Logic and **L**ogical **P**hilosophy
Volume 35 (2026), 303–309
DOI: 10.12775/LLP.2025.021

Anna Maria Karczewska

The Notion of Temporal Logic and the Problem of Priority

Abstract. The paper addresses Øhstrøm and Hasle's argument against regarding Jerzy Łoś's "axiomatization of a fragment of the physical language" as the first temporal logic. It is pointed out that the arguments are insufficient to establish their claim.

Keywords: temporal logic; tense logic; Jerzy Łoś; realization connective

1. Introduction

A paper by Marcin Tkaczyk and Tomasz Jarmużek (2019) challenged the widespread view on the origin of temporal logic. The authors argue that, notwithstanding Arthur Prior's remarkable accomplishments in the field of tense logic and modal logic in general, it is Jerzy Łoś who invented temporal logic. (From now on, we will refer to this claim as Tkaczyk-Jarmużek's thesis). They make three points in support of their claim: (A) Jerzy Łoś's temporal logic was forged already in 1947, that is, before Prior's first papers on tense logic were published and (B) Łoś's logic was known to the English-speaking world by means of Henryk Hiż's review of Łoś's paper published in *Journal of Symbolic Logic* in 1951; lastly, (C) Tkaczyk and Jarmużek cite evidence suggesting that Prior knew about Łoś's logic when working on his tense logics. Notice that point (A) by itself justifies Tkaczyk and Jarmużek's thesis (that Jerzy Łoś *invented* temporal logic), while points (B) and (C) concern the significance Łoś's invention bears for the subsequent research on temporal logic.

Tkaczyk's claim was rebutted by Peter Øhstrøm and Per Hasle (2019), who objected to the above points (A) and (C). Øhstrøm and

Received September 3, 2025. *Accepted* November 17, 2025. *Published online* November 21, 2025

Hasle's view was upheld, e.g., in (Copeland, 2022; Goranko and Rumberg, 2024; Rybaříková, 2022).

It will be pointed out in the present paper that Øhstrøm and Hasle's arguments are insufficient to establish their claim. The dissatisfaction with the conclusiveness of Øhstrøm and Hasle's argumentation was already expressed by Aleksander Parol (2020). Although we agree in many points with Parol, we offer here different grounds for this dissatisfaction. With regard to Øhstrøm and Hasle's objection to point (A) Parol's diagnosis is that "the authors do not use [the definitions they quote] in any way and abandon the thread of thought" (Parol, 2020, p. 111). In reference to the point (C) Parol claims that "[t]he arguments presented by the authors are psychological in nature and based on the conviction of knowing Prior's intentions and feelings as of 1954. However, such assumptions cannot be part of a serious justification in this historical matter" (Parol, 2020, p. 119).

We argue, instead, that the first argument Øhstrøm and Hasle present involves quantifier shift, while the second one suffers from ignoratio elenchi. The first section of the paper includes an exposition of the authors' conceptual analysis with the distinction of two meanings of *temporal logic*. The second one critically examines that analysis. Last section is concerned with Øhstrøm and Hasle's historical analysis regarding Tkaczyk and Jarmużek's point (C).

2. Broad and narrow understanding of *temporal logic*

Øhstrøm and Hasle address first the claim (A), arguing that Łoś's system does not qualify as temporal, at least not according to "straightforward and commonly accepted understanding of *temporal logic*" (Øhstrøm and Hasle, 2019, pp. 31, 33). The authors appeal to Valentin Goranko and Antony Galton (2015) for an explication of such an understanding and distinguish broad and narrow understanding of the term:

> the term "temporal logic" is sometimes simply identified with "tense-logic", whereas the term understood in a broader sense covers "all approaches to representation and reasoning about time and temporal information within a logical framework".
>
> (Øhstrøm and Hasle, 2019, p. 33)

Compare also:

> Broadly construed, *Temporal Logic* covers all formal approaches to representing and reasoning about time and temporal information. More narrowly, it usually refers to the modal-logic style approach introduced by Arthur Prior in the 1950s under the name *Tense Logic* and subsequently developed further by many logicians and computer scientists.
> Goranko and Rumberg (2024)

Łoś's logic is clearly not temporal in the narrow sense, as its language doesn't include tense operators (nor is provided with relational semantics) and he explicitly states that his system is an "axiomatization of a fragment of the physical language". On the other hand, it is a platitude that temporal logic in this narrow sense was invented by Prior.

