

Exhaustification and Semantic Relations in Discourse

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1 Introduction

Exhaustification is a species of conversational implicature that adds to a proposition p the meaning that *only*(p), i.e. that no other proposition from a distinguished domain of quantification holds. In this paper I propose an application of this mechanism to account for the inference of temporal and part-whole relations between events in coherent discourse. Inference of such relations has been a central issue of discourse interpretation theories such as DRT and SDRT, but none of them seems to have considered integrating Exhaustification as an explanatory device. I will argue that Exhaustification can handle the semantic consequences of a class of SDRT discourse relations (Asher and Lascarides, 2003) without having to infer those relations as an intermediate step.

The paper is structured as follows: Section 2 introduces a phenomenon in discourse semantics where Exhaustification can be argued to play a central role. It also presents some informal ideas available in the literature on what this role is. Section 3 implements these ideas in event semantics, whereas Section 4 compares the proposed analysis to the SDRT approach to the same phenomenon.

2 The phenomenon

I concentrate on the semantic contrasts between Russian discourses like (1a) and (1b), cf. their English translations in (2a) vs. (2b), respectively.

When uttered as an answer to a question like *What was Alena doing while Marina was out?*, the most natural interpretation of (1a/2a) is that Alena was cooking raspberry jam and *in doing so* she was fulfilling Marina’s assignment, i.e. Marina’s assignment for Alena was to cook raspberry jam. This is also a possible interpretation of (1b/2b), however the insertion of the conjunc-

tion *i* ‘and’ adds another possible reading under which Alena’s task is not to cook raspberry jam, but to do something else, e.g. to listen to the broadcast news, and she performs these two activities simultaneously. This latter reading is not available for (1a) as long as both sentences bear a falling “completeness” intonation: (H)L*L% in Russian, comparable to H*L-L% in English.¹ But interestingly, if both clauses are pronounced with a rising “comma” intonation as a kind of open list, the weak simultaneity reading seems to reappear even in the absence of *and*.

- (1) a. Alena varila malinovie
Alena cook.IMPERF.PAST raspberry
varen’e.
jam
Ona vpolnjala Marinino
she fulfill.IMPERF.PAST Marina’s
zadanie.
assignment
- b. Alena varila malinovie
Alena cook.IMPERF.PAST raspberry
varen’e
jam
i vpolnjala Marinino
and fulfill.IMPERF.PAST Marina’s
zadanie.
assignment

- (2) a. Alena was cooking raspberry jam.
She was fulfilling Marina’s assignment.
- b. Alena was cooking raspberry jam
and fulfilling Marina’s assignment.

Thus, apparently, both conjunction and pro-sody play a role in inducing the effect on discourse interpretation illustrated above. This ef-

¹The joint effect of intonation and conjunction was tested for Russian in a pilot perception experiment.

fect has been discussed in various contexts (e.g. Nakajima and Allen, 1993; Swerts and Geluykens, 1994), and given quite an intuitive informal explanation which matches neatly with standard assumptions about the function of rising and falling intonation. Assuming that, roughly, a rise signals “continuation” and a fall signals “completeness”, if an utterance ends with a fall, it is interpreted as “completing” some local communicative goal or topic, i.e. it provides *all* the relevant information wrt. that topic. If after the fall the discourse continues, and there are no reasons to believe that the new utterance addresses a completely different topic, then it can only be interpreted as a kind of “comment” on what has already been said: it can restate, reformulate the previous utterance, but it cannot add anything significantly new. By contrast, a rising continuation tune makes the hearer expect more information to come, so the completion-followed-by-restatement effect does not appear. (See Blake-more and Carston (1999) for an implementation of a similar idea for conjunction *and*.)

Arguably this is what happens in the examples above. The first clause of (1a/2a) ending with a fall gives a complete answer to the question *What was Alena doing?*, so the second clause is just a redescription of Alena’s actions. In contrast, the conjunction *and* in (1b/2b), possibly accompanied with a rising intonation, precludes the first clause from being perceived as a complete answer, and the effect does not arise.

