What is Dead and Alive in Logical Positivism Today?

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1. Introduction

Logical positivism was an ambitious project in the 1920s and 30s that aimed to provide a concrete framework for scientific communication.[1] The goal was to reduce scientific knowledge to empirical statements verified by sense data and logical formulation.[2] The project failed for various reasons, such as being overloaded with complicated information and an inability to account for scientific laws, metaphysics, and ethics. However, there are still some faint lessons to be learned today. These lessons can be drawn from what remains of logical positivism today. While logical positivism as a movement and a theory is not discussed today, its core ideas—such as cognitive meaning in scientific hypotheses, the verifiability principle, and the push for precise language—still emanate in current scientific methodology. In this paper, I will explore which elements remain relevant in scientific discussions.

In section 2, I will review the history of logical positivism, mainly focusing on the works of R. Carnap and O. Neurath. In section 3, I will review examples of reasons why the project failed. In section 4, I will focus on three areas of logical positivism observed in current scientific practices, including the cognitive meaning of scientific hypothesis (4.1), the verifiability principle (4.2), and precise language (4.3).

1 "Logical Empiricism (Stanford Encyclopedia of Philosophy)," *Stanford Encyclopedia of Philosophy*, September 21, 2022, https://plato.stanford.edu/entries/logical-empricism.

2 "Logical Empiricism."

2. Brief History of Logical Positivism

Logical positivism was a movement in philosophy that began in the early 1900s, and the goal was to unify science under the same language framework. Its goal was establishing firm rules for the empirical formulation.[3] Empirical knowledge refers to statements whose truth can be verified by observation or logical reasoning. Some leading movement proponents were part of the Vienna Circle, such as Rudolf Carnap, Otto Neurath, and many more. The logical positivism project was concerned with scientific methodology. Its ultimate goal was to unify science under a framework that could be empirically verifiable .[4]Simply put, scientific statements should be precise and testable by experimentation. If they are only theoretical, they should be proven through logical formulations.

Neurath's essay from *Logical Positivism* on the protocol sentences is an excellent example of an essay that emerged from the movement. The book itself is about reductionism and scientific knowledge's verifiability. Neurath discusses the imprecision of scientific language. He argues that we should strive to eliminate vague and metaphysical terms only to have a precise physicalist language.[5] Metaphysical terms are statements that cannot be empirically observed or proved through mathematics, such as the soul. We cannot see the soul nor have tests that can verify its existence. This is also called the verifiability requirement; for a sentence to count as scientific knowledge, it must be verifiable by experimentation that will yield observable facts or sound logical formulation.[6]

Returning to the idea of reductionism, Neurath's statement should be condensed. It should be reduced to a concise physicalist version that can be empirically verified. This also means that some statements, even if observable, are more accurate than others. For example, "Otto is observing an angry person" is less precise than "Otto is observing a thermometer reading 24 degrees".[7] That is because many variables affect whether we deem a person angry.

Additionally, it is also a subjective evaluation. In contrast, a thermometer at a specific temperature is universal. Its reading leaves no room for widely different interpretations of the temperature. That is why, in science, ordinary language should be replaced with the physicalist language of advanced science, which is reduced and verifiable by observation.

Neurath suggests using protocol sentences to make scientific statements more precise. A protocol sentence is a factual sentence where a personal noun occurs multiple times with specific association to other terms.[8] An example of a simple

3 "Logical Empiricism."

4 "Logical Empiricism."

5 "Otto Neurath," *Stanford Encyclopedia of Philosophy*, March 1, 2024, https://plato.stanford.edu/entries/neurath/.

6 Carl G. Hempel, "Problems and Changes in the Empiricist Criterion of Meaning," *Revue Internationale De Philosophie* 4, no. 11 (1950): 41–63, https://jwww.jstor.org/stable/23932368.

7 "Otto Neurath."

