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Article

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ŁUKASIEWICZ AND QUINE ON EMPIRICAL AND *A PRIORI* SCIENCES

SUMMARY: Although Łukasiewicz and Quine do not share many common views, they agreed on one important point in the 1950s: they both denied the distinction between empirical and a *priori* sciences. This agreement might be surprising as this denial was rather controversial at that time. This paper focuses on Quine's and Łukasiewicz's denials of the distinction between empirical and a *priori* sciences, and proposes three possible answers to the question of why both formulated the same conclusion at a similar time. Firstly, it discusses Quine's possible influence on Łukasiewicz as Łukasiewicz agreed with Quine's criticism of modality at that time. Secondly, it considers the possibility that Quine was affected by Łukasiewicz via his debates with Łukasiewicz's student, Tarski. Lastly, it takes into account the possibility that both philosophers were inspired by an external source, namely the rise of quantum mechanics.

KEYWORDS: W. V. O. Quine, Jan Łukasiewicz, analytic-synthetic distinction, reductionism, holism, four-valued logic, a *priori* sciences, empirical sciences.

Quine's paper, *Two Dogmas of Empiricism*, is one of the most influential, and also controversial, papers in the history of analytic philosophy. In it, Quine famously denied two convictions that were accepted in analytic philosophy but which, according to him, were unsustainable: the distinction between analytic and synthetic statements, and reductionism. These views led to his holism, but also to another denial—namely, the denial of the distinction between empirical and a *priori* sciences.

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Quine was not the only philosopher who held such controversial views in that period. He admitted that he was stimulated by his discussions with Alfred Tarski, Morton White and Nelson Goodman (see Quine, 1991, pp. 267–268). However, he did not mention another logician who argued against this distinction at a similar time: Jan Łukasiewicz. This paper aims to discuss why these controversial claims appeared in the views of representatives of different traditions in analytic philosophy and investigates the possible interaction between them in the formulation of the denial of the distinction between empirical and a *priori* sciences.

There are three possible ways such state of affairs may have occurred. Firstly, Łukasiewicz could have been affected by Quine's views, as Quine published his paper, *Two Dogmas of Empiricism*, prior to Lukasiewicz's book, *Aristotle's Syllogistic from the Standpoint of Modern Formal Logic,* in which the latter presented his views. Secondly, Łukasiewicz could also have influenced Quine, who visited the University of Warsaw in the '30s and who, as was mentioned previously, also discussed his views with Łukasiewicz's student, Alfred Tarski. Finally, they both could have been affected by a global event: the rise and development of the natural sciences.

QUINE'S *TWO DOGMAS OF EMPIRICISM*

Quine published *Two Dogmas of Empiricism* in 1951. He claimed, however, that certain lines of argumentation that appeared in this paper could be traced back to his years at college (see Quine, 1991, pp. 265–266). The path to the formulation of his attack on the analytic-synthetic distinction and on reductionism, however, was not straightforward. The main arguments of the paper are directed against Rudolf Carnap, whom he admired (see Quine, 1991, p. 266). The precise moment at which he abandoned the possibility of differentiating between analytic and synthetic statements is still vividly debated by historians of logic (see Creath, 1990, pp. 28–36; Mancosu, 2005, p. 331; Isaac, 2005, pp. 228–229; Frost-Arnold, 2011).

Quine (1991, pp. 266–267) suggested that his first criticism of Carnap's views could be found in his paper, *Truth by Convention*, from 1935. Creath (1990, pp. 28–30) points out, however, that this paper was based on Quine's lectures concerning Carnap's most recent philosophy. The lectures contain explanations of Carnap's analytic truths, even though Quine also pointed out conditions under which analytic truths are untenable. Creath claimed that, when Quine expressed his doubts about the meaning of the term "analytic" in the paper *Truth by Convention*, it was not meant as an attack, but rather as a plea for clarification.

