

1 Kuhn vs. Popper

Compare and contrast Kuhn and Popper. Because many philosophers consider both to be outdated philosophical positions, critique the central elements of both of them. That is, provide a strong case against Kuhn and provide a strong case against Popper. Use examples from the social sciences to augment your arguments. Your main focus should be on your critiques, not your summaries.

1.1 Introduction

Any discussion on the philosophy of science would be incomplete without giving consideration to both Thomas Kuhn and Karl Popper. These two men may be, perhaps inadvertently, the most divisive figures science produced in the twentieth century. Each had a vastly different epistemology with regard to their position on science. Kuhn posed a more pragmatic approach in that “normal science” is a process which allows investigators of nature to work well among each other, while Popper’s position was one that sought to disprove any prevailing theory.

Thomas Kuhn, a trained physicist, spent much of his career observing the manner in which scientists approached questions. It was not until he stepped out of the physical sciences that he began to see that the history of science works largely in cycles. In *The Structures of Scientific Revolutions* (1962/1970), Kuhn describes science as periodically experiencing rapid and unpredictable transformations before settling into a period in which science can return to operating normally.

Karl Popper was extremely critical of the Kuhnian approach to science. Popper felt that merely solving puzzles and working within a framework brought us no closer to actual answers in science. It was his belief that any given theory must be able to be falsified through empirical research in order to be accepted. Even then, Popper would refute that a theory that successfully stood the test of falsification would be considered true.

Each of these men’s approaches to science offer a distinctly different landscape in which to operate. While many philosophers have labored to reconcile the two approaches, this paper takes a different aim. Both Kuhn’s and Popper’s positions on science will be reviewed for its own viability as a standard model under which psychology should, or should not, operate. Ultimately, neither approach, in isolation, is solely appropriate. Rather, a combination of the two would work best for the future of science.

1.2 Kuhnian Philosophy

In *The Structures of Scientific Revolutions* (1970), Kuhn puts forth a description of science which was revolutionary in itself. He used historical scientific figures in order to describe the manner in which the field, or fields, of science progress. Discarding the Baconian notion that science continues linearly

forward, adding novel findings onto the theories of the past, Kuhn suggests a number of steps science must pass through which qualify it as a “mature science.” These steps occur in lulls and busts over time, alternating, and constantly revising the manner in which we see the world that we strive to understand.

Kuhn begins by suggesting that science generally operates in a state which largely amounts to gathering answers to small problems. Kuhn refers to these small problems that scientists attempt to make sense of as “puzzles” which need to be “solved” (1962/1970 35-42). He did not desire to undermine the value of work being done at this level as simply biding-by. Instead, he insisted that the value of any puzzle solved depended on the capabilities and influence of the puzzle-solver. He deemed these periods “normal science” which operate using major theories, methods, and values previously established in order to function within a disciplinary matrix.

The disciplinary matrix is a consensus of exemplary standards of scientific work. Kuhn cites Ptolemy’s planetary predictions and Newtonian physics as exemplars which lead to the establishment of a “paradigm.” Kuhn cites Ptolemy and Newton, amongst others, as exemplars because their texts state not only the theories and laws of their findings, but also applications and solutions as well, making them self-contained paradigms.

A paradigm, described more broadly, is a consensus on fundamentals. Kuhn explained that consensus is necessary in order to bring a chaotic, pre-paradigmatic, state of “immature” science into one of agreement. He goes on to describe periods of history which had competing schools of thought that possessed different theories, methods, and equipment with which to test their theories. For instance, at the onset of thermodynamics research in the sixteenth and seventeenth centuries, scientists had no standard scale with which to measure the coldness or hotness of a substance. A scale would have done them little good, anyhow, as there still was not a standard method of constructing thermometers (PBS, 2008). With gradual acceptance of phlogiston and subsequently caloric theories, consensus grew into a paradigm under which scientists could operate freely and interchangeably with one another.

