Cognitive science and psychology: An advantageous relationship

Psychology was the first discipline to study the mind by applying experimentation. Wilhelm Wundt set up the first experimental psychology laboratory in 1879, and throughout the decades, psychology has been influenced by various different approaches using different methods. Some of these have been paradigmatic, influencing the whole field of psychology, but today, psychology is a divided field. It has no widely accepted theory of the mind, and the identity crisis affects the field negatively. Furthermore, psychology finds itself in the middle of a replication crisis. The methodological foundations of psychology have been an issue placing psychology on the threshold between science and pseudoscience, and now the methodology seems to show extensive problems. In a recent study by the Open Science Collaboration (2015), 100 psychological studies were replicated by different teams of researchers. The study succeeded in replicating only 36% of the statistically significant, original results. This serves as an eye-opener to how important this issue is. And it shows that some action is needed for psychology to retain their classification as a science.

In this essay, it will be argued that cognitive science can make important and unique contributions to improving the methodological and theoretical foundations of psychology and its related fields. To do so, three arguments will be presented.
The first argument concerns psychology's struggles to be considered a science, and the recent identity crisis culminating as the so-called replication crisis in psychology. It addresses how cognitive science might be a solution to these problems, because of the use of computational models as a methodological tool.
The need of a change in methodology in psychology, which was seen with the emergence of behaviourism, leads us to a second argument: Cognitive science has contributed to psychology before by overcoming the negative aspects of behaviouralism. It will become clear from the argumentation, how this should be seen as a positive movement that weakened the behaviouristic paradigm.
The third argument that will be presented in this paper is that to obtain a fulfilling theory of the mind, psychology cannot stand on its own. It must collaborate and take advantage of interdisciplinary contributions. This interdisciplinarity is what we find in cognitive science.

At the end of this paper it will be clear that cognitive science has been, is, and will be an important contributor to psychological science and to uncovering the mysteries of the human mind.

Historical background

Psychology has a long and diverse history; from voluntarism, to gestalt, to behaviourism, and today several different psychological approaches exist. Psychology can be defined as the scientific study of mind and behaviour (Friedenberg & Silverman, 2012). This includes several aspects: describing, explaining, predicting, and changing (Cherry, 2015). Elaborating on these, psychology must be able to describe mind and behaviour, and it must be able to explain these; assessing the "how" of the mind. Psychology must additionally be able to make predictions about how we think and behave, and lastly, one of its goals are to change, that is, both to treat for example psychological illnesses and help improve various areas, e.g., education, with its knowledge.

Psychology has throughout history implemented the scientific method. Earlier psychological approaches made use of techniques such as introspection and phenomenology; methods that did not comply with the scientific method. Today, interpretative phenomenological analysis is still a tool used in psychology and has been criticised for its use of phenomenology (Lyons & Coyle, 2007).

A strict implementation of the scientific method was found in behaviourism. Behaviourists believed that the mind could not be studied scientifically, because the internal states were unobservable (Skinner, 1965). Consequently, they constrained their studies to behaviour. Comparing their approach to the goals of psychology defined above, they described behaviour in terms of reinforcement and punishment, they explained behaviour in terms of purely external factors, and they predicted behaviour by observation of previous, external reinforcers.

Just as behaviouralism was a reaction to weak scientific approaches, e.g., psychoanalysis, cognitive science was a reaction to behaviourism. Behaviourism was the leading paradigm of psychology for around 50 years (Friedenberg & Silverman, 2012), but cognitive scientists did not accept that the mind could not be studied. Evidence was accumulating that the behaviourists could not explain (Tolman, 1948, Bartlett, 1932, Miller, 1956), and as new technology made possible the more scientific access to the mind, and the personal computer was developed, the new theory emerged.

