

## Where Have All the Californian Tense-logicians Gone?

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**Abstract:** Arthur N. Prior, in the Preface of *Past, Present and Future*, made clear his indebtedness to “the very lively tense-logicians of California for many discussions”. Strangely, with a notable exception of Copeland (1996), there is no extensive discussion of these scholars (as a group, if not a school) in the literature on the history of tense logic. In this paper, I propose to study how Nino B. Cocchiarella, as a foremost Californian tense-logician, interacted with Prior in the late 1960s. By gathering clues from their correspondence available at Virtual Lab for Prior Studies, I will highlight some of the differences between their views on tense-logic, which might still have far-reaching philosophical implications. I will conclude with a sketch of how to study in what ways Prior and Cocchiarella influenced some other Californian tense-logicians.

**Keywords:** Arthur N. Prior, Nino B. Cocchiarella, Tense logic, Californian tense-logicians, Montague grammar

### 1. Introduction

Arthur N. Prior’s book *Past, Present and Future* is no doubt one of the landmarks in the history of tense logic. As a consequence, it is all too natural to be curious about its secret of success. The answer is not far to seek, for Prior himself in the Preface of the book hints at one of the most important factors: his indebtedness to “the very lively tense-logicians of California for many discussions with them about their results and mine” [Prior (1967a), vi] Prior’s high esteem of the Californian tense-logicians seems far greater than one might believe, for he even supposes “that California is the most logically mature place in the world, and now that the logic of tenses is pursued so widely and so vigorously there, its raw pioneering days can be considered over”. [Ibid.] What is strange is that (with a notable exception of Copeland (1996)) there is no extensive discussion of the tense-logicians of California in the literature on the history of tense logic. This must be unfortunate, insofar as we pay due respect to Prior as the pioneer of modern tense logic or Prior as a historian of tense logic. Where have all the Californian tense-logicians gone?

In this study, we propose to recover the forgotten achievements of the Californian tense-logicians. For this purpose, after briefly discussing who these people could be (section 2), we would like to launch a historical conjecture (with some basic reasons) that it was primarily Cocchiarella’s doctoral dissertation that made Prior to invoke “Californian tense-logicians” (section 3). Then, by taking clues from the letters between Prior and Cocchiarella during the period between 1965 and 1968, as archived in Virtual Lab for Prior Studies, I will sketch how they interacted and influenced each other (section 4). I will conclude with a sketch of how to study in what ways Prior and Cocchiarella influenced some other Californian tense-logicians (section 5).

### 2. Who are the Californian Tense-logicians?

We do know who those tense-logicians of California were. Above all, Prior explicitly names three of them: “notably Nino Cocchiarella in San Francisco, Dana Scott in Stanford, and again E. J. Lemmon, in Claremont”. [Ibid.] Prior indeed discusses extensively the ideas of all these three tense-logicians throughout the book. Furthermore, we already have useful information as to in what ways they contributed to tense logic as well as in what ways they interacted with Prior. For example, Copeland reminds us of the fact that at the time of Prior’s several months’ visit to UCLA “Nino Cocchiarella was just completing a Ph.D. thesis on quantified modal and tense logic under Montague’s supervision (‘Tense and Modal Logic: A Study in the Topology of Temporal Reference’). [Copeland (1996), p. 24; Cocchiarella (1966)]

Interestingly, we have a very good reason to believe that Prior would be happy to include himself among the Californian tense-logicians. For, in the same place, Prior proudly enumerates some of his distinguished students at UCLA: “particularly, Hans Kamp, Patricia Kribs, John Clifford, and Richard Harschman”. [Prior (1967a), p. vi] Copeland again efficiently highlights this point. According to him, Kamp not only wrote a dissertation on tense logic, i.e., ‘On Tense Logic and the Theory of Order’ [Kamp (1968)] but also “achieved a new level of formal sophistication” for tense logic. [Copeland (1996), p. 24]