As Kuhn explains, the puzzle solving of normal science works reasonably well for most scientists. Puzzle solutions can lead to solidifying approximations adhered to with normal science. These solutions can also lead to generating new puzzles with which to solve. However, to Kuhn, paradigms are necessarily unstable and infallible. Solutions to puzzles will inevitably return findings that are inconsistent with the established paradigm. As these anomalous findings mount to a state where the paradigm seems no longer viable, science enters a period of “crisis” that can only be resolved with a complete revision of the current paradigm; this Kuhn labels “revolutionary science”.

Revolutionary science is a period of rapid scientific advancement that begins as a quest to reconcile a paradigm with its anomalistic findings. As such, this period is generally greeted positively as previously unexplained findings begin to grow more predictable. In response to this rapid growth in advancement, the scientists at the forefront begin to establish a disciplinary matrix. This is a necessary step given

that the old matrix' theories, methods, and values did not account well for the findings. This amounts to a "paradigm shift." New theories are developed with which to derive hypotheses. New instruments and measures are developed with which to test these hypotheses. Perhaps, most importantly, a new set of values are put in place which typically divides the revolutionary scientists from those that are either defiant or content to continue practicing normal science as they had. Also, Kuhn makes a clear distinction that revolutionary science is not cumulative (1962/1970, 92). Prior achievements and truths are not retained, nor are they necessarily built on in order to move forward.

A vital and immutable characteristic of the paradigm shift is that the old paradigm is necessarily incommensurable. That is to say, the new disciplinary matrix generated cannot possibly be measured in such a way that it can be compared with the old paradigm; that they share no common measure. Kuhn suggests that since paradigms determine the methods in which normal science is conducted, then puzzle solutions developed in a different period of normal science would be subjected to different rules of verification. This would effectively be as if a European soccer team was to face an American football team. Although both sports trace their roots back to schoolyard rugby, and do exhibit subtle similarities, a match would not fare well if each tried to play by its own sport's rules.

The sports analogy above demonstrates Kuhn's methodological incommensurability. More broadly, given that theories are not fixed – that they are dynamic and dependent on disciplinary matrices from which they were developed – there is not a common mindset which is capable of judging them objectively. Moreover, scientists from competing paradigms likely will have no consensus as to what problems should even address (1962/1970, 148).

Kuhn also argues that a paradigm shift alters the manner in which a scientist is able to perceive the world around them. He argues that perception is heavily based on prior experience and belief. As mentioned above, a shift from one disciplinary matrix to the next results in an entirely different value and belief structure. To demonstrate this, he describes a situation in which an Aristotelian and Galilean look at a pendulum and come to different conclusions. Where the Aristotelian, based on his disciplinary matrix, will conclude that this object simply pendulums repeatedly back and forth, Galileo sees a bound object falling down slowly (1962/1970, 150).

Kuhn's descriptions of the manner in which science progressed were revolutionary. As such, his account of the scientific revolutions received both criticism and praise for his work. His account was lauded by many social scientists that saw Kuhn as the man to validate fields such as sociology and psychology that had been working to make a name for themselves since Popper cast them on the metaphysics side of the demarcation line. In line with Popper, many realists took issue with Kuhn suggesting that allowing people to believe that there is no truth to discover might hinder the pursuit of true knowledge. Here I will provide some critiques of Kuhn's work as well as attempt to paint a picture of a wholly Kuhnian psychology.

Criticism of Kuhn's scientific revolutions begins with the stages through which science traverses from one paradigm to the next. Few would argue that scientists themselves operate within "normal science", however, for some there are disagreements about what is accomplished during these periods. For Kuhn, normal science was a necessary stage. It generated puzzles that would eventually prove inconsistent with the current paradigm, leading to crisis, and ultimately to a revolution. Other scientists saw value in normal science, but for an entirely different reason. Popper described it as for "the science student who accepts the ruling dogma of the day; who does not wish to challenge it... it becomes fashionable by a kind of bandwagon effect" (1970, 52).

In a sense, the psychology landscape largely does look this way and is by no means an accident. Steve Fuller (2004) outlines Kuhn's rise through the American academic system as largely consistent with both Kuhn's description of normal science and Popper's criticism of it. The landscape of psychology falls within Fuller's (2004) descriptions of the worst way forward. Many notable psychologists establish themselves as the head of a paradigm and "monopolize the means of intellectual reproduction, specifically, the terms in which the next generation learns about a past ... they are entrusted to take forward" (2004, 22). This unfortunate consequence perhaps has a deleterious effect on the advancement of psychology as a whole. If Fuller is correct, then it is likely that those establishing "exemplary" work at the top will have to be muted until they fade away or die off.