Cognitive science is the scientific, interdisciplinary study of the mind (Friedenberg & Silverman, 2012). The interdisciplinarity consists of collaboration between the fields of psychology, philosophy, linguistics, artificial intelligence, neuroscience, and anthropology. Cognitive scientists viewed the mind as an information processor, using the computer as a metaphor. This was termed

the paradigm of computationalism. Computationalism was by the classical computationalist theory defined as the view that cognition is computation (Rescorla, 2015). Less radical computationalists acknowledge that the mind is not identical to a computer, which have sometimes been understood from this statement, and Hardcastle writes that: "the best we can hope to say (…) is that we understand it in a virtue of a computational model, not that it and the computational model are equivalent." (Hardcastle, 1996, p. 74). She argues that computationalism is not about claiming that the mind is actually performing computation, like those in our models. Instead, she is arguing that the computationalist view is suited for describing the mental processes: "It is better to remain agnostic about the true essence of mental states and instead focus on how to describe mental states as fruitfully as possible." (Hardcastle, 1996, p. 74). When later referring to computationalism, it is this view that will be referred to as a definition.

Science and its stages

To further facilitate the discussion, some key terms must first be defined. *Science*, and its demarcation, is one of the important terms. The scientific method is a key ingredient to science. Additionally, science will be defined as using models that can be wrong, that can predict, and that can be applied to the real world (Scott, 2003). Models, theories, natural explanations are all examples of what science is. Examples of what science is not are facts and supernatural explanations (Scott, 2003). Implicit in this definition is that science is falsifiable. This was introduced by Popper: "statements or systems of statements, in order to be ranked as scientific, must be capable of conflicting with possible, or conceivable observations" (Popper, 1962, p. 39, as cited by Hansson, 2015). For theories to be scientific, they must be possible to prove wrong. This puts constraints on theories in relation to the above definition, namely that facts are not science because they cannot be falsified, and that supernatural explanations cannot either.

Positivism had another definition of science, which will not be adopted here, but I will briefly account for it. They believed that for a theory to be scientific it should be possible to verify, thereby the verifiability theory (Bechtel, 1988). This has the implication, though, that supernatural theories can often be verified. Take the example of creationism, which is easy to verify and therefore would be a science in a positivist viewpoint. However, it is almost impossible to falsify, and therefore would not be considered a science according to falsificationism. Positivists did, though, contribute to the definition of science, as they argued for the use of a hypothetic-deductive approach, which laid the foundation for the scientific method (Bechtel, 1988).

The last term to be defined is *paradigm*. Thomas Kuhn (1962) argues for a theory concerning three stages of a science. The first is *pre-science*. This, he argues, is the stage wherein the science is collecting data and observing the world; the accumulation of effects. In this stage, theories are basic assumptions about how things work and are often based on common sense. The pre-scientific stage is developing towards *the paradigmatic stage*. At some point, a theory will be developed that can account for most of the evidence, and this will gain acceptance and popularity among a group of scientists. If the theory is good enough, it can evolve into a paradigm. This means that theories and experiments will be guided by the basic assumptions of the paradigm, and this will narrow down the questions that are asked. More detailed models can be developed and research will focus on more specific areas. *Revolutionary science* is the third phase that Kuhn (1962) presents. This is the stage, wherein we see a paradigm shift. Evidence is accumulated which cannot be explained by the existing paradigm, and therefore theories will start to break away from the paradigm. New terms and explanations are developed, and the field of the science will be scattered.

The weakness of psychology

Having explained that psychology stands in the middle of a reproducibility crisis, cognitive science may be able to help overcome it. Yet first it should be explained why this is a problem that psychology must deal with, and cannot simply overlook. The low degree of reproducibility is a problem in psychology compared to other sciences, because psychology is often seen as a weak scientific subject or may even be considered to have pseudoscientific characteristics. Psychology's label as a science has often been discussed, and even among psychologists themselves, it takes up much of their time trying to prove that psychology is indeed a science: "When I took my first college level course in psychology, I was blown away by how much time was spent trying to prove that psychology was a science just like any other science." (Prenatt, 2016, para. 4). By arguing that psychology does have some areas of weakness, where they risk seeming pseudoscientific instead of scientific, it will be concluded that cognitive science can improve the scientific status of the field of psychology. Improving the scientific status of psychology will be a part of the solution to the replication problem in psychology.