8 "Otto Neurath."

protocol sentence would be, "Otto now sees a red circle".[9]

An established list of true protocol sentences must be created to achieve unified science. This list would be essential for a consistent framework in scientific writing.[10] In theory, this list would be composed of empirical scientific truths upon which more research could be built. However, empirical observations often change, so the protocol sentences should also change if that happens. This is crucial because we cannot have two conflicting protocol sentences in the same framework. If we did, such conflicts would prevent the system from being unified.[11] This means there would also need to be a protocol to decide which protocol sentence should be eliminated.

Rudolf Carnap was another proponent of logical positivism who also worked on protocol sentences and reduced scientific knowledge to neutral ones to help unify the scientific language.[12] Carnap states that every scientific statement should be based on and be reducible to statements solely of empirical observations. So instead of asking, for example, "What kinds of words occur in protocol sentences?" it would be more precise to reformulate it as "What objects are the elements of a given direct experience?".[13] Once again, by learning how reducing statements to a physicalist language works, they could translate statements from different branches of science into a unified language.

Carnap also argues that statements should be verifiable through logical syntax. An argument based on empirical evidence could be translated into a set of unified symbols.[14] For example, if empirical properties A and B are the same, they could be written as A=B. Nevertheless, the project of scientific unification ultimately failed due to various reasons, including the verifiability principle and reductionism.

3. Reasons Why the Logical Positivism Project Failed

Logical positivism burned bright in the early 1900s but died in the next forty years due to various issues, such as those with the verifiability principle. One significant outcome of logical positivism was that all non-analytic knowledge must be based on experience, which excludes large parts of metaphysics, ethics, and aesthetics.[15] For a statement to have a meaning, it must be testable or observable.[16] So, for example, we have a sentence, "I see a red apple now." My observation confirms its empirical meaning on the assumption that I have pre-

9 "Otto Neurath."
10 "Otto Neurath."
11 "Otto Neurath."
12 "The Unity of Science," *Stanford Encyclopedia of Philosophy*, January 9, 2024, https://plato.stanford.edu/entries/scientific-unity/.
13 "The Unity of Science."
14 "The Unity of Science."
15 Hempel, "Problems and Changes," 1950.
16 Hempel, "Problems and Changes," 1950.

vious knowledge of what red means. However, as Carl Gustav Hempel indicates, this type of filter excludes large parts of science that are not verifiable in this way. For example, this excludes general laws as they cannot be conclusively verified by observational data.[17] This also raises the question of what kind of verification is enough to be scientific knowledge.

One issue with the verifiability of a scientific statement is that we do not know what counts as enough experimental evidence for a statement to be scientific. For example, the existence of electrons has been proven through experiments such as the one by J.J. Thomson with cathode ray tubes and others.[18] However, whether this evidence is enough is unclear because we cannot directly observe all the electrons or infer knowledge from our observations at any given point.

Logical positivism also failed to encompass objective truths that do not have empirical evidence.[19] For example, the theory of relativity, for which we do not yet have any experimental evidence that would fully explain all of its moving parts. If we cannot directly observe it, it would not count under logical positivism as good scientific knowledge. All a priori statements, knowledge acquired without experience, would not have a place in the unified science.

Scientific theories are complex, and some argue that logical positivism has also failed to encompass its complexity.[20] Logical positivism fails to encompass complex scientific theories that derive inference from multiple sources of evidence and thus are not only a collection of isolated statements that can be verified by observation. Nevertheless, there are many other reasons why the project ultimately failed in unifying science under one language framework. However, some valuable lessons can be learned from it that can inform our scientific practices. Specifically, I will talk about the cognitive meaning of the scientific hypothesis (4.1), the verifiability principle (4.2), and precise language (4.3).

4. Valuable Lessons From Logical Positivism

Despite its ultimate failure of logical positivism, it still introduced some key ideas to scientific reasoning, methodology, and writing. The following sections will explore three aspects that remain relevant today.

