessary or sufficient to obtain the results".* Open Science Collaboration (2015). This is approximately the same criticism, which the theoretical and methodological foundations of Sigmund Freund were exposed to 100 years ago. The criticism contests whether the results offer a guaranteed effect. This perspective is a problem. If the human mind simply behaved like gravity or any other natural

phenomenon, then it would be fair to ask for a guaranteed effect, laws of causality and universal truths. However, we have already addressed the complexity of human cognition and the profound amount of variables, which makes it necessary to consider the inputs from 1-person-data. Because we have seen the work of Sigmund Freud being beneficial/contributive to the field of psychology, we can draw a line and say that contributive science is not only equal to objective science. However, the skepticism and uncertainty, which is included with a lot of research in psychology, mainly comes from idea of *"Potentially problematic practices"* (2015) I find that this is the exact spot where cognitive science is contributing in a unique way; by building the necessary bridge between 1-person and 3-person-data.

Cognitive science is unique in its flexibility, because it tackles the questions about human mind from an interdisciplinary position. The flexibility occurs when cognitive science becomes the interactive medium between "hard" and "soft" sciences. This includes that cognitive science is constantly balancing, adjusting and mediating between different scientific perspectives. When a cognitive scientist preforms experiments trying to achieve third-person objective data while a long side collecting first-person experience data, he/she connects the different interests: the interest of producing objective evidence-based knowledge, and the interest of understanding the individual. Thereby the unique character of cognitive science is explicit in its way of fitting the contemporary political discourse. The practical interest in understanding the complexity of humans, parallel with the influence from the technical interests (objectivity and the criteria of evidence-based-knowledge) puts research under a lot of pressure.

Imagine the interacting relationship between a physicist and an engineer. When the physicist discovers that the properties of water can make an engine run he will be happy with the knowledge. The engineer, however, builds a motor running on water, but he has to apply the theory to a lot of complex elements in reality. When he succeeds, he delivers the motor back to the physicist. Now the physicist has to apply the complexity of the motor to the theoretical properties of water in order to improve the work of the engineer. This interplay happens between cognitive science and its related fields as well. Cognitive science interacts in the same way with psychology and related fields by contributing with a unique experimental structure that mediates the pressure from both the technical and practical the interests.

References:

Boudon, Raymond. 1991. "Review: What Middle-Range Theories are". Contemporary Sociology, Vol. 20 Num. 4 pp 519–522.

Chalmers, D.J. 1996. *The Conscious Mind: In Search of a Fundamental Theory*. Oxford, England: Oxford University Press.

Chalmers, D.J. 2004. How Can We Construct a Science of Consciousness? *the Cognitive Neurosciences III* (MIT Press)

Habermas, J. 2004. How Can We Construct a Science of Consciousness? *the Cognitive Neurosciences III* (MIT Press)

Jay Friedenberg, Gordon Silverman. 2006 Cognitive science: an introduction to the study of mind p. 65-95

Open Science Collaboration (2015). Estimating the reproducibility of psychological science. Science, 349 (6251)

Skinner, B. F. (1990). Behaviourism. In *Reason at Work: Introductory Readings in Philosophy* (S. M. Kahn, P Kitcher, G Sher, & P. J. Markie, Eds.)

Searle, J. R. (1990). Is the brain's mind a computer program? *Scientific American, Jan,* 26-31.

Sonne-Ragans, Vanessa 2012, Anvendt videnskabsteori – reflekteret teoribrug I videnskabelige opgaver, kapitel 5.

Thomas S. Kuhn 1962, The Structure of Scientific Revolutions THE UNIVERSITY OF CHICAGO PRESS , (p 92-136)

Turing, Allan M. (1950). Computing Machinery and intelligence, Oxford University Press

Wacquant, Loic. 1992. "Positivism." In Bottomore, Tom and William Outhwaite, ed., The Blackwell Dictionary of Twentieth-Century Social Thought

Warren S. Mcculloch and Walter Pitts, 1943, A logical calculus of the ideas immanent in nervous activity, the university of Illinois, college of medicini, department of psychiatry at the Illinois neuropsychiatricinstitute, and the university of Chicago

Internet references:

Rescorla, Michael, "The Computational Theory of Mind", The Stanford Encyclopedia of Philosophy(Winter2015Edition),EdwardN.Zalta (ed.),
URL=<http://plato.stanford.edu/archives/win2015/entries/computational-mind/>.

Thagard, Paul, "Cognitive Science", The Stanford Encyclopedia of Philosophy (Fall 2014 Edition),EdwardN.Zalta (ed.),
URL=<http://plato.stanford.edu/archives/fall2014/entries/cognitive-science/>

Wilson, Robert A. and Foglia, Lucia, "Embodied Cognition", The Stanford Encyclopedia of Philosophy(Spring2016Edition),EdwardN.Zalta (ed.),
URL=<http://plato.stanford.edu/archives/spr2016/entries/embodied-cognition/>.