Quine further discussed the distinction between analytic and synthetic statements with Carnap, Russell and Tarski during World War II, at Harvard University. Those discussions contained a negative approach to the issue, as Quine and Tarski denied the analytic-synthetic distinction. The impulse for formulating some positive results from the denial came, according to Quine (1991, pp. 267–

268), from discussions with Nelson Goodman and Morton White after the war. When the committee of the American Philosophical Association asked Quine to present a paper concerning modern trends in philosophy at their meeting in 1951, he decided to announce these results under the title *Two Dogmas of Empiricism*.[1]

As the title of the paper indicates, there were two dogmas, both of which Quine aimed to deny. Besides the analytic-synthetic distinction, there was also reductionism, i.e. the view that knowledge could be segmented into basic protocol statements, which are evaluated according to our immediate experience and which stand solely upon that evaluation.

Quine's denial of the analytic-synthetic distinction stemmed largely from the lack of clarity surrounding the notion of analytic statements, as was mentioned previously. In his previous works, Quine had tried and failed to find the proper meaning of this term. In *Two Dogmas of Empiricism*, he adopted a similar strategy (see Quine, 1951, pp. 21–34). At first, he tried to make sense of analytic statements using definitions, synonymy, interchangeability, and semantic rules.[2] All these attempts, though, were unconvincing. Quine (1951, p. 34) concluded that there are no genuine analytic or synthetic statements; rather, the truth-value of every statement depends on language as well as the external world.

Quine's (1951, pp. 35–38) second argument was directed against reductionism. Reductionism is the view that every meaningful synthetic statement can be translated into a statement on experience, and thus exerts an impact on empirical evidence. The evidence, however, is just the part of the evidence that concerns the statement. Reductionism reduces its range to just this isolated piece of evidence, which is the main reason why Quine criticised it. Quine (1951, p. 38) claimed, to the contrary, that statements concerning the empirical world are not evaluated separately; rather, their truth-values could be assigned only in aggregate.

Quine (1951, pp. 39–40) pictured human knowledge as a field, whose boundary is affected by empirical evidence. No evidence concerns just one statement; instead, all empirical evidence is incorporated into many statements. Some new evidence might affect true-values of the statements that lie on the boundary of this knowing but, as the statements are connected it could also have an impact on the statements that are further from the boundary. In general, every statement in the field has the potential of being revised. This view was later called "holism" and the field "the web of belief" (see Quine, 1991, p. 272).

The denial of the two dogmas affected Quine's view on the distinction between empirical and a *priori* sciences. Firstly, the distinction between these two

[1] Verhaegh (2018) points out that the importance of *Two Dogmas of Empiricism* was recognised almost immediately. This was surprising for Quine, who was not completely satisfied with his paper.

[2] Creath (1990, p. 12) points out that, in denying the analytic-synthetic distinction, Quine contested also the terms through which he had attempted to define analytic statements as "synonymy", "meaning", "necessity", "self-contradictory" or "is defined as".

kinds of sciences was traditionally based on the analytic-synthetic distinction. Synthetic statements were used in empirical sciences, while analytic statements occurred in a *priori* sciences. Refusing the analytic-synthetic distinction, Quine had to also abandon this distinction. Secondly, the statements of both kinds of sciences, in Quine's view, are parts of the same web of belief (both dependent on empirical evidence and linguistic, logical, and mathematical conventions; see Quine, 1951, pp. 41–43). Consequently, there is no distinction between empirical and a *priori* sciences, according to Quine.

ŁUKASIEWICZ'S VIEW ON EMPIRICAL AND A *PRIORI* SCIENCES

Łukasiewicz is renowned primarily as the founding father of modern many-valued logic. Nonetheless, his interests embraced a wider range of fields, including the philosophy of science and the denial of the distinction between empirical and a *priori* sciences. In a fashion similar to Quine, Łukasiewicz's views underwent a certain development. Woleński (1989, pp. 196–197) points out that, at the beginning of his career, Łukasiewicz claimed that logic is based on a *priori* truths. Although he did not specify his position, it seems that he differentiated between empirical and a *priori* sciences at that time and listed logic among the latter.