4.1. Cognitive Meaning of Scientific Hypothesis

Hempel was concerned with empirically verified statements and those that could be verified or falsified against empirical evidence, which he called cognitively meaningful. For example, let us say we have a statement: "All apples are

17 Hempel, "Problems and Changes in the Empiricist Criterion of Meaning," 1950.

18 Allison Marsh, "Did J.J. Thomson Discover the Electron?" *IEEE Spectrum*, November 22, 2022, https://spectrum.ieee.org/discovery-of-the-electron.

19 Hempel, "Problems and Changes in the Empiricist Criterion of Meaning," 1950.

20 Hans Poser, "The Failure of Logical Positivism to Cope With Problems of Modal Theory," in *Synthese Historical Library*, 1988, 311–27, https://doi.org/10.1007/978-94-009-2915-9-8.

red." We do not know whether that is true or false, but we can empirically verify that by looking at various apples. Someone then goes into an orchard and observes all of the apples there; if they are all red, they have evidence supporting their claim, and if some are green, they have a reason to refute the statement. This means that the statement "all apples are red" is cognitively meaningful even though it is not empirically verified. We can go into the real world and check. Some sentences are not cognitively meaningful.[21] For example, the sentence "All mothmans are rainbow" is not cognitively meaningful because it is based on a fictional figure, so we cannot go to the real world and check through our library of empirical observations.

The idea of cognitively meaningful sentences can be expanded to a scientific hypothesis.[22] Hempel states that the hypothesis still has meaning even without implying that there are possible tests that would reveal whether it is confirmed by observation. This goes against logical positivism's notion that empirical statements are the only scientifically meaningful sentences. Hempel argues that to understand a hypothesis in empirical language, we must look at what observational sentences contain and what non-observational empirical sentences are related. This would help us determine whether the hypothesis confirms or disagrees with the empirical statements.[23]

Cognitively meaningful sentences can also help us make better scientific predictions. If we have an established set of empirical statements for which we have solid evidence to believe to be accurate, introducing a hypothesis and estimating whether it is correct before designing an experiment to test is a meaningful analysis. We can have a central hypothesis we wish to test and an alternative one if we do not get the expected results. For example, fish have a sensory system called the lateral line system on their skin that helps them detect water flow.[24] Based on the assumption from our empirical research, we know that this lateral line system can detect vibrations, so if we expose the fish to an oscillating probe, we may hypothesize that if the fish feels it, it will swim away.[25] However, from another set of empirical statements, we also know that the fish hearing system can detect vibrations in water.[26] So, let's run the experiment, and the fish swim away. It informs us that either hypothesis could be true, which is still cognitively informative but does not produce another empirical statement.

When multiple hypotheses are possible, empirical statements from a

21 Hempel, "Problems and Changes," 1950.

22 Hempel, "Problems and Changes," 1950.

23 Hempel, "Problems and Changes," 1950.

24 Matthew S. Weeg and Andrew H. Bass, "Frequency Response Properties of Lateral Line Superficial Neuromasts in a Vocal Fish, With Evidence for Acoustic Sensitivity," *Journal of Neurophysiology* 88, no. 3 (September 1, 2002): 1252–62, https://doi.org/10.1152/jn.2002.88.3.1252.

25 Weeg and Bass, "Frequency Response Properties."

26 Weeg and Bass, "Frequency Response Properties."

positivist framework can help us create better experimental predictions. This is already being done, and it uses part of what Hempel discussed in terms of cognitively meaningful sentences.

4.2. Verifiability Principle

Rynin defends the verifiability principle by stating that it permits us to reformulate sentences and cognitive statements, which helps develop a semantics system. He argues that if we have a statement P, it will only be valid under necessary and sufficient conditions to establish the statement as true; he calls this the sufficient truth condition.[27] The same applies to cognitive statements: for them to be true, there has to be a condition that makes them true. Rynin argues that for a cognitive statement to have meaning, it has sufficient and necessary conditions under which it is either true or false. However, there are two types of cognitive meaning.