The weakness of psychology lies in regard to falsification. As defined earlier in this essay, theories must be falsifiable to be considered science. It will now be argued that some psychological theories do not live up to this criterion of being able to be wrong. The neglect of falsification is seen in the

general way of assigning functions to the mind in psychology: "Since psychology's task is to account for the intelligence or rationality of men and animals, it cannot fulfill its task if anywhere along the line it presupposes intelligence or rationality" (Dennett, 1981, p. 58). Dennett concludes on what was observed by Skinner (1965), which is that psychologists have a tendency to explain observations by a *virtus domitiva*. This means that a psychological theory explains some observation by inventing an internal explanation or homunculus that essentially has the same properties as what the theory is trying to explain. This *virtus domitiva* will never be falsifiable, and therefore violates the criterion for science.

Cognitive science is much less likely to run into the falsification problem. The reason is in the way it builds its theories: with computational models. With the emergence of cognitive science came the view that the mind is, similarly to a computer, an information processer. This means that it is possible to build computational models that describe how cognition work, in the same way that models can describe the algorithms and programs of a computer. Think about the programs that run on a computer; build on logic and different stages of processing. They can easily be tested, and it is easy to predict what the outcome will be, once you know the program. The same applies for the models in cognitive science; they are built around processing of information, and they can easily make predictions. Therefore, it can easily be assessed whether a given model is right or wrong in its predictions. Computational models are falsifiable when applied to real-world problems, whereas some psychological theories may sometimes be even impossible to falsify.

The researchers behind the Open Science Collaboration (2015) hint that this might be where the solution to the reproducibility crisis is to be found. It was found that there was a difference in replication results between different fields in psychology: “reproducibility was stronger in studies and journals representing cognitive psychology than social psychology topics.” (Open Science Collaboration, 2015, p. 5). This, the article suggests, may be a result of the experimental designs used more frequently in cognitive psychology. The reason for these experimental designs is to be found in the structure of research in cognitive science; specifically, its models. Therefore, making theories more easily tested and falsified will likely make replication rate higher, and this is what cognitive science can do. This is the methodological contribution of cognitive science to psychology.

The falsification problem is by no means the only aspect of the reproducibility crisis, and several others could have been included in this essay (E.g., Spellman, 2015, for an overview, or Scargle, 1999, on the file-drawer problem). Part of the replication problem may also stem from the many different approaches in psychology. Psychology has had no unified paradigm since behaviourism, and instead different approaches seem to be working in parallel (Friedenberg & Silverman, 2012), none of them being able to incorporate all empirical findings. They have different ways of building theories; some basing things on evolutionary theory, some on social aspects, and so on. This is making it hard for the field to collaborate, and it may entail that researchers from different backgrounds are unable to accept each other's theories, and unable to replicate findings.
What a paradigm does, as defined earlier, is that it lays out the foundations on which new studies are to be conducted and new questions are to be asked (Kuhn, 1962). This is what it can and shall do, and it is what no approach in psychology is currently doing. There is, however, an approach that may be able do it: cognitive psychology. Cognitive psychology is the cognitive scientists' answer to what will unite the field of psychology. Whether it will, will of course be shown by time, and whether it should, is what will be argued in the rest of this essay.

Why behaviourism is not the solution

Behaviouralism may have seemed as a solution to some of the methodological issues seen in psychology; those issues described above. Cognitive science brought on the realisation that behaviourism is not the all-explaining, methodologically ideal paradigm. It will be shown how cognitive science by bringing about this realisation has contributed to the theoretical foundations of psychology.
When it was realised that the earlier psychological movements, such as psychoanalysis and gestalt, were never going to provide enough constraints on their theories to live up to the scientific demands, behaviourism arose. Psychology was being influenced by positivism in philosophy, and this meant that evidence should be based on observable, empirical data, and not vague interpretations or introspection. Behaviourism may have seemed the perfect answer, because it discarded all that could not be directly observed or measured; it discarded internal states. As such, behaviourism was an important step towards a better methodological approach in psychology, but did also set enormous constraints on the study of the mind. When cognitive science emerged in the 1950's, it was because of the realisation that it was impossible to explain the mind and behaviour