As Copeland aptly points out, the manuscript of Prior (1967a) was completed “in this fecund atmosphere”, when “[f]or the first time Prior found himself among a group of enthusiasts for tense logic”. [Copeland (1996), pp. 24-25] But have we fully understood the importance of the Californian tense-logicians for Prior? I think not. If Prior was right in his assessment of the tense-logicians of California, why aren’t we familiar with their achievements? Even if Prior was correct, wasn’t it a mere historical accident that all those tense logicians were there in California around 1965? In other words, do we have enough ground to lump them together under a common spirit or method, let alone a definite set of shared beliefs? Rather, it seems much more promising to find a common link for those tense logicians of California from Prior himself. Probably, in a similar vein, Storrs McCall asked Prior: “Was it in fact your visit to California in 1965 that sparked off the renaissance of tense-logic?” [McCall (1967)] Prior’s answer to McCall’s question is this:

Maybe you exaggerate the importance to anyone but myself of my visit to California 1965, since Cocchiarella, Scott and Lemmon had got most of their results before I went there; on the other hand they hadn’t published them (& still haven’t), and I dare say I stirred them up a bit and pulled a few things together. [Prior (1967b)]

As is well-known, Prior passed away due to a heart attack at the age of fifty six in 1969. In 1966, Lemmon also died from a heart attack during mountain climbing at the age of 36. Cocchiarella moved from San Francisco State College to Indiana University in the fall of 1968. Scott moved from Stanford University to Princeton University in 1969. Montague, who is the Doktor Vater of both Cocchiarella and Kamp at UCLA, was murdered in 1971 at the age of 40. So, by 1971, there were not many tense-logicians of California left any longer.

No doubt, some of these historical facts indeed have contributed to our lack of interest in the tense-logicians of California in the 1960s. Insofar as Prior was insightful on the future of tense logic, however, all this cannot be the end of the story. There is still more left to

answer my question “Where have all the Californian tense-logicians gone?”

### 3. A Historical Conjecture: Granting Cocchiarella the Lion’s Share

Some people might think that, since Prior rather extensively discussed the achievements of the Californian tense-logicians in PPF, my question is at best of a historical curiosity. So, they might say: “Of course, we can ask questions like ‘How did Prior masterly synthesize the achievements of Californian tense-logicians in PPF?’ or ‘From Prior’s point of view, what aspects of their contributions were most valuable? But virtually everything truly important is already there in PPF’”.

I believe, however, something goes wrong exactly here. For, we are ignoring the possibility that Prior in PPF did not represent all important results of the Californian tense-logicians. Prior’s answer to McCall’s query indicates indeed such a possibility. For example, there could have been some significant results of the Californian tense-logicians that Prior failed to discuss in PPF. There could be any number of possible explanations for such a failure. It could have been simply because they had not been published. Or, more importantly, it could have been the case because of the seriousness and the difficulties of the issues involved. Now, what would be the consequence, if those results are what impressed Prior so much as to invoke “Californian tense-logicians”?

It seems to me that there are some forgotten achievements of the Californian tense-logicians. Even if we have not forgotten anything, there must something we are failing to appreciate its true value. In order to recover or to grant a fair hearing to it, I would like to launch a historical conjecture that it was primarily Cocchiarella’s doctoral dissertation that led Prior to invoke “Californian tense-logicians”. In particular, Prior could have been deeply impressed by Cocchiarella’s completeness results for tense logic, though there are also other significant results such as the quantified tense logic and semantics of tense logic achieved in his dissertation. [See Massey (1969); Pizzi (1974)] Further, it could have been due to the seriousness and the intrinsic difficulties of the issues involved that Prior failed to discuss some of Cocchiarella’s achievements such as completeness results in PPF. Let me sketch some initial supporting arguments for these interrelated historical conjectures.