In what follows, I attempt to formalize the explanation presented above. In line with a common view, the communicative goals, or topics, will be understood as *Questions under Discussion* (cf. e.g. Roberts, 1996), and utterances in discourse as answers to those questions. Then the Exhaustification of the answers appears as a rather straightforward way to encode the idea of completeness associated with falling intonation and the absence of a conjunction.

3 The analysis

Semantic representation: The relevant semantic differences between the discourses discussed in the previous section are represented in (3). The expression in (3a) corresponds to the

meaning of (1a/2a), where the second sentence “re-describes” the event introduced by the first sentence, that is, there is an event which is both Alena’s cooking raspberry jam and her fulfilling Marina’s assignment. The reading of (1b/2b) under which Alena’s cooking raspberry jam and her fulfilling Marina’s assignment are two simultaneous but possibly distinct events is represented in (3b). The expression $\tau(e_1) \circ \tau(e_2)$ indicates that the time intervals covered by the cooking event and the fulfilling event overlap.

- (3) a. $\exists e_1 \exists e_2$
 $\|A. \text{ was cooking raspberry jam}\|(e_1) \wedge$
 $\|A. \text{ was fulfilling M.'s assignment}\|(e_2) \wedge$
 $e_1 = e_2$
 b. $\exists e_1 \exists e_2$
 $\|A. \text{ was cooking raspberry jam}\|(e_1) \wedge$
 $\|A. \text{ was fulfilling M.'s assignment}\|(e_2) \wedge$
 $\tau(e_1) \circ \tau(e_2)$

Note that (3b) follows from (3a), since an event overlaps in time with itself, but the reverse does not hold, i.e. if two distinct events have the above properties, it is not necessarily the case that there is a single event that has both properties.² This reflects the less restrictive character of (1b/2b)’s semantics as compared to (1a/2a).³

The SDRT way of representing the semantics of these discourses would be to say that in (1a/2a) the discourse relation between the sentences is *Elaboration*, whereas in (1b/2b) it is something like *Parallel* (cf. Asher and Lascarides, 2003). *Elaboration* ensures that the event described by the second sentence is *part of* the event introduced by the first sentence ($e_2 \leq e_1$), whereas *Parallel* does not have this consequence. Adopting Eckardt’s (1998) notion of a part-whole relation between events (\leq), one could say that (3a) entails the semantics of SDRT’s *Elaboration*: $e_1 = e_2 \Rightarrow e_2 \leq e_1$.

Exhaustification and distinctness: Now let’s turn to Exhaustification and the way it in-

²Following Eckardt (1998), persistence of event properties is not adopted in the current analysis, i.e. if $P(e)$ and $e \leq e'$ it is not necessarily the case that $P(e')$. With persistence (3a) and (3b) would be equivalent.

³Note that (3) is intended primarily to capture the semantic contrasts between (1a/2a) and (1b/2b), but not necessarily all their entailments.

duces the event redescription effect, i.e. the (3a) reading of (1a/2a). The Exhaustification operator *Exh* used in the current analysis is defined in (4). The definition says that *Exh* takes a property of events as argument (e.g. $\lambda e.\|A. \text{ was cooking raspberry jam}\|(e)$), and specifies that there is an event that has that property, and that is, roughly speaking, the only event available. Any other events are either part of it (as, for instance, melting sugar is part of cooking jam) or their properties are irrelevant to the current Question under Discussion (QuD). Irrelevant properties are handled by the restriction $Q \in D_{\langle E,t \rangle}$, which makes Exhaustification dependent on a set of (alternative) event properties $D_{\langle E,t \rangle}$ relevant to the current QuD, as is standardly assumed for overt Exhaustification operators such as *only*, cf. Rooth (1992). The requirement $e' \leq e$ on the other hand ensures that subevents are not excluded by Exhaustification, that is, if Alena is only cooking raspberry jam and doing nothing else, this is not to say that she does not melt sugar as part of it. This restriction on exhaustive quantification, proposed by Kratzer (1989), is based on the intuition that when we count, we only count *distinct* entities, and, as we'll see, it plays a crucial role in our analysis of semantic relations in discourse.⁴

$$(4) \quad \text{Exh}(P) = \exists e.P(e) \wedge \forall e' \forall Q \in D_{\langle E,t \rangle} : Q(e') \rightarrow e' \leq e$$