without considering internal processes. Cognitive science was the answer that could live up to both the high methodological demands and still justify the study of internal states.
The reason that cognitive science was the answer was that it had the methods to observe the previously unobservable. Skinner (1965) describes his issue with internal states as: "There is nothing wrong with an inner explanation as such, but events which are located inside a system are likely to be difficult to observe." (Skinner, 1965, p. 27). This argument builds on positivism, and it was, at that time, hard to study the inner workings of the mind. As new technology emerged, however, tools that could provide data on mental processes, e.g., EEG and fMRI, made visible the inside of systems. The view that the mind is an information processor, comparable to a computer, also made structured studies of the mind possible. Skinner wrote about the inside of a system being difficult to observe, but this is not true of a computer. A computer is a system that makes the steps from input to output observable in their programs. When viewing the mind as a computer, it was thus possible to describe the processes that might occur between stimulus and response; those that behaviourists considered a black box.

Elaborating on why behaviourism is not the solution to psychology, we see that as other psychological approaches can be argued to have pseudoscientific characteristics, this is also true of behaviourism. Previously in this paper, Dennett's argument that psychology uses a *virtus domitiva* (Dennett, 1981) was presented, and this is a conclusion adopted from Skinner (1965). What Dennett actually does, though, is that he turns the argument against behaviourism. Whereas Skinner sees his approach as the solution to removing the homunculus from psychology, Dennett shows how Skinner only disguises his homunculus as something else: "But see what Skinner is doing here. He is positioning an external virtus domitiva. He has no record of any earlier experiences of this sort, but infers their existence." (Dennett, 1981, p. 67). Behaviourism makes the same mistake as other psychological approaches; they make claims that cannot be falsified. Therefore, they violate a principle of scientific theory, and therefore behaviourism could not have survived as a paradigm, even if their theory had been better.

To really convince the reader that the argument holds and that cognitive science improved the theoretical possibilities in psychology, it is of course essential to convince the reader that computationalism was a valid theory of the mind. Let us return to the theory of computationalism: the mind can be described as doing computational processes. This theory is helpful because it

enables us to describe internal states as if they were computational processes; that is, with steps that each process some information. This view helps us make models of the mind. Marr's theory of vision (Marr, 1982) is an example of the computational theory in action. His theory explained three different steps of vision which work like in a computer: the first step he calls the primal sketch, where stimulus is presented and analysed. The next step he calls the 2½D-sketch, where the grouping of features is happening. The last step is where parts are linked into recognisable objects, and he refers to this as the 3D-sketch. This theory became famous because Marr succeeded in solving the object constancy problem; a well-known problem in vision theories. Marr's theory is definitely testable experimentally, both using psychological experiments and neurophysiology, because of the detailed level of description of what happens at each of these levels. We, then, have a theory that has overcome the problem of behaviouralism without assuming any *virtus domitiva*, and which has successfully described a property of the mind.

As a counter-argument to this, it may be said that computationalism cannot account for all mental phenomena, for example consciousness. This was shown by Searle (1990) who presented the famous Chinese Room Argument against computationalism. I will not explain further how this argument works, but reveal my agreement with this problem. Nevertheless, computationalism has still been very fruitful for psychology and for cognitive science. It has developed new ways of thinking about the mind that facilitate scientific thinking, and it has led us in the right direction towards a deeper understanding of the mind. Cognitive science has made it possible for us to observe internal processes. Furthermore, the above problem need not entail that cognitive science is no longer able to contribute to psychology. Instead, we see new theoretical approaches appearing in the field of cognitive science, e.g., connectionism and embodiment. The two approaches will not be explained in this paper, but they may prove able to explain some of the things that the computational theory of the mind cannot (Wilson & Foglia, 2015). In the same way that psychology has to keep developing, cognitive science has to, too, and as Thagard puts it: "I am very hopeful that cognitive science will continue to progress" (Thagard, 2011, para. 6).