Whenever Prior invoked the Californian tense-logicians, Cocchiarella was always named first.<sup>1</sup>[Prior (1967a), p. vi; Prior (1967b)] But this could be a mere accident, of course. More notable thing is that not only was Cocchiarella’s dissertation a substantial study on tense-logic but also *it was born in California*. Cocchiarella went to UCLA in 1958 in order to study with Rudolf Carnap. Indeed, he attended Carnap’s seminars in logic, philosophy of mathematics, philosophy of science, and formal semantics until the latter’s retirement. Through Montague and Donald Kalish, both of whom were in his committee, Cocchiarella was also well versed in Tarskian corpus. [Cocchiarella (1993), (1966)]<sup>2</sup>

Needless to say, the completeness result can be a sure arbiter for testifying the maturity of a given field of logic. Some have tried to avoid the problem of granting credit for

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<sup>1</sup> Please note that Prior was not always following the alphabetical order in naming the Californian tense-logicians.

<sup>2</sup> Other than Montague (chair) and Kalish, there were Alfred Horn, Abraham Robinson, and Robert Stockwell in the committee. [Cocchiarella (1966)]

the first completeness proof for tense logic to any particular logician. [e.g., Burgess (1984, 2002), p. 13] Whenever this problem arises, however, Cocchiarella was considered to be one of the most promising candidates. [e.g., Rescher and Urquhart (1971); Gabbay (1976), p.301] By now, it is rather an established fact that it was Cocchiarella who got the completeness results for tense logic first. [Carnielli and Pizzi (2009), p. 157, 180; Gabbay&Woods (2009), pp. 52-53] Unpublished UCLA dissertations on tense logic also testify the correctness of such an ascription. [Kamp (1968), p. 14; Vlach (1973), p. xi]<sup>3</sup>

In his reply to Copeland's query, Cocchiarella wrote;

I achieved the basic results of my thesis, along with a number of results about quantified modal logic, sometime in 1963, when I gave a "report" to the UCLA logic group/colloquium that used to meet regularly then. [Cocchiarella (1993)]

It is not difficult to imagine how much surprised and excited the members of UCLA logic group were. One of their graduate students might have acquired some groundbreaking results in a relatively new promising field of logic. It is by no means an irresponsible daydreaming. For, Cocchiarella continued to report:

I believe that as a result of my work on tense logic while at UCLA during the early 1960s, Montague and Kalish became interested in having Prior come to UCLA as a visitor. [Ibid.]<sup>4</sup>

Cocchiarella's belief seems quite supportable by some circumstantial evidences. Though the bibliography of Cocchiarella (1966) contains 15 items, only one of them, i.e., Prior (1957), deals with tense-logic proper. Ernst Moody explicitly suggested Prior to offer a course or a seminar on *Time and Modality*. [Prior (1964)] According to Cocchiarella (1993), Prior was temporarily on the committee for Cocchiarella's thesis during his defense in order to replace Abraham Robinson, who was in Europe.<sup>5</sup> Cocchiarella (1966) was a landmark in the history of tense logic, remarkable enough to *surprise* everyone.

Then, how about Lemmon and Scott? Could they also pass both California test and Surprise test? We have 49 letters from Lemmon to Prior in Virtual Lab for Prior Studies. It started in 1956 and ended in 1966. (None of Prior's letters to Lemmon survived.) So, it was no news to Prior in 1965 that Lemmon was a distinguished tense logician. Further, since Lemmon moved to Claremont in 1964, it is unlikely that Prior was impressed by the Californian tense-logicians because of the existence of Lemmon in California.

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<sup>3</sup> Kamp (1968) cites only 5 items in the bibliography, among which 2 are Cocchiarella's work. Vlach (1973) cites 9 items, among which 2 are Cocchiarella's, another 2 are Kamp's, and still another 2 are Prior's. The chapter 3 of Vlach (1973) entitled "An Axiomatization" seems to be the most extensive study of Cocchiarella (1966) to date.

<sup>4</sup> In the Virtual Lab of Prior Studies, there are quite a lot of letters written by Prior to UCLA people. These can be grouped under three categories: (1) Prior to Ms. Drake, (2) Prior to Moody, and (3) Prior to Kalish. The earliest item is Prior's telegram to Moody declining the invitation, dated February 8, 1963. [Prior (1963)] But there was a second chance. In Prior (1964), we find Prior accepting UCLA's invitation for the Fall semester (September 1965 – January 1966).