As was noted in Section 2, falling intonation signals “completeness” of the unit it applies to. In our terms completeness translates into Exhaustification. If two consecutive clauses, as in (1a/2a), both bear a falling tune and there is no other overt indication of connection between them, such as *and*, the Exhaustification operator applies to each of the clauses separately:

$$(5) \quad \text{Exh}(\lambda e.\|A. \text{ was cooking raspberry jam}\|(e)) \wedge \text{Exh}(\lambda e.\|A. \text{ was fulfilling M.'s assignment}\|(e))$$

Let's assume that both clauses in (1a/2a) ad-

⁴Though (4) is based on Kratzer's idea, it is different from her intended semantics for *only*, in that it uses \leq on events directly, rather than going via the intermediate notion of *lumping* on propositions. Something similar to (4) was proposed by Bonomi and Casalegno, but the underlying semantics of \leq is in turn different (cf. Bonomi and Casalegno, 1993, p. 20ff).

dress the same QuD and the $D_{\langle E,t \rangle}$ variable in the semantics of *Exh* is instantiated by the same set of event properties. And assume that the properties $\lambda e.\|A. \text{ was cooking raspberry jam}\|(e)$ and $\lambda e.\|A. \text{ was fulfilling M.'s assignment}\|(e)$ are both in that set, i.e. they are both relevant to the current question. Then (5) is equivalent to (6), which in turn entails (3a), the interpretation of (1a/2a) we wanted.

$$(6) \quad \exists e.\|A. \text{ was cooking raspberry jam}\|(e) \wedge \|A. \text{ was fulfilling M.'s assignment}\|(e) \wedge \forall X \in D_{\langle E,t \rangle} [X(e') \rightarrow e' \leq e]$$

Intuitively the derivation goes as follows: *Alena was cooking raspberry jam* bears a falling intonation, so it is a complete answer to *What was Alena doing?* Thus Alena's cooking raspberry jam is the only relevant event that happened, anything else either did not take place or was part of Alena's cooking jam. Then Alena's fulfilling Marina's assignment must be part of her cooking ($e_2 \leq e_1$). Since the clause *Alena was fulfilling Marina's assignment* also ends in a fall, the same derivation applies and we get the part-whole relation to hold in the other direction ($e_1 \leq e_2$). Thus the identity of the cooking and the fulfilling event is inferred.

To sum up, we have derived the event redescription effect with the help of the proposed notion of Exhaustification and without postulating any ontologically primitive discourse relations except the relation of “addressing the same QuD”.

The scope of exhaustification: The discourse (1b/2b) differs from (1a/2a) in that the Exhaustification of the first clause alone is blocked. The presence of *and* or an intonational rise signals that the speaker is not done with the utterance yet, so the hearer should wait with drawing his implicatures. If the second clause then ends in a fall, the *Exh*-operator applies to the whole conjunction, rather than to each of the conjuncts separately.

$$(7) \quad \text{Exh}(\lambda e.\|A. \text{ was cooking raspberry jam}\|(e) \oplus_* \lambda e.\|A. \text{ was fulfilling M.'s assignment}\|(e))$$

The operator \oplus_* , summation of properties of events, corresponds to the meaning of the natural language conjunction *and*, and is adopted from Eckardt (1998), cf. (8). It is not a type-shifted

version of the classical Boolean conjunction, since in addition to conjoining the two event properties, it joins (\oplus^5) the corresponding events e_1 and e_2 into one complex event e . This complex event is needed as a handle for further Exhaustification. Although \oplus_* as a semantic correlate of *and* is admittedly a non-standard solution, it is independently motivated, cf. Eckardt’s (1998) account of adverbial modification.

$$(8) P \oplus_* Q = \lambda e \exists e_1 \exists e_2 [P(e_1) \wedge Q(e_2) \wedge e = e_1 \oplus e_2]$$

Given (7) and (8), and the definition of Exhaustification (4), the meaning of (1b/2b) results in (9). It says that there are two events, one of Alena’s cooking jam and one of her fulfilling Marina’s assignment. These events may but need not be identical. Since the whole conjunction is a complete answer to the current QuD, the sum of these two events ($e = e_1 \oplus e_2$) is the only relevant event available, and whatever follows would have to comment on that event.