Instead, what is at stake here is the authorship of temporal logic in a broad sense. In fact, Øhstrøm and Hasle are interested in the broad understanding of the term. Based on the cited definition, they draw the conclusion that:

> [In other words,] in this broader sense temporal logic should offer a formal language rich enough to *deal with all* [emphasis mine] philosophical and scientific discussions that take the temporal aspects of reality into account. (Øhstrøm and Hasle, 2019, p. 33)

They go on, relying on Prior for an explanation of what makes a logic suitable for "dealing with all philosophical and scientific discussions that take the temporal aspects of reality into account". Such a logic should be "a re-invention of the view of logic in Antiquity and the Middle Ages" (Øhstrøm and Hasle, 2019, p. 34) and embody two ideas regarding time and tense central to Medieval logic, that is:

(i) tense distinctions are a proper subject matter of logical analysis
(ii) truth values are relative to time.

Since Łoś's logic does not include analysis of tenses, and consequently does not meet the condition (i), the (tacit) conclusion is that Łoś's logic isn't temporal.

3. The concept of *temporal* logic*

Øhstrøm and Hasle argument includes some important gaps.

Firstly, despite declarations, the concept of *temporal logic* that it involves is not the "straightforward and commonly accepted understanding", but in fact an understanding the authors themselves coin for the sake of argument. What is supposed to be Øhstrøm and Hasle's para-

phrase of the definition they refer their readers to is neither equivalent to that definition, nor its consequence. Observe that in Goranko and Galton (as well as in Goranko and Rumberg (2024)) all approaches of the specified kind qualify distributively as temporal logic, while in Øhstrøm and Hasle's rendering they qualify as temporal logic collectively. Thus one should read the original definition as:

> for every x, x is a temporal logic, provided x is *an* "approach to reasoning about time and temporal information" or its "formal representation within a logical framework".

Instead, Øhstrøm and Hasle read it in the following way:

> for every x, x is a temporal logic, provided x deals with *all* "approach[es] to reasoning about time and temporal information" and their "formal representation within a logical framework".

As those two are distinct accounts of temporal logic, let us use an asterisk to distinguish the one proposed by Øhstrøm and Hasle and consider it in its own right.

The authors seem to claim that a logic satisfying the postulates (i) and (ii) already qualifies as temporal*. Yet, as (i) and (ii) provide for a "temporal aspect of reality", they only constitute necessary, but not sufficient conditions defining temporal* logic. It turns out every temporal* logic is a tense logic but not *vice versa*!

In fact, it is doubtful, whether Prior's own logic, satisfying both (i) and (ii), should be considered an example of temporal* logic. Suffice it to mention that in his early writings Prior simply dismissed the importance of relativistic physics for the logic of time (see Kofod, 2020). Although he did consider the logic of Special Relativity in Appendix B.5 of his later book *Past, Present and Future*, there is no consensus to this day over whether the logic of special or, even better, general relativity has been entirely worked out (see, e.g., Burgess, 2002; Tkaczyk, 2009).

What is more, the concept of time differs in different areas:

> [...] it is obvious that time plays such a fundamental role in our thinking that there is a clear need for precise reasoning about it, such as we see in Physics, formal Linguistics, Computer Science, and Artificial Intelligence. While these enterprises are not necessarily concerned with the same concept of time, they all could go under the heading of Temporal Logic. (Venema, 2017, p. 203)

Bearing that in mind, temporal* logic may not be feasible at all.

It seems, then, that Øhstrøm and Hasle's conceptual (or terminological) analysis fails at refuting Tkaczyk-Jarmużek's thesis. Łoś's logic is a logic of a connective of temporal realization (*it is the case at . . . that . . .*) and as such it should be considered a temporal logic.

On a side note, Øhstrøm and Hasle's reference to Hans Reichenbach's analysis of tenses may be a testament to the fact, that a modification of a definition is needed: it is not enough to be a "formal approach" to qualify as temporal logic, but it is necessary to be a logic.

4. *Ignoratio elenchi*

Consider now the problem (C) of Prior's awareness of Łoś's work and the possible influence of Łoś on Prior. Tkaczyk and Jarmużek claim that:

> Prior was aware of and inspired by Łoś's ideas when beginning his own work in the field. (Tkaczyk and Jarmużek, 2019, p. 259)

or more precisely:

> [Prior] was actually inspired by Łoś when beginning to work on his first elaborated book on tense logic, i.e., *Time and Modality*. (Tkaczyk and Jarmużek, 2019, p. 274)

The claim is based on the following quote by Prior:

> This calculus [Łoś's - AK] influenced my own formulation of a 'calculus of dates' (using the form *Utp*) in *Time and Modality*, and also has points of resemblance to Rescher's system of 1965. (Prior, 1967, p. 212)

It is evident that Prior himself acknowledged Łoś's priority and influence on his (Prior's) usage of the connective of realization (i.e. Łoś's idea). In order to disprove that, one should present some evidence that Prior had used that connective before he had chance to learn about Łoś.