<sup>5</sup> According to the title page of Cocchiarella (1966), the final examination was given on January 7, 1966, which is after Robinson returned from Europe.

Scott's case is entirely different from that of Lemmon's. Scott not only had been teaching in California since 1960 but also schooling at Berkeley in early 1950s. But he was more of a mathematician or mathematical logician than a devoted tense logician. Lemmon's *Introduction to Intensional Logic*, posthumously edited and published by Scott, is not primarily a contribution to tense logic either. However, Copeland (1996) informs us of Scott's early interest in tense logic in a somewhat surprisingly interesting way. According to Copeland's presentation, Scott's understanding of tense was influenced by Reichenbach, Hintikka, Montague. Of course, Copeland never forgets to mention that "Scott was aware of Prior's work". But he seems to be more impressed by the fact that Prior "learned of Scott's work in a letter from Lemmon dated January 1964". [Lemmon (1964)] Further, according to Copeland, "Scott's tense logic was rather different in style from Prior's". All this seems to be culminated in Copeland's following report:

Scott established the completeness and decidability of various axiomatic tense logics. He also showed that the temporal predicate logic of the reals is non-axiomatizable. His work in tense logic is cited widely but remains unpublished. [Copeland (1996), p. 24]<sup>6</sup>

Though quite interesting, I tend to believe that Copeland's report of Scott's achievements in tense logic should be read with caution. For, his evidences seem largely circumstantial, after all. It might be harmless, if these circumstantial evidences are merely used to enhance our understanding of Scott's early interest or even expert knowledge in tense logic. But Copeland tends to ascribe substantial achievements in tense logic to early stages in Scott's career. For example, he reports that "in 1962 Scott gave a lecture on tense logic in Amsterdam". Here, Copeland's source of information is Kamp, who then an undergraduate was in the audience. Similarly, Copeland claims that

Scott's work on tense logic was one aspect of his study of the semantics of natural language, which he pursued in collaboration with Richard Montague. [Ibid, pp. 23-4]

Indeed, Montague discussed the influence of Scott's treatment of modal logic to the outline of extended pragmatics. But that was "in June, 1967". [Montague (1970), p. 140; See also Ibid., p. 122, 125, and Cocchiarella (1981), p. 118] We may note, however, neither Montague nor Cocchiarella cites any published work of Scott in the field of semantics of natural language. Barbara H. Partee seems to trace the beginning of Montague grammar back to the late 1960s (around 1968), counting 1970s as the first decade of Montague grammar. [Partee (2004), pp. 5-10] There is no discussion of Scott in her brief historical narrative of the early days of Montague grammar.

Some might think that Scott's Hume Society talk "The Logic of Tenses" could have been a nice surprise to Prior. Frankly speaking, I also actually thought that way. Suppose that

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<sup>6</sup> In order to support Copeland's view that emphasizes Scott's early involvement with tense logic, we may also cite Clifford and Segerberg. Clifford mentions Scott's talk on the modification of Priorian logic of the future before the Southern California Logic Colloquium, October, 1963. [Clifford (1966), 220] Segerberg presents Scott as the dominant figure at Stanford in the 1960s, who had been working with problems in tense and modal logic since the late 'fifties". [Segerberg (1977), p. v]

Prior was not acquainted with Scott prior to the talk. Assume further that Prior heard about Scott's mathematical caliber but nothing about his interest in tense logic. Then, Prior could have been surprised enough to exclaim "Wow! Here is still another Californian tense logician". Thanks to Copeland, we do know that all these assumptions cannot be made. Through Lemmon, Prior was already familiar with Scott's serious interest and novel researches in tense logic. [Lemmon (1964); Copeland (1996)]

#### 4. Prior-Cocchiarella Correspondence

There are sixteen letters between Prior and Cocchiarella during the period between 1965 and 1968 archived in Virtual Lab. In the chronological order, let me first list all these letters with brief description.

