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Evidence for a Scalar Analysis of Result in SDRT from a Study of the French Temporal Connective *alors*

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This paper presents a preliminary analysis of the French temporal connective *alors* (generally translated in English by *then, at that time, so*). It is part of a broader project to provide a systematic analysis of French temporal connectives within Asher's formal framework of *Segmented Discourse Representation Theory* (Asher 1993, Asher and Lascarides 2003). Among the linguistic markers that establish a temporal relation between the eventualities introduced by two clauses (henceforth *discourse constituents*) to be discourse linked, temporal connectives are distinguished by the fact that they introduce at the same time some sort of discourse relation.

In previous work some of us showed that *puis*, which induces a temporal connection between constituents, is just such a connective; its role in SDRT is to impose a relation of Narration and to block causal relations like Result (cf. Bras et. al. 2001, Borillo et. al 2004). We argue here that *alors* can also be such a temporal connective under specific conditions.

Much work has been done on *alors* (cf. *inter alia* Jayez 1981, 1988a&b; Franckel 1987; Gerecht 1987; Hybertie 1996; Reyle 1998; Gosselin in press). Most authors distinguish three major uses of *alors* in assertions: temporal uses (with or without a consequential value), merely consequential uses (close to *donc* 'therefore'), and other uses where *alors* is a kind of « structuration » marker.

Le Draoulec and Bras (2004) studied the temporal uses of *alors* when it relates two assertions describing events. They showed that the temporal value is necessarily associated with a consequential value only when *alors* is in clause initial position. When *alors* is in a clause internal or final position, its role is merely that of a temporal anaphoric adverb conveying a temporal relation (with only possible semantic effects of consequentiality). Moreover, the temporal value itself depends on the sentential position: clause initial *alors* gives rise to a relation of temporal succession between the events; clause internal or final *alors* denotes a temporal relation of concomitance or coincidence.

In this paper we focus on uses of *alors* in initial position, still restricting the study to clauses describing events (states are left for future research). We investigate which discourse relation(s) is (are) able to express the consequential value necessarily involved by *alors*.

In (1), SDRT predicts a discourse relation of Result between the two constituents.

(1) Olivier a fait tomber la carafe. Alors elle s'est cassée.
Oliver dropped the carafe. *Alors*[1] it broke.

[1] In this example *alors* could be translated by *so* or *then*. We prefer not to choose a translation, so as not to blur the problem.

SDRT allows us to deduce the discourse relation Result when one can infer from lexical or domain information the predicate $cause_D$ (we simplify the axiom of Asher and Lascarides (2003) as we will not consider different aspectual classes).

Axiom_Result $(?(\alpha, \beta, \lambda) \wedge \text{cause}_D(\alpha, \beta)) > \text{Result}(\alpha, \beta, \lambda)$

In (1), the information needed to infer $cause_D$ is readily available – *tomber*(x) is a permissible cause of *se casser*(x). Initial *alors* goes very well with this inference. However its role is not completely evident in this example, as we would have the same inference for (1) without *alors.*

The role of *alors* is clearer in examples like (2) or (3):

(2) Je suis allée jusqu'à la place du village, alors je l'ai vu arriver.
I walked up to the village square. *Alors* I saw him arrive.

(3) Il m'a rejointe. Alors je me suis souvenue que j'avais oublié mes clés.
He joined me. *Alors* I remembered that I had forgotten my keys.

From a strict SDRT point of view, the requisite information needed to infer $cause_D$ for (2) or (3) is lacking. So we cannot infer Result. It also seems improbable that *occasion*, the relevant predicate on eventuality types needed to infer Narration, holds between the two constituents[2]. So the appropriate axiom (Axiom_Narration) can not be used to infer Narration. As SDRT does not yet account for the role of *alors*, it would predict Narration by default.

Axiom_Narration $(?(\alpha, \beta, \lambda) \wedge \text{Occasion}(\alpha, \beta)) > \text{Narration}(\alpha, \beta, \lambda)$

Following Hybertie (1996), Le Draoulec and Bras (2004) show that in examples such as (2) and (3), *alors* triggers a discourse relation requiring that 'the event expressed by the first constituent is a necessary condition for the event described by the second constituent'. This relation differs from the extant, similar SDRT relations of Result and Narration.

Asher and Lascarides (2003) don't give a complete definition of Result but they take Result(α,β) to imply that the main eventuality in α is the cause of the main eventuality in β.

It thus seems necessary to introduce a new relation, which we will call *Weak-Result*. *Alors* is a trigger for this relation, which expresses a causal link close to that proposed by Lewis (1973):

> An event e_α associated with a description K_α (in a discourse constituent α) *is a necessary cause for* an event e_β (associated with a description K_β in a discourse constituent β) iff $(\neg K_\alpha \mathrel{\Box\!\!\rightarrow} \neg K_\beta) \wedge (K_\alpha \wedge K_\beta)$
>
> where $A \mathrel{\Box\!\!\rightarrow} B$ is true in a world w if and only if in every world closest to w where A is true, B is true too.

In less formal terms, e_α is *a necessary cause for* e_β means that:

(i) if e_α had not occurred, e_β wouldn't have occurred either, in all the worlds closest to α's world, and

(ii) K_α and K_β are true.

[2] Occasion and Cause_D are not Discourse Relations but predicates specifying information from a variety of knowledge sources leading to the inference of the Discourse Relation at stake.

This relation is weaker than the one according to which the first event *is the cause of* the second:

e_α *is the cause of* e_β if and only if e_α is a necessary cause for e_β, and $K_\alpha > K_\beta$

thanks to the expression $K_\alpha > K_\beta$ (normally if K_α obtains then K_β).