When he started to develop many-valued systems of logic, Łukasiewicz began to link logic more with reality. He became convinced that, among several systems of logic that appeared in his period (classical propositional calculus, intuitionistic logic and his system of three-valued logic), only one is valid (see Łukasiewicz, 1970c, p. 233). Łukasiewicz (1970d, pp. 247–248) maintained that only empirical data could provide clues as to which of the systems of logic are proper.[3]

The explicit denial of the distinction between empirical and a *priori* sciences appeared in his final period of writing, in a paper, *Arithmetic and Modal Logic*, and in a book, *Aristotle's Syllogistic from the Standpoint of Modern Formal Logic*. During this period, Łukasiewicz worked on his system of four-valued modal logic. His arguments against the distinction between empirical and a *priori* sciences were introduced during a presentation of this system and are affected by certain features of the system. One of the distinctive features of Łukasiewicz's system of four-valued logic is that he denied the existence of necessary truth (apodictic) statements. No necessary statement could be true in this system of logic. As will be demonstrated further, Łukasiewicz (1970g, p. 394) considered this feature a great advantage of his system. Since apodictic statements were a domain of a *priori* sciences, Łukasiewicz denied the distinction between empir-

[3] In his latest period, Łukasiewicz (1970f, pp. 378–379) abandoned this view and considered systems of logic as instruments that could be used with respect to the aim of the user.

ical and a *priori* sciences with this claim. He was aware of this fact and argued for it directly (see Łukasiewicz, 1957, p. 205):

> Under the influence of Plato's theory of ideas Aristotle developed a logic of universal terms and set forth views on necessity which were, in my opinion, disastrous for philosophy. Propositions which ascribe essential properties to objects are according to him not only factually, but also necessarily true. This erroneous distinction was the beginning of a long evolution which led to the division of sciences into two groups: the a *priori* sciences consisting of apodeictic theorems, such as logic and mathematics, and the a *posteriori* or empirical sciences consisting chiefly of assertoric statements based on experience. This distinction is, in my opinion, false. There are no true apodeictic propositions, and from the standpoint of logic there is no difference between a mathematical and an empirical truth.

The phrase "… from the standpoint of logic…" should be emphasised. As will be demonstrated further, Łukasiewicz was primary interested in a system of logic, though he denied the distinction between empirical and a *priori* sciences. He argued that the distinction began in Aristotle's philosophy, namely in his logic and theory of science and led to paradoxical consequences. Łukasiewicz's system of many-valued logic, which does not contain apodictic statements, did not imply this distinction or the paradoxes, however.

ŁUKASIEWICZ AND QUINE ON THE PARADOXES OF MODAL LOGIC AND IDENTITY

Aside from his denial of the two dogmas, Quine was renowned in the '40s and '50s as a prominent critic of modern systems of modal logic. The relevance of his criticism has been questioned (see e.g. Ciecierski & Wilkin, 2008), though there are also authors who see at least some of his arguments as justified (see e.g. Tuboly, 2015). However, the aim of this chapter is not to discuss the relevance of his views, but demonstrate to what extent Quine's criticism influenced Łukasiewicz's system of four-valued logic and, consequently, Łukasiewicz's denial of the distinction between empirical and a *priori* sciences. For that reason, not all of Quine's arguments against modal logic will be introduced; rather, the focus below is on just two arguments that were further discussed by Łukasiewicz.

Quine (1966, pp. 177–178) derived the first paradox that interested Łukasiewicz from the law of substitutivity of identity, namely, from the formula:

$$\forall x\, \forall y\, [(x = y) \rightarrow (\mathrm{F}(x) \leftrightarrow \mathrm{F}(y))]$$

Under the condition that the necessity operator "$\Box$" is not referentially opaque, "F(x)" could be replaced by $\Box(x = x)$ and "F(y)" by $\Box(x = y)$. Since the formula $\Box(x = x)$ is true, according to Quine, the law of substitutivity implies the formula:

$\forall x\ \forall y\ [(x = y) \rightarrow \Box(x = y)]$

which means: "if identity holds, it holds necessarily". This formula, however, contains paradoxical consequences as Quine demonstrated. If "*x*" is replaced by "the number of great planets" and "*y*" by the number "9", then the interpretation of the formula is:

(the number of the great planets = 9) $\rightarrow \Box$(the number of the great planets = 9)

The antecedent of the implication was true according to the majority of astronomers when Quine wrote his paper,[4] hence the consequent of the implication:

$\Box$(the number of the great planets = 9)

should be also true. The truthfulness of it could be questioned, however.