- (1) 931. Cocchiarella to Prior 07.10.1965 (Box 1) 2 p. typed letter from San Francisco: Comparison of Cocchiarella's and Prior's Axioms; Plan for Ch. 5 of Cocchiarella's dissertation; Completeness theorem for various systems of tense logic; Plan for deleting Ch. 2; Cocchiarella's troublesome example related to the use of definite descriptions in tense logic. [Cocchiarella (1965a)]
- (2) 932. Cocchiarella to Prior 04.11.1965 (Box 1) 2 p. typed letter from San Francisco: a brief description of Cocchiarella's axioms (A19) and (A20). [Cocchiarella (1965b)]
- (3) 933. Cocchiarella to Prior 12.11.1965 (Box 1) 2 p. typed letter from San Francisco: taking back claims made in the letter to Lemmon.
- (4) 939. Mary Prior to Libbie Cocchiarella 12.08.1966 2 p. handwritten letter from Oxford (Box 1): Mrs. Prior explains life of Priors at Oxford to Mrs. Cocchiarella.
- (5) 924. Prior to Cocchiarella 20.12.1967\* (Box 1) [\* should be 1966] 1 p. handwritten letter from Oxford: Prior's Review of Hughes and Londey; trouble with Routley's calculus FR\*
- (6) 934. Cocchiarella to Prior 02.01.1967 (Box 1) 2 p. typed letter from **San Francisco**: Reply to "924 Prior to C 20.12.1967\*" [\* should be 1966]: Discussion of Routley's FR\*; Difficulties with Routley's R\* as well as his "Meinongian" systems.
- (7) 925. Prior to Cocchiarella 27.12.1967 (Box 1): 1 p. handwritten letter from Oxford: scholars who might be interested in Cocchiarella's tense logic (A. Trew, G. E. Hughes, B. Mates)
- (8) 926. Prior to Cocchiarella 15.01.1968 (Box 1) 1 p. handwritten letter from Oxford: Prior's *Nous* Paper; a weaker tense logic than Cocchiarella's in his dissertation
- (9) 927. Prior to Cocchiarella 01.02.1968 (Box 1) 1 p. handwritten letter from Oxford: Comments(?) on Cocchiarella's paper (posted in San Francisco on Dec. 5, 1967); References to PPF, p. 162.
- (10) 928. Prior to Cocchiarella 25.02.1968 (Box 1) 1p. handwritten letter from Oxford: Comments on Cocchiarella's article on second-order logic for *Journal of Symbolic Logic*; quantification over propositional variables.
- (11) 1224. Cocchiarella to Prior 11.03.1968 (Box 4) 10p. handwritten letter from Michigan: technical piece
- (12) 929. Prior to Cocchiarella 19.03.1968 (Box 1) 1 p. handwritten letter from Oxford: declining George Nakhnikian's invitation.
- (13) 1223. Cocchiarella to Prior 05.04.1968 (Box 4) 1p. handwritten letter from Michigan: on the cut-down version of the second order of extension paper.
- (14) 935. Cocchiarella to Prior 07.10.1968 (Box 1) 2 p. typed letter from Indiana: Report

of Cocchiarella's work done in Summer of 1968: completeness theorem for second order tense logic; article on existence and the notion of e-attribute; complaints about Leblanc Case

- (15) 930. Prior to Cocchiarella 10.10.1968 (Box 1) 1 p. handwritten letter from Oxford: On Leblanc Case
- (16) 936. Cocchiarella to Prior 21.10.1968 (Box 1) 2 p. typed letter from Indiana: Further notes on Leblanc