Another criticism of Kuhn's revolutions comes from Stephen Toulmin (1972). Toulmin takes issue with Kuhn's assertion that science only progresses through revolutionary periods; that science instead progresses through innovation and adaption that resemble evolutionary progress. This evolutionary model posits that science progresses when one concept best explains (adapts) a phenomenon amidst an arena of alternative ideas. While Kuhn might suggest this appears as his "pre-paradigmatic" stage in which there is generally no consensus amongst parties, Toulmin's evolutionary model appears to best explain advances in technology and medicine. Advancements in microprocessor production have led to faster, smarter, and smaller computing devices used to conduct operations Kuhn could only have dreamed of in 1962. There was no paradigmatic shift in medicine from which the sequencing of DNA emerged. However, it is possible that, as Kuhn would suggest, these periods of advancements are in fact periods of revolutionary science, and as such, the actors carrying it forward will remain unaware.

Psychology, at present, appears to be operating more in an evolutionary pace than one which progresses through revolutions and periods of normal science. A Kuhnian psychology would have all fields operate under one disciplinary matrix. Instead, psychology has many competing theories predicting the same outcome. For instance, the resource depletion model (Muraven, Tice & Baumeister, 1998) posits a single resource involved in self-control while Metcalfe & Mischel's (1999) model supports two separate processes. These two models are ultimately irreconcilable yet the latter follows the former in Vohs and Baumeister (2004) Handbook of Self-Regulation. This is merely one example, but a striking one that

psychology, let alone the topic of self-regulation, inside of social psychology, operates under the same disciplinary matrix. While this might appear as “normal science” in meeting the requirement of puzzle solving, there appears to be little consensus as to the disciplinary matrix in which it operates. The APA alone has 54 divisions, many of which have their own fields, conduct their own conferences, and publish their own journals largely in isolation with one another.

Considering psychology as either good or bad depends largely on the goal of psychology in the first place. If the goal is to understand the manner in which humans behave to the best of our ability, then yes, a Kuhnian approach would be a sufficient model under which to operate. Kuhn’s anti-realist perspective allows for paradigms to shift and allows for reality to shift as well. This approach is perhaps necessary when dealing with humans as opposed to physics. Psychologies of peoples do shift over hours, over days, over millennia. Kuhn simply proposed a way to keep up.

1.3 Popperian Philosophy

Whereas Kuhn might have considered science as a tool for an institution to discover knowledge, Popper was determined to uphold science as the window through which discovery and truth are viewed. Popper’s contributions to science, philosophy, and history are widespread and well entrenched in the manner through which scientists conduct science. That being said, the following section will be limited to Popper’s take on the problem of induction and his resolution of falsifiability.

British philosopher David Hume (1888) first addressed the issue of induction in stating connections should not be made “which cannot lead us beyond the immediate impressions of our memory and senses” (p 89). Essentially establishing the principle of induction (making universal statements from few observations), Hume immediately refutes it as insufficient. He instead recommends that “demonstrations,” or previous observations, to make assertions about the connections that had taken place.

Popper adopted Hume’s criticisms of inductive logic in his efforts to contradict the induction-based verificationist view of science. Popper objected to the notion that a theory can be proven true, or at least probable, by cumulative observations consistent with the theory’s predictions (Carnap, 1966 p. 20). Seeking verification for theory amounts to inductive reasoning, and given inductive reasoning was not considered to exist to Popper (2002, p. 18), would therefore not be considered scientific.