Quine's second argument against modal logic, that Łukasiewicz mentioned in his works, appeared in the paper *The Problem of Interpreting Modal Logic*, from 1943. The paradox concerns the planet Venus, which is also known as the Morning Star and the Evening Star. Quine (1943, p. 47) called the relation which is between Venus, the Morning Star and the Evening Star *congruence* and expressed this relation by an operator "**c**". Congruence is an identity according to empirical evidence. The relation between the Morning Star and the Evening Star could be formalised as:

(Morning Star **c** Evening Star) $\wedge \Box$(Morning Star **c** Morning Star)

and:

$\exists x$ (x **c** Evening Star) $\wedge \Box$(x **c** Morning Star)

but also:

(Evening Star **c** Evening Star) $\wedge \neg\Box$(Evening Star **c** Morning Star)

and therefore:

$\exists x$ (x **c** Evening Star) $\wedge \neg\Box$(x **c** Morning Star)

It appears from the previous formulas that there are two objects; one which is congruent with the Evening Star and is necessarily the Morning Star and the

[4] It is not true currently (10 May 2019), however, as Pluto was excluded from the group of great planets in 2006.

other that is congruent with the Evening Star, but is not necessarily the Morning Star. The paradox lies in the fact that modal logic seems to require a postulation of two or more objects in the situation where there is just one from the empirical point of view (see Quine, 1943, pp. 47–48).

Arthur Prior (1957, pp. 8–9) formulated this argument in natural language as:[5]

1. The Morning Star is necessarily identical with the Morning Star;
2. But the Evening Star is not necessarily identical with the Morning Star (being merely identical with it in fact).
3. But one and the same object cannot have contradictory properties (cannot both be *A* and not be *A*).

Therefore, the Morning Star and the Evening Star are different objects.

Łukasiewicz (1970g, pp. 391–392) presented the issue with the contemporary systems of modal logic and identity in an argument that, to some extent, resembles Quine's paradoxes, but which has certain original features. He claimed that from the law of identity:

1. $a = a$

and the law of extensionality:

2. $(a = b) \to (\delta a \to \delta b)$[6]

could be derived a paradox using the tools of the modal logic that was developed in his time. The two features of the contemporary systems of modal logic that cause the paradoxes were, according to him, the law of necessitation: $\vdash \alpha \vDash \vdash \Box \alpha$ and, further the fact that they allow the truthfulness of apodictic statements.[7] The paradox has the form:

1.	$a = a$	the law of identity	
2.	$(a = b) \to (\delta a \to \delta b)$	the law of extensionality	
3.	$(a = b) \to [\Box(a = a) \to \Box(a = b)]$	the replacement δ / $\Box(a =$	[2]
4.	$\Box(a = a) \to [(a = b) \to \Box(a = b)]$	the law of commutativity	[3]

[5] Łukasiewicz discussed Prior's version of the argument, hence I added it here.

[6] "δ" is a functorial variable and could be replaced by a truth-value, unary operator or a fragment of a formula that is transformed into a function as $p \vee$ or $(\neg p \wedge q) \to$ etc. (see Łukasiewicz, 1970e, p. 313).

[7] Łukasiewicz (1970g, pp. 395–396) entitled the law of necessitation "Aristotle's law", as it appears in Aristotle's *On Interpretation.*

5.	$\Box(a = a)$	the law of necessitation	[1]
6.	$(a = b) \rightarrow \Box(a = b)$	the law of detachment	[4, 5]
7.	$(a = b) \rightarrow \neg\Diamond\neg(a = b)$	Morgan's law for "$\Box$"	[6]
8.	$\Diamond \neg(a = b) \rightarrow \neg(a = b)$	the law of transposition	[7]

The dubious formula that was discussed by Quine appears in Line 6. According to Łukasiewicz, all the theorems that are below Line 5 are paradoxical and the paradox was caused by the use of the law of necessitation.

Łukasiewicz (1957, p. 171) was also able to solve the paradox concerning the Morning Star and the Evening Star in his system of four-valued logic. It has already been mentioned that he excluded apodictic statements from his systems, i.e. they could never be true in his system of four-valued logic. Therefore, the first premise of Prior's formulation of Quine's paradox is not true and the paradox does not arise. In the case of Quine's original formulation, the first and the second premises would be false if they are analysed in Łukasiewicz's four-valued modal logic. Łukasiewicz suggested a system of modals where Quine's paradoxes do not appear. In contrast, the denial of the law of necessitation and the truthfulness of apodictic statements make his system of modal logic somewhat non-standard.