It is not clear exactly when Prior read for the first time some early drafts of Cocchiarella's dissertation. For, there is no record before Cocchiarella (1965a), which Cocchiarella wrote "so soon after" his first letter to Prior, who arrived at Los Angeles in September, 1965. Prior sent "a copy of his latest work in tense logic" to Cocchiarella, suggesting his interest in Cocchiarella's work. Upon Prior's request, Cocchiarella was enclosing a copy of the typed portion of his work. So, Prior probably read a substantial part of Cocchiarella (1966) in the second week of October 1965. I tend to believe that at that time Prior realized that "*California* is the most logically mature place in the world, and now that the logic of tenses is pursued so widely and so vigorously there, *its raw pioneering days can be considered over*". (my emphasis) [Prior (1967), p. vi; supra, 1] Ever enthusiastic, Prior forwarded Cocchiarella's work to Lemmon immediately. And, we have Lemmon's extensive letter to Cocchiarella [Lemmon (1965)] and Cocchiarella's reply [Cocchiarella (1965d); See also Cocchiarella (1966b)].

Cocchiarella invited the Prior's to San Francisco, asking to give a talk at the student philosophy club. [Cocchiarella (1965a)] From Cocchiarella (1965b), we can see that all this was actually realized. Not to mention their lively interaction in 1965, when Prior visited California, we do have ample source of information as to how they influenced each other's work on tense logic in the late 1960s. Prior-Cocchiarella correspondence provides us with a sort of documentary for this. For example, Cocchiarella opens his articles on existence-attributes with Prior's suggestion in PPF. [Cocchiarella (1968a), (1969a); see also Cocchiarella (1967), (1968b), (1968c), (1969b)] Cocchiarella (1965a) contains several revealing clues, especially where Cocchiarella discusses why he would delete the section 5 from chapter 2 of his dissertation. Cocchiarella suggests to consider the following example:

But rather than the example "there will exist an object which is (now?) larger than any object which has existed" consider "there did exist someone who is (now?) an ancestor of everyone (now) existing. [Cocchiarella (1965a)]

Interestingly, this example appears again in Cocchiarella's later work on tense logic, e.g., Cocchiarella (2002), p. 266. Much more remarkable, however, is the fact that in PPF Prior introduced this issue in the context of discussing Cocchiarella:

Cocchiarella's system is consistent with using the form  $\phi a$  to cover not only assertions about what does not yet or does not any longer exist but also assertions about 'objects' which do not exist and never existed and never will". [Prior (1967), p. 160]

According to Cocchiarella (2013a), he saw Prior's point that Cocchiarella was committed in his logic to a distinction between e-properties and e-relations as opposed to properties and

relations in general right away and quickly wrote up the formal details of such a logic in Cocchiarella (1968). [Cocchiarella (2013a)] Though I cannot do justice to this issue here, it is closely related to another substantive issue, i.e., that no tense-logician in the 1960s other than Cocchiarella was working on *quantified* tense logic. [Ibid.] If one works only on the propositional level, then one would “ignore the philosophical interests Prior had for problems that appear on the quantificational level”. [Cocchiarella (2013d)]

It may not be too difficult to find the traces of Cocchiarella’s influence on Prior either. For, I think, it must have been one of the most important factors in Prior’s turn to more ontological issues in his last years, as culminated in Prior (1977). Also, I would like to draw attention of the readers to the fact that Prior’s monumental paper “Now” [Prior (1968e)] was published in *Nous*, which was edited at Indiana. It is well-known that Prior (1968e) provided a springboard with Kamp’s now-operator and Vlach’s then-operator. [Kamp (1968),(1973); Vlach (1973)] The sixteen letters between Prior and Kamp written in 1967 would testify how their distinguished works resulted from such an intensive interaction. Although nowhere in Prior (1968e) we can find the name of Cocchiarella, I think, Cocchiarella’s question, examples, and views were always at the background. Above all, when Prior made Cocchiarella a legendary Californian tense-logician in PPF, he himself was fully conceding Cocchiarella’s influence on his own thought.