Popper took to induction by showing that verifying a theory with an observation allows still for the possibility of the theory being false. Consider the following (amended from Trafimow, 2012):

- Premise 1} If all cats are red, then the next cat I see will be red
- Premise 2} I see a red cat
- Conclusion} Therefore, all cats are red

This syllogism does not account for any blue cats that might exist elsewhere. Popper proposed structuring theories in such that when premise two fails to occur, the conclusion is false:

- Premise 1} If all cats are red, then the next cat I see will be red
- Premise 2} I see a blue cat
- Conclusion} Not all cats are red

Illustrated here is an example of the Popperian method of falsification. If a scientist were to put forth a theory suggesting that all cats were red, then the best method to test his theory would limit him focus to searching for only non-blue cats. The use of inductive logic does not put a theory at risk by predicting observations which would necessitate its dissolution. Therefore, any proposition should be put up to tests in which the observations are irreconcilable with the predictions of the initial proposal. If an experimental finding is inconsistent with the propositions predictions, then the proposition has been falsified. However, if the proposition successfully withstands this scrutiny, the proposal has passed a “severe test,” allowing it to stand as a prominent theory for the time being (2002, p. 94).

While some might suggest that Popper’s corroboration is simply verification in reverse and that he simply snuck a method of induction in through the back, Popper insists differently. Popper holds that any theory that has been corroborated many times is no more likely to be true than any other theories; a better theory simply has yet to be proposed. His stand against all things induction would not allow him to admit that corroboration did, at least subjectively, offer verification to the theory holding prominence.

The field of psychology relies heavily on the principles of induction and inferential reasoning. The matter seems simple in that there is no feasible manner in which to test, as of now, a theory regarding the manner in which people behave on every single person. For instance, perhaps a natural response to the first syllogism above might be that since only red cats have been observed, a suitable conclusion would be that most cats are red. That is, it is highly probable all cats are red, and it would be a pretty good bet if you guessed that the next cat would follow suit. Popper takes issue with this as well, stating:

“For if a certain degree of probability is to be assigned to statements based on inductive inference, then this will have to be justified by invoking a new principle of induction, appropriately modified. And this new principle in its turn will have to be justified, and so on. Nothing is gained, moreover, if the principle of induction, in its turn, is taken not as ‘true’ but only as ‘probable’.” (2002. p. 6)

The field has come a long way in attempting to standardize the methods through which it makes its conclusions. There have been attempts to establish internal, external, and construct validity to our measurements in order to best rule out alternative explanations. And while null hypothesis significance

testing has its flaws (see Trafimow, 2003), as most probabilistic statistics do, the field may very well be one Kuhnian shift from developing a new method of hypothesis testing that offers more validity.

One aspect that Popper appeared to miss early on, that he seemed to accept by the time he wrote *Conjectures and Refutations* (2002), was Duhem's (1914/1954) concepts of auxiliary hypotheses (later addressed at length by Lakatos, 1978; Quine 1952). Duhem asserted that when testing any principle, one must take into consideration the necessary conditions for which a prediction of that principle should occur. That is, one must consider auxiliary assumptions when constructing and interpreting the results. An excellent example of an auxiliary assumption regarding measurement comes from Boghossain (2001):

“Suppose that an experiment observation is inconsistent with a theory that you believe: the theory predicts that the needle will read “10” and the needle does not budge from zero.
... This does not necessarily refute the theory”.

Boghossain is illustrating here Duhem's notions that results do not occur in a vacuum – that when a prediction fails, it is not necessarily for the weakness of the theory but that it could always be the case that the result occurred as the result of an (un)intended auxiliary cause.

This is a very important concept in psychology, and one Popper probably would not care to address. When a psychologist makes a prediction about how a person will behave, they are making this prediction based on the auxiliary assumption that everything used to take the measurements are valid. The scales being used have internal consistency. The manipulations have been verified to work. The hand grip has been calibrated. The wildest, most unpredictable auxiliary assumption, however, is that the observational unit – the person works correctly. This is something that psychology must continue to struggle with, as it is a very large hurdle to overcome. However, until Popperian logic dictates a consistently valid way to measure possible the most inconsistently behaving observational unit, probability and inference will have to be our best bet.

1.4 Revolution and Falsification in the Social Sciences - Ego Depletion

Perhaps the most glaring demonstration of the weaknesses inherent to Kuhn's and Popper's science philosophies is the story (or perhaps, tragedy) of ego depletion. To not spend too much space on the topic here (as it is also addressed in another section), I will provide a brief description, albeit a bit of an ad-hoc historicism, of how ego depletion navigated the stages of Kuhn's revolutions, how falsification is currently being applied, and the downsides of each.