This denial of the law of necessitation and the truthfulness of apodictic statements caused Łukasiewicz to also deny the distinction between empirical and a *priori* sciences. Łukasiewicz was aware of this and appreciated it, as demonstrated in the quotation above. Nonetheless, there is no textual evidence that he was influenced by Quine in this feature. It could be the case that Łukasiewicz denied the distinction between empirical and a *priori* sciences long before the postulation of his system of four-valued logic. As a matter of fact, Łukasiewicz was focused more on a system of modal logic without paradoxes, while Quine stressed the opacity of modal reference and ontological implications in his criticism. Furthermore, it is not certain whether Quine would have appreciated Łukasiewicz's system (that does not imply the previously mentioned paradoxes, but, at the same time, contains quite unusual features).

TARSKI'S INFLUENCE ON QUINE

If there is no conclusive evidence that Łukasiewicz was influenced by Quine in his denial of the distinction between empirical and a *priori* sciences, it could be the other way around. Although Quine, in his paper, did not acknowledge that Łukasiewicz had contributed to his formulation of *Two Dogmas of Empiricism*, he claimed that he was affected by his discussions with Alfred Tarski (see Quine, 1951, p. 20). As Tarski was Łukasiewicz's student at the University of Warsaw, it could be the case that Łukasiewicz influenced Quine indirectly via Tarski.

Tarski was primarily a logician and a mathematician, and his philosophical views were only sparsely revealed in print (see Mancosu, 2009, p. 131). In con-

trast, it seems that he enjoyed a discussion on philosophical issues in personal communications. Quine (1990, pp. 295–296) recalled, in his letter to Carnap, their discussions with Tarski concerning the denial of the analytic-synthetic distinction (where Tarski sided with Quine). Moreover, soon after Tarski's death, Morton White published a letter that Tarski had written to him in 1944. In this letter, Tarski also discussed the analytic-synthetic distinction and the distinction between empirical and a *priori* sciences. Tarski argued there: "I would be inclined to believe (following J. S. Mill) that logical and mathematical truths don't differ in their origin from empirical truths—both are results of accumulated experience" (1987, p. 31).

In addition, Mancosu (2005, pp. 328–329) found evidence that Tarski had held this view even before he met Quine in Warsaw. In Carnap's diary, there is a note that Tarski discussed this issue with Carnap as early as 1930.

From the previously mentioned remarks, it seems that Tarski had a certain influence on Quine's formulation of *Two Dogmas of Empiricism* and, consequently, on his denial of the distinction between empirical and a *priori* sciences. However, there is no evidence that Tarski was the originator of the idea. There are even hints that Tarski was not. In his paper, *Two Dogmas in Retrospect*, Quine (1991, p. 266) quoted another note from Carnap's diary. This note shows that Quine had argued against the analytic-synthetic at Carnap's seminar in Prague, i.e. before he went to Warsaw and met Tarski and other philosophers from the Lvov-Warsaw School:

> Quine, 31.3.33 He says after some reading of my "Syntax" MS: 1. Is there a difference in principle between logical axioms and empirical sentences! He thinks not. Perhaps I seek a distinction just for its utility, but it seems he is right: gradual difference: they are the sentences we want to hold.

Despite the long-term discussion and development of Quine's ideas in the '30s and '40s, it seems that Quine formulated the first doubts concerning the distinction between analytic and synthetic statements, and also between empirical and a *priori* sciences *before* he was aware of Tarski's views. However, Tarski—and through him also Łukasiewicz—affected the final form of his views, as they were presented in *Two Dogmas of Empiricism*.

QUANTUM MECHANICS

It appears that there is neither conclusive evidence that Quine affected Łukasiewicz nor sufficient evidence that it was the other way around. Could there be some third external factor that led both philosophers to the denial of the distinction between empirical and a *priori* sciences? If this is the case, then the most promising candidate for this external factor seems to be the development of the natural sciences in this time period. Among the theories of natural sciences, the most appealing one is quantum mechanics, which appears in Quine's and also Tarski's papers (see Quine, 1951, p. 40; Tarski, 1987, p. 32). There are also clues

that quantum mechanics had a certain influence on Łukasiewicz's views (see Łukasiewicz, 1970b, p. 110).