In view of this happy interaction between Prior and Cocchiarella, we are becoming more and more curious about the reason why Prior did not explicitly discuss Cocchiarella’s completeness results in tense logic in PPF. Ironically, if Burgess is on the right track, the clue seems to be found again in PPF, exactly where Prior explicitly criticized certain aspects of Cocchiarella’s approach to tense logic. According to Burgess, Prior “firmly rejected” the suggestion of some philosophical logicians who urge that “tense *logic* ought to be especially or exclusively concerned with enumerating those arguments in tensed language whose validity can be certified *a priori*, without recourse to facts or hypotheses from science or philosophy”, [Burgess (1979), 567] Here, Burgess gives only one example of such philosophical logicians. And that is nothing but from Cocchiarella’s thesis. In this regard, Burgess quotes Prior’s opening remarks of chapter 4 of PPF: “Logical purity ... is a will-o’-the-wisp. The logician must be like a lawyer ... in the sense that he is there to provide the metaphysician, perhaps even the physicist, the tense-logic he wants, provided that it be consistent” [Prior (1967a), p. 59; as quoted by Burgess] In fact, a few pages earlier, Prior wrote: “The conception of logical ‘purity’ underlying Cocchiarella’s excisions is a questionable one”. [Prior (1967a), p. 51]<sup>7</sup>

To the best of my knowledge, Cocchiarella has never tried to meet this criticism directly, though he has sustained interest in tense logic to date. [See Cocchiarella (1991), (1984, 2002)] Even when he pins down the differences between Prior and himself, he does not invoke this issue of logical purity:

“We did have our differences, however, esp’ly on the issue of quantifying over past and future objects, and the issue of whether ‘propositions’ could have truth values at times when the objects they are ‘about’ do not exist. We also differed

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<sup>7</sup>Cocchiarella never used the term “logical purity”, though he extensively discussed tense-logical truth in his dissertation and in his letters to Prior.



about the openness of the future and the question of the connectedness of (for me, local) time”. [Cocchiarella (1993)]

Fortunately, Cocchiarella (2013a) elaborates all these points as well as the issue of logical purity. He wrote:

Turning now to the more substantive issue of “logical purity” or “a priority”, the main point of contention between Prior and me was the connectedness of local time (or what Einstein called an *Eigenzeit*). Is it knowable a priori that a local time is connected? Is the connectedness assumption “logically pure”? I say yes, because it is part of the concept of a local time. Prior rejected connectedness, or rather he took its assumption as “logically impure”. But, let us keep in mind that, like me, Prior never doubted the transitivity of the earlier-than relation of time. Is the assumption of transitivity “logically pure”? Certainly, it is for me, because, like connectedness, transitivity is part of the concept of a local time. I do not know how one can maintain that transitivity is “logically pure” whereas connectedness is not. [Cocchiarella (2013a)]

Cocchiarella now thinks “what Prior’s argument about “logical purity” shows is that he was arguing from a purely syntactic view of logic, despite his having a very definite ontological view about the nature of propositions and how they to be represented in tense logic, which might suggest an intensional view instead”. [Cocchiarella (2013d)] Cocchiarella also thinks that “some philosophers other than Prior were confusing the non-connectedness of the causal tenses based on a signal relation between different local times (world lines in Einstein’s relativity theory) with the connectedness of the earlier-than relation of the standard tenses of the local time of a world line”. [Cocchiarella (2014)] The differences between these two kinds of tenses are explained and discussed in Cocchiarella (1984, 2002). Prior did not think of the connectedness issue in this way because that would have made the existence of past and future objects relative and not absolute at a given moment of a local time.

## 5. Concluding Remarks: The Legacy of Californian Tense-logicians

In this paper, I focused on Cocchiarella among the Californian tense-logicians. But it is rather obvious that I have failed to solve some crucial problems such as why Prior did not discuss Cocchiarella’s completeness results in quantificational tense logic in PPF. In order to solve such problems, and, in order to appreciate the central role Cocchiarella played in the interaction between Prior and the Californian tense-logicians, it seems advisable to broaden our purview. At least, it would be quite helpful to see how Prior and Cocchiarella influenced other Californian tense-logicians, including some of the younger Californian tense-logicians, i.e., Prior’s students at UCLA, who made significant achievements in the subsequent history of tense-logic.[Kamp (1968); Clifford (1975)] But it seems impossible for me to discuss what happened to the Californian tense-logicians other than Cocchiarella here. Let me conclude with a sketch of a few important issues.