1.4.1 Development of a paradigm

Prior to the 1990's, theories on self-control fell into what Thomas Kuhn identified as “immature science.” Researchers operated largely independently of one another, producing results from different

disciplinary matrices. For example, Carver and Scheier (1982) described a negative feedback loop which would come to be called the *Control Theory of Self-Regulation*. The process through which people alter their behavior in order to obtain a goal, according to Carver and Scheier, uses this feedback loop in an effort to reduce the discrepancy between their current behavior and the behavior necessary to obtain that goal.

Other research in the area of self-regulation demonstrated that some people are able to exert self-control more consistently than others. Mischel, Shroda, and Peake (1988) showed that four year-old children who were better at a delay of gratification task were in better academic standing after ten years than those that performed poorly on the task. This study provided evidence that small children who were able to forgo immediate gratification for the sake of a longer term goal were also likely to immerse themselves in their studies rather than play enjoyable video games as young adults.

Beginning in the mid 1990's, research on the topic of self-control received a resurgence due in large part to the research of Roy Baumeister and colleagues. Baumeister, Heatherton, and Tice (1994) had observed that one's ability to exert self-control appears to decrease over a period of repeated use and asserted that the ability to self-regulate stems from a centralized, finite resource which, when accessed, remains subsequently depleted until a sufficient refractory period has elapsed. Muraven, Tice, and Baumeister (1998) identified their resource depletion model through studies that showed that, indeed, participants who exerted self-control at one time were less capable of regulating their cognitions and behaviors afterwards.

1.4.2 Normal Science

With the resource depletion paradigm established, social psychologists sought to uncover the limits of the model through puzzle solving. While the broadest explanation of the resource depletion model is that exerting an initial effort will reduce the likelihood that control can be exerted subsequently, puzzle solving laid out myriad domains, or spheres, of control that were affected by depletion. Baumeister and Vohs (2007) categorized (but did not limit) these self-control task spheres as a) controlling attention, b) controlling emotions, c) controlling impulses, d) cognitive processing, f) choice and volition and g) behavioral persistence (see Hagger et. al, 2010 for a meta-analysis of ego depletion studies).

Despite the preponderance of supporting evidence in favor of the resource model of self-control, one major question haunted Baumeister and colleagues' explanation of self-control: If self-control relies on a centralized resource for all acts of cognitive, emotional, inhibitory, and behavioral, then what is that resource? Can ego depletion be explained by some physical presence? Or is this control resource inherently metaphysical?

1.4.3 Crisis

In response to calls for physical evidence of this central resource, Gailliot et al. (2007) produced a series of experiments demonstrating that the presence of glucose in the blood, being metabolized in the brain, was the physical source responsible for one's ability to exert self-control. Gailliot and colleagues' findings maintained the model's elegant simplicity in that they identified a simple carbohydrate responsible for humans' ability to regulate myriad aspects of voluntary behavior.

The glucose explanation was not without its critics, however. In a scathing critique of the glucose model of self-control, Kurzban (2010) outlined the process the body undergoes when metabolizing glucose. He notes that this metabolism of blood glucose in the periphery (glucose levels were drawn from participants' finger tips) is unlikely to reflect any changes in the presence of glucose in the brain.

In addition to the issues of glucose metabolism in the brain, further research has suggested that the ingestion of glucose is not necessary for substantial buffering against ego-depletion. Hagger and Chatzisarantis (2013), citing findings from exercise physiology, found that swishing or gargling (but not swallowing) a glucose solution was just as effective at buffering against the effects of ego-depletion as Gailliot et al. (2007) had reported of those ingesting a glucose solution. Hagger and Chatzisarantis (2013) explain that merely the presence of glucose in the oral cavity activates dopamine channels responsible for sensing reward and, in turn, renders individuals less prone to self-regulatory failure on subsequent tasks.