We thus define Weak-Result as a discourse relation on constituents as follows:

Definition_Weak-Result Weak-Result $(\alpha, \beta, \lambda) \leftrightarrow ((\neg\ K_\alpha \Box\!\!\rightarrow \neg\ K_\beta) \wedge (K_\alpha \wedge K_\beta \wedge e_\alpha < e_\beta))$

Axiom_Weak-Result $(?\ (\alpha, \beta, \lambda) \wedge \text{alors}(\beta)) \rightarrow$ Weak-Result (α, β, λ)

This formulation of Weak-Result yields an immediate consequence: there is a temporal succession between the events, which corresponds to what Le Draoulec and Bras (2004) describe for clause initial *alors*.

As we said before, we restrict ourselves here to events. There is still a lot of work to do on states: in many uses of *alors*, in particular consequential uses, the eventualities involved are states (with different temporal implications for temporal uses). Dealing with states will also imply accounting for logical consequence uses, as:

(4) Puisque A est vrai, alors A ou B est vrai
As A is true, *alors* A or B is true

But we can also have events in the uses of *alors* that express logical consequence, as in:

(5) Toutes les filles sont arrivées à l'heure, alors Myriam est arrivée à l'heure
All the girls arrived on time, alors Myriam arrived on time

In order to be able to account for these cases, we should add a disjunction in our formula:

Definition_Weak-Result_bis

Weak-Result $(\alpha, \beta, \lambda) \leftrightarrow ((\neg\ K_\alpha \Box\!\!\rightarrow \neg\ K_\beta) \wedge (K_\alpha \wedge K_\beta \wedge e_\alpha < e_\beta)) \vee \Box(K_\alpha \rightarrow K_\beta)$

Weak-Result now is defined to hold between clauses that involve logical consequential uses of *alors*. We could have separated out these consequential uses, but including them within Weak-Result will enable us to define another result relation that entails Weak-Result, as we shall see in a minute.

Let us see how we can now account for our examples with the definition and axiom on Weak-Result given above. The relation of Weak-Result as defined is the appropriate one linking the clauses in (2) and (3). For example, in (3): if he hadn't rejoined me, I wouldn't have remembered; further, it is both true that he rejoined me and that I remembered; and finally, the event of his rejoining me precedes the event of my remembering.

On the other hand, Weak-Result is insufficient to describe the discourse link in (1): the causal link at stake is stronger than what the predicate '*is a necessary cause for*' expresses: it corresponds to the predicate '*is the cause of*' defined above. This leads us to the conclusion that Result is a scalar relation: along with Weak-Result, there is also a relation that we call *Strong-*

Result, which can be defeasibly inferred from $cause_D$, and which we define using the predicate '*is the cause of*'.

Definition_Strong-Result Strong-Result $(\alpha, \beta, \lambda) \leftrightarrow$ (Weak-Result $(\alpha, \beta, l) \wedge K_\alpha > K_\beta$)

Axiom_Strong-Result $(? (\alpha, \beta, \lambda) \wedge \text{cause}_D(\alpha, \beta)) >$ Strong-Result (α, β, λ)

For example (1), both Axiom_Weak-Result and Axiom_Strong-Result will apply: both Weak-Result and Strong-Result will be inferred. For the same example without *alors*, Strong-Result would be inferred too.

We finally examine cases when *alors* combines with *occasion*, as in (6):

(6) Il est tombé. Alors je l'ai aidé à se relever.
He fell. *Alors* I helped him up.

In such a case, the extant axioms lead to infer Narration and Weak-Result. However, we feel that Weak-Result is not sufficient, and that the relation of Strong-Result would be more appropriate to capture the interpretation of (6). This leads to add the following axiom which has the consequence in following theorem.

Axiom_Strong-Result2 $(? (\alpha, \beta, \lambda) \wedge \text{alors}(\beta) \wedge \text{occasion}(\alpha, \beta)) \rightarrow$ Strong-Result (α, β, λ)

Theorem $(? (\alpha, \beta, \lambda) \wedge \text{alors}(\beta) \wedge \text{occasion}(\alpha, \beta)) \rightarrow (K_\alpha > K_\beta)$

From these definitions and axioms, we can deduce that both Strong-Result and Weak-Result are veridical relations in the sense of Asher and Lascarides (2003).

We finally come back to the uses of *alors* expressing a logical consequence. In our definition of Weak-Result they are described by the second disjunct ($\Box(K_\alpha \rightarrow K_\beta)$). We now see that these uses of *alors* are now entailed to be cases of Strong-Result as well, which is intuitively what is desired: this is the case because we can infer the theorem $K_\alpha > K_\beta$, from $\Box(K_\alpha \rightarrow K_\beta)$. We added $\Box(K_\alpha \rightarrow K_\beta)$ as a disjunct in the right part of Definition_Weak-Result_bis because we wanted to guarantee the scalarity of Result : as it is defined now, Strong-Result is stronger than Weak-Result thanks to the conjunct $K_\alpha > K_\beta$. We thus have a scalar relation with a strong form and a weak one.

Our analysis of the discursive uses of *alors* in initial position with clauses that involve events paints a uniform but complex picture of this discourse connective. In future work we intend to extend this study to treat uses of *alors* that involve reference to states. We hope that this work promises to be helpful in unravelling the intricacies of other discourse connectives also related to causality such as *donc*, and the Explanation markers like *parce que*, *puisque* and *car*.

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