The first type of cognitive meaning is 1) the concept of cognitive meaningfulness and 2) the concept of cognitive meaning.[28]
A sentence is meaningful if it has a necessary or sufficient truth condition determining whether it is true or false. For example, if I have a statement, "I see a red apple now," and I have a necessary condition where the thing I am looking at is red, but that is not sufficient because I see a strawberry, my observation is false. However, if the condition is necessary and sufficient, it will yield a true condition. Rynin argues that when we try to explain the meaning of a statement, we need to do so through necessary and sufficient conditions. So, going back to the red apple, an object is a red apple if and only if it is red and possesses all the characteristics of an apple. This is why Rynin states that just because we know a statement is meaningful does not mean we understand its meaning because it needs to be explained in a sufficient and necessary condition, thus confirming the verifiability principle.[29]

For Rynin, the meaning of statements is composed of sufficient and necessary conditions, and if a statement does not fulfill it, it is deemed cognitively meaningless. For example, let us take the statement "For any substance, there exists a solvent," in which we cannot specify the necessary and sufficient conditions, so it would be deemed cognitively meaningless in terms of the verifiability principle.[30]

There is some scientific use for the distinction of proposition P being meaningful versus having meaning in terms of providing context. If I go back to the solvent example, it may be necessary for my solvent to be poler to dissolve

27 David Rynin, "Vindication of L*G*C*L P*S*T*V*SM," *Proceedings and Addresses of the American Philosophical Association* 30 (1957): 45–67, https://doi.org/10.2307/3129288https://www.jstor.org/stable/3129288.

28 Rynin, "Vindication."

29 Rynin, "Vindication."

30 Rynin, "Vindication."

the substrate, but that may not be sufficient if it does not have the correct concentration. In that sense, I have a helpful observation that does not achieve the final goal. The necessary and sufficient condition rule for verifiability is helpful for methodological writing within the scientific context.

4.3. Precise Language

Many modern scientific papers use the passive voice rather than the active voice, which may be a fragment of logical positivism. The preference for passive voice may stem from logical positivism's goal of depersonalizing scientific claims and thus making them appear more objective and universally valid.

Part of this discussion of using precise language involves protocol sentences. As stated before, a protocol sentence is a factual sentence where a personal noun occurs with a specific association with other terms.[31] A protocol sentence that may be found in a scientific journal may look like "The experiment found that there was an increased amount of protein X." Here we have the noun and an association it found. Usually, scientific writing steers away from using a first-person perspective that would instead state, "We found that there was an increased amount of protein X." One of the goals of logical positivism was to make scientific knowledge more factual and reduced such as stated in the theory of reductionism by Carnap.

This notation may make science look more like an objective truth rather than inferential evidence. From the perspective of logical positivism, a meaningful scientific statement must contain an empirical claim, which both first-person and passive-voice statements can contain. However, looking at Carnap's examples of reduced sentences, I am not surprised if formulating scientific more objectively, aka in passive voice, is preferred as they appear more empirical. Even though, as mentioned by Neurath protocol sentences need to be reviewed if proven wrong or inconsistent with the other ones, making them appear more objective truths rather than something a person designed and tested may add to their false sense of credibility.

5. Conclusion

The Vienna Circle project for the unification of science attempted to create a solid foundation for precise and reduced language, but it ultimately failed to implement this idea. However, some of its proponents' ideas are still used. For example, Hempel's theory of cognitive meaningful sentences can be expanded to a hypothesis, and one should be based on previous empirical findings. Another example is Rynin's attempt to salvage the verifiability principle by introducing the distinction between meaningful sentences and the meaning of a sentence. His formulation helps advise using sufficient and necessary conditions when explaining experienced outcomes. Lastly, even if uncertain, the passive voice used

31 "Otto Neurath."

in scientific writing may be a reminder of logical positivism's attempt to create an objective empirical statement about scientific knowledge. So, even if logical positivism is mainly regarded as a dead movement, cognitive meaning in scientific hypotheses, the verifiability principle, and the push for precise language are still present in contemporary science.