Prior-Kamp Correspondence deserves very careful study, not only as a success story in the history of tense logic but also as a model of scientific collaboration. It would be also of utmost importance to uncover what Kamp and Vlach might have learned from Cocchiarella as well as Prior. Further, such a research should pay due attention to the intriguing context in

which were influenced by Prior and Cocchiarella: i.e., the department of philosophy at UCLA in the late 1960s and the early 1970s. And, it seems to me that all this can be pursued by probing the question as to Cocchiarella's role in the origin of Montague Grammar. Both Montague (1968) and Montague (1970) referred to Cocchiarella's achievement. Also, both included Cocchiarella (1966a) and Cocchiarella (1966b) in the references. Above all, in both cases, Montague claimed that, unlike semantics, pragmatics should concern with truth with respect to a context of use as well as interpretation. Then, he reported that in his studies of some of the special cases of pragmatics *he was indebted to his student Nino Cocchiarella for a treatment of quantifiers*. He enumerated cases such as "those involving personal pronouns, demonstratives, modal operators, tenses, probability operators, contextual ambiguity, and direct reference", in all of which a treatment of quantifiers was an important feature. [Montague (1968), p. 96; Montague (1970), p. 120] We may also note that, when Montague discussed ordinary tense logic and generalized tense logic, he reported again Cocchiarella's achievements. For, after briefly sketching how we can obtain Cocchiarella's tense logic, not only Montague reported Cocchiarella's observation that "the completeness theorem holds for  $K_2(L)$ " but also Cocchiarella's "elegant axiomatizations of the  $K_2(L)$ -valid sentences of  $L$ ". [Montague (1968), p. 106] The whole point of all this could be that tense logic has played a much more important role in contexts than usually assumed.

There are some intriguing issues between Prior and Cocchiarella. In fact, Gerald Massey even discussed the rivalry among tenses, i.e., P-tenses and C-tenses, who were attempting "the tense revolution". [Massey (1969)]<sup>8</sup> Of course, Cocchiarella denies once and for all that there was a rivalry between Prior and himself. He rather thinks that Prior "was pleased that someone from the Tarski-Montague formal semantics school of logic was working on a subject that he had initiated". [Cocchiarella (2013c)] According to Cocchiarella's account, Prior viewed model-theoretic semantic approach "as complementing his, not rivaling it". [Ibid.] However, I believe, we have good reasons to pursue further contrasting the differences between Prior and Cocchiarella in sharper focus. As Prior anticipated [Prior (1967a), p. vi], and as everyone testified [Burgess (1979), 567; Øhrstøm and Hasle(1995)], PPF has become the starter for huge literature on tense logic. Technical applications of tense logic far outweigh more philosophical discussions, however. It is only through a handful of researchers we can remember and appreciate the philosophical aspects of Prior's pioneering work in tense logic. According to the late Mrs. Mary Prior, "Arthur enjoyed philosophical conversations with colleagues enormously, and this included students as much as anyone else". [Prior (2003), p. 300] The moral of all this is that we need to revive exactly that philosophical spirit of Prior and the Californian tense-logicians.

In connection with Montague Grammar, we noticed the possibility that tense logic might have been playing more significant roles in broader contexts. In fact, Cocchiarella himself counts all his work on formal ontology, intentionality, the logic of plurals and the logic of mass nouns, *as a continuation of his work on tense logic*. [Cocchiarella (2013a)] If so, the answer to my question "Where have all the Californian tense-logicians gone?" seems to be this: Together with Arthur Prior, the Californian tense-logicians were, are, and will be always with us.

### <Acknowledgements>

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<sup>8</sup> Nor do we find anyone else witnessing the alleged revolution.

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