When Tarski denied the analytic-synthetic distinction and the distinction between empirical and a *priori* sciences, he argued that some empirical evidence could undermine axioms of logic. This, according to Tarski, implies that there is no significant distinction between empirical and a *priori* sciences: the statements of both types of sciences could be questioned. Tarski (1987, pp. 31–32) claimed that a new development of quantum mechanics could affect logic:

> I can imagine that certain new experiences of a very fundamental nature may make us inclined to change just some axioms of logic. And certain new developments in quantum mechanics seem clearly to indicate this possibility.

Among the logicians from the Lvov-Warsaw School, Tarski had one important predecessor in questioning the laws of logic: certain laws of logic had previously been denied by Łukasiewicz. In addition, Tarski's suggestion resembles Łukasiewicz's remarks concerning determinism. Łukasiewicz was an opponent of this view; moreover, his development of many-valued logic was considerably affected by his denial of certain laws of logic, e.g. the law of excluded middle. Łukasiewicz (1970a, pp. 84–86) argued that there are two coercions that force us to believe in determinism: laws of logic and laws of physics.

Łukasiewicz fought the first coercion by the introduction of three-valued and *n*-valued systems of logic, as they do not contain the law of the excluded middle. He also suggested an argument against the second coercion, but was aware that his argument was not conclusive (see Łukasiewicz, 1970b, pp. 117–120). Nonetheless, he was convinced that further developments in physics would confirm his views. In a foreword to his paper, *On Determinism*, Łukasiewicz (1970b, p. 110) argued:

> At the time when I gave my address those facts and theories in the field of atomic physics which subsequently led to the undermining of determinism were still unknown. In order not to deviate too much from, and not to interfere with, the original content of the address, I have not amplified my article with arguments drawn from this branch of knowledge.

It seems that Łukasiewicz had in mind quantum mechanics here. With respect to the fact that Łukasiewicz (1970c, p. 233; 1970d, pp. 247–248) argued in that period for a strong relationship between logic and reality, he could see that quantum mechanics also offered support for his system of many-valued logic.

In similar fashion to Tarski, Quine (1951, p. 40) also used quantum mechanics as an example of the theory of empirical sciences, which could have an impact on a *priori* sciences, demonstrating that every statement could be revised. He claimed:

> Revision even of the logical law of the excluded middle has been proposed as a means of simplifying quantum mechanics; and what difference is there in principle between such a shift and the shift whereby Kepler superseded Ptolemy, or Einstein Newton, or Darwin Aristotle?

Tarski's and Quine's views are quite similar. Both authors suggested quantum mechanics as an example of an empirical theory that could affect a *priori* science. Tarski's claim precedes Quine's, and there is a history of their discussions on that topic (see Frost-Arnold, 2011, p. 301). Therefore, there might be a certain influence between these two authors, though perhaps more Tarski over Quine than vice versa.

In addition, Tarski's claim resembles Łukasiewicz's argument for many-valued systems of logic. Consequently, the role of quantum mechanics in the development of Łukasiewicz's, Tarski's and Quine's view is quite opaque. It seems that Łukasiewicz is the originator of an idea that was later assumed by Tarski (1987, p. 32), and from Tarski by Quine (1951, p. 40). However, the development of quantum mechanics itself probably did not initiate their doubts concerning the distinction between empirical and a *priori* sciences.

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In the '50s, Quine and Łukasiewicz stand among philosophers who denied the distinction between empirical and a *priori* sciences. Although Łukasiewicz was influenced by Quine's paradoxes of modal logic and Quine discussed his views with Łukasiewicz's student, Tarski, there is no clear evidence that Łukasiewicz affected Quine in this view or vice versa. It rather seems that they postulated their views independently. Furthermore, their reasons for denying the distinction differed. Łukasiewicz focused on his system of logic, while Quine was concerned with epistemology and philosophy of language. To conclude, while they formulated similar views, their aims were different.

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