Instead Øhstrøm and Hasle suggest that Prior could have been overly "conscientious about crediting his influences". To make their point, they cite Prior's works preceding 1955 and which (a) do not refer to Łoś's calculus, (b) are concerned with tense connectives and treat truth as time-relative, i.e. satisfy both postulates (i) and (ii) (Øhstrøm and Hasle, 2019, pp. 35–36). The authors contend that had Prior knew about Łoś, "he would by any reasonable assumption have made a reference to Łoś in the paper" (Øhstrøm and Hasle, 2019, p. 36). That is because: Prior revered and promoted Polish logic, Łoś's notation is more advantageous,

because of Prior's moral character and that he needed support to make case for temporal logic, which was considered contentious at the time (Øhstrøm and Hasle, 2019, p. 36).

Certainly Øhstrøm and Hasle hypothesis that Prior had not read and been influenced by Łoś before August 1954 is better justified than the contrary hypothesis, since under the contrary hypothesis the lack of reference to Łoś in Prior's earliest works remains a mystery. However, this argument suffers from *ignoratio elenchi*, as (i) was absent from Łoś's logic and (ii) was characteristic to ancient and medieval logic, and could hardly be supposed to originate from Łoś's 1947 calculus.

5. Conclusions

Øhstrøm and Hasle present two arguments designed to refute Tkaczyk and Jarmużek's points (A) and (C): conceptual (with respect to the point (A)) and historical one (regarding point (C)). It has been shown that the first argument is based on a blunder concerning quantifiers, and that in fact Øhstrøm and Hasle do not test Łoś's logic against the "commonly accepted understanding" of *temporal logic* but against the understanding they themselves devised. It is claimed next that the historical argument suffers from *ignoratio elenchi*. The authors strive to prove that Łoś should not be credited with influencing Prior's use of tense connectives and treating truth as time-relative, as both are present in Prior's works supposedly preceding the time he knew about Łoś's logic. That is definitely true but does not disprove (C). Because of that Øhstrøm and Hasle fail to refute Tkaczyk-Jarmużek's thesis.

Acknowledgments. I thank Doctor Piotr Lipski for his critical comments on the draft version of the paper.

References

Burgess, J. P., 2002, "Basic Tense Logic", pages 1–42 in D. M. Gabbay and F. Guenthner (eds.), *Handbook of Philosophical Logic*, vol. 7., Dordrecht: Springer. DOI: 10.1007/978-94-017-0462-5_1

Copeland, B. J., "Arthur Prior", in E. N. Zalta and U. Nodelman (eds.), *The Stanford Encyclopedia of Philosophy*, Winter 2022 Edition. https://plato.stanford.edu/archives/win2022/entries/prior/

Goranko, V., and A. Galton, 2015, "Temporal Logic", in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2015 Edition). https://plato.stanford.edu/archives/win2015/entries/logictemporal/

Goranko, V. and A. Rumberg, "Temporal Logic", in E. N. Zalta and U. Nodelman (eds.), *The Stanford Encyclopedia of Philosophy*, Summer 2024 Edition. https://plato.stanford.edu/archives/sum2024/entries/logic-temporal/

Kofod, J.L., 2020, "Arthur Prior and special theory of relativity: Two standpoints from the nachlass", pages 227-247 in P. Hasle, D. Jakobsen and P. Øhstrøm (eds.), *The Metaphysics of Time: Themes from Prior*, Aalborg Universitetsforlag, (Logic and Philosophy of Time, vol. 4).

Øhstrøm, P., and P. Hasle, 2019, "The significance of the contributions of A. N. Prior and Jerzy Łoś in the early history of modern temporal logic", pages 31–40 in P. Blackburn, P. Hasle, and P. Øhstrøm (eds.), *Logic and Philosophy of Time: Further Themes from Prior* (Vol. 2), Aalborg: Aalborg University Press.

Parol, A., 2020, "The influence of Jerzy Łoś on early developments in temporal logic", *Studia z Historii Filozofii* 11 (3): 105-–126. DOI: 10.12775/szhf.2020.020

Prior, A. N., 1967, *Past, Present and Future*, Oxford: Oxford University Press.

Rybaříková, Z., 2022, "Arthur N. Prior and the Lvov-Warsaw School", *History and Philosophy of Logic* 44 (1): 91–103. DOI: 10.1080/01445340.2022.2062696

Tkaczyk, M., 2009, *Logika czasu empirycznego* (Logic of Empirical Time), Lublin: Wydawnictwo KUL.

Tkaczyk, M., and T. Jarmużek, 2019, "Jerzy Łoś positional calculus and the origin of temporal logic", *Logic and Logical Philosophy* 28: 259–276. DOI: 10.12775/LLP.2018.013

Venema, Y., 2017, "Temporal logic", pages 203–223 in L. Goble (ed.) *The Blackwell Guide to Philosophical Logic*, Blackwell. DOI: 10.1002/9781405164801.ch10

Anna Maria Karczewska
Department of Philosophy
The John Paul II Catholic University of Lublin
Lublin, Poland
anna.karczewska@kul.pl
https://orcid.org/0000-0001-5269-8891