A meta-analysis conducted by Hagger et al. (2010) has proven to be a vital inflection point in the story of ego depletion. While initially, this paper provided support for the presence of ego depletion, the methods employed did not account for the possibility of publication bias, small-study effects, or *p*-hacking. In light of larger replication issues in the social sciences, Carter and McCullough (2014; Carter, Kofler, & McCullough, 2015) conducted reanalyses of Hagger et al.'s meta-analysis. The first reanalysis showed evidence of publication bias (2014), while the second (2015), which included previously unpublished data from solicited from researchers' "file drawers", let Carter et al. to conclude they "find very little evidence that the ego depletion effect is a real phenomenon" (p. 796).

In addition to these reanalyses, several critical tests intended to falsify ego depletion have since been conducted. These experiments were largely preregistered, reducing at least the possibility that potential null findings would be relegated to the proverbial file drawer. A large-scale, registered replication report (RRR), conducted by Hagger et al. (2015), was unable to find support for ego depletion. Overall, the experiment across the 23 labs revealed a null effect. Osborne et al. (2016) was unable to replicate Masicampo et al.'s (2008) glucose findings. Lurquin et al. (2016) was unable to replicate ego depletion on cognitive regulation tasks.

Most recently, and perhaps most damning, Etherton et al. (2018) conducted 12 small studies traversing depletion procedures and dependent control tasks. In three groups of four independent studies,

participant either 1) crossed out letter (or did not) and then solved anagrams, 2) Stroop task on hand grip persistence, or 3) wrote a story without (or with) using the letters *a* or *n*. Of these 12 studies, only one returned a statistically significant ($p < 0.05$) instance of a control group performing better than a depletion group.

1.4.4 Discussion

As I hope to have demonstrated, the Kuhnian and Popperian approaches to science produced some positive and some negative outcomes in their application to ego depletion.

First, the scientific revolution did some good for researchers. From a sociological perspective (the perspective Kuhn was arguably taking), the ego depletion revolution created a great number of personal and professional communities and relationships. When a paradigm unites researchers, it not only provides a framework for talking about science; it also creates opportunities for professional growth, for collaborations, and for friendships. From a humanist perspective, the scientific revolution has been arguably beneficial. From a scientific perspective, however, we are no closer to a consensus on how self-control operates than we were 30 years ago.

The Popperian approach of applying falsification to ego depletion assuredly would have prevented a 15-year period of minimal progress and puzzle solving. From a Truth-seeking perspective, conducting critical tests of ego depletion early on would have likely falsified the theory (as opposed to corroborating evidence that piled up over time). From a pragmatist or utilitarian perspective, however, a hypothetical analysis must be conducted to determine whether conducting “good,” Popperian science would come at significant cost to the livelihoods created from those publishing in the ego depletion literature.

One final problem with a strictly Popperian approach to science is whether critical tests that falsify theories indeed impact the scientific community’s perception of those theories. Recall above where a number of preregistered studies, supplemented by reanalyses, repeatedly failed to replicate support for ego depletion. As Kuhn would argue, scientific theories are partly sociological, and in this instance, it seems as though this theory is difficult for researchers to let die. In the first three months of 2020 alone, nearly 500 studies articles about ego depletion have been published. So, while it would be ideal for a critical test to put ego depletion to bed, perhaps it is as Jerry Seinfeld said about the dissolution of relationships: “Breaking up is like knocking over a Coke machine. You can’t do it in one push, you gotta rock it back and forth a few times and *then* it goes over.”

1.5 Conclusion

The best approach for psychology weighs more on the Kuhnian perspective rather than the Popperian. Popper’s stance on science was too strict to operate in a functional field of psychology. His fierce stance against all inferential reasoning would force the field to focus on itself constantly. Take for example a

researcher who investigates the antecedents to domestic abuse. According to Popper, it would be of no value for this researcher to infer from her findings that what she has observed in the lab might help stop one child from being beaten. Even if it is not falsifiable, at least Kuhn's "normal science" would eventually level it out.

Kuhn appears to be more pragmatic about approaches to science. His observations involve the manner in which scientists interact with one another, which is inherently a social and psychological experience. His anti-realist perspective also allows for science to cater best to the world which it serves. This is an important point as well. The objective of psychology is necessarily to understand the manner in which humans behave, but it must serve some pragmatic value to the humanity that allows it to operate in the first place.

1.6 References

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