The interdisciplinary study of the mind

It is not only the different theories in cognitive science, whether that be computationalism or connectionism, that are contributors to an enhanced study of the mind. The last argument for the case is to be found in the core definition of cognitive science; interdisciplinarity. To have a full model of the mind, interdisciplinarity is necessary. Since the goal of psychology is to study the

mind, psychology needs cognitive science. One may be able to explain parts of the human mind in psychology, other parts in neuroscience, and again other in linguistics (and so on), but it is not until we put it all together that a complete theory of the mind will be found.

The interdisciplinary approach does not mean that all areas have to work together all the time. Naturally, some of these will work on different levels, but the goal is for the levels to interact. This is described in a paper by Thagard (2009). He explains that, for example, anthropology operates on the social level, psychology on the individual level, and neuroscience on the neuronal level. The goal, then, is to find out how these levels should all work together, and this is the job of philosophy. Thagard (2009) suggests a relation between levels based on interaction. Explanations on one level should interact with explanations on other levels. This means that findings in anthropology or in neuroscience should influence theories in psychology. It also provides a possibility for theories to be tested on all levels, thereby gaining additional credibility. For example, social psychologists have used the neuroscientific method fMRI to underpin their theory of first impressions (Mende-Siedlecki, Cai & Todorov, 2012).

To provide an example of how the interdisciplinarity can be fruitful in a scientific field, we can apply the idea to global politics. Taking a global issue such as global warming, we have an example of a problem that obviously needs to be solved by many different countries working together. It requires countries like Russia, USA, and China, different countries indeed, to work together and to find a solution that works for everyone. USA may try to solve the problem on their own, but this will never succeed, because global warming is, as the name implies, global. USA can, though, go great lengths on their own, but never completely solve the problem. The question is how these very different countries can work together. Part of the answer is the UN. The UN provides a forum where all countries can talk and discuss, and hopefully come to agreements and solve the problem. Cognitive science takes the part of the UN in the study of the mind. The problem we are trying to solve is how the mind works. Each scientific field may provide excellent explanations on their own, but not until they work together, will there be a complete theory on how the mind works.

An advantageous relationship

The replication crisis in psychology is an expression of some serious problems in the psychological approach. For one, it has to do with the fact that psychology is on the border of being a science, because some of its approaches tend to have theories that are unfalsifiable. Another point is that there is no unified paradigm in psychology, which gives a sense of chaos and contradictory results

in the field. There are numerous possible reasons for the low reproducibility, but these are, in my view, two important ones. These are also the ones where cognitive science can be the solution to the problem. The theories in cognitive science are falsifiable to a higher degree, as was also suggested in the Open Science Collaboration (2015). It is probably due to the computational view of the mind as an information processor and computational models, which are predictive and falsifiable.
Cognitive science can also serve to unify the psychological field, because it provides a new approach that is interdisciplinary. This interdisciplinarity is also, in my opinion, the future for a study of the mind. Different scientific fields can each contribute with important and indispensable knowledge about the mind and the tools for studying it. Therefore, a collaboration and interaction between the fields is necessary, and it is achieved with cognitive science.
Besides being able to enrich the psychological approach further on, it has been argued that cognitive science has already contributed significantly to psychology by breaking up the behaviourist paradigm. This paradigm was persistent for many years, and it was not until the emergence of the cognitive revolution that the study of internal processes of the mind was finally allowed into psychology again. The computational theory succeeded in doing this, but even this theory is limited and new discoveries may lead to new theories or even a new paradigm in cognitive science. However, computationalism has contributed and is contributing to the methodological and theoretical aspects of psychology. This both in its models and methods and its interdisciplinarity.
Psychology cannot explain the mind on its own; it needs cognitive science to provide the foundations for working together across different sciences. The relationship, though, is a two-way one. Cognitive science also needs psychology; it would be impossible to imagine a science of the mind without psychology.
The conclusion is that cognitive science and psychology must continue in collaboration, and hopefully psychology will be open to the improvements that it can gain from cognitive science.

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