$$(9) \exists e \exists e_1 \exists e_2. \\ \parallel \text{A. was cooking raspberry jam} \parallel (e_1) \wedge \\ \parallel \text{A. was fulfilling M.'s assignment} \parallel (e_2) \wedge \\ e = e_1 \oplus e_2 \wedge \\ \forall e' \forall X \in D_{\langle E, t \rangle} [X(e') \rightarrow e' \leq e]$$

Note that the temporal overlap of the cooking and the fulfilling event in (3b) does not follow from (9). That is, the simultaneity effect in (1b/2b) has nothing to do with Exhaustification in the proposed sense. Rather it is a consequence of the pragmatics of the Russian imperfective aspect (IMPERF), comparable to the English progressive, or the French *imparfait* (cf. Dowty, 1986; Kamp and Rohrer, 1983). Indeed, if the imperfective is replaced by perfective in (1), the temporal overlap is preserved in (1a) but lost in (1b). This is reminiscent of the observation made for English that verbal aspect affects the inference of temporal relations in discourse in a crucial way, but that this effect is overridden by the temporal consequences of part-whole relations, whenever we have reasons to infer such relations. In contrast with the current analysis, SDRT stipulates this generalization in the inference rule for each discourse

⁵The operator \oplus is (spatio-temporally unconstrained) summation of events in the classical sense, cf. Krifka (1989); Eckardt (1998).

relation of *Elaboration*-type, cf. Asher and Lascarides (2003, p. 206).

Part-whole relations without identity: We have shown above how the relation of identity between events in discourse can be inferred using the mechanism of Exhaustification. But identity is a special case of a part-whole relation. To complete this discussion, it is necessary to note that the proposed formal tools can also be used to infer “one-way” part-whole relations, which is closer to the original SDRT notion of *Elaboration*. For an illustration, consider (10).

- (10) Alena was fulfilling Marina’s assignment.
She was cooking raspberry jam
and putting it into jars.

Assuming that the first and the last clause end with a falling intonation, the Exhaustification operator applies to the first clause, and to the non-Boolean conjunction of the second and the third clause, since they are connected by *and*:

$$(11) \text{Exh}(\lambda e. \parallel \text{A. was fulfilling M.'s assignment} \parallel (e)) \wedge \\ \text{Exh}(\lambda e. \parallel \text{A. was cooking raspberry jam} \parallel (e) \\ \oplus_* \lambda e. \parallel \text{A. was putting jam into jars} \parallel (e))$$

Thus we infer event identity in the usual way. However, it does not hold between all the three events, but only between the event of Alena’s fulfilling Marina’s assignment (e) and the sum of the other two ($e_1 \oplus e_2$). Consequently, $e_1 \leq e$ and $e_2 \leq e$, but not necessarily $e_1 = e$ or $e_2 = e$.

$$(12) \exists e \exists e_1 \exists e_2. \\ \parallel \text{A. was fulfilling M.'s assignment} \parallel (e) \wedge \\ \parallel \text{A. was cooking raspberry jam} \parallel (e_1) \wedge \\ \parallel \text{A. was putting jam into jars} \parallel (e_2) \wedge \\ e = e_1 \oplus e_2 \wedge \\ \forall e' \forall X \in D_{\langle E, t \rangle} [X(e') \rightarrow e' \leq e]$$

The derived meaning of (10) says that Alena was involved in two (separate) activities—cooking raspberry jam and putting it into jars—and in doing both of these, Alena was fulfilling Marina’s assignment, i.e. Marina had told Alena to do both. Cooking jam and putting it into jars are both temporally included in the fulfilling event. This reflects well our intuitive understanding of (10).

Cancellation: Finally, it is necessary to say a few words about all those discourses in which, apparently, the sentences are not connected by a conjunction and end in a falling intonation, yet no event redescription effect appears, as in (13) and (14). Here the sentences present a succession of events, and in SDRT terms are connected by the discourse relation of *Narration*.

- (13) Alena was cooking raspberry jam.
 After that, she was fulfilling Marina's assignment.
- (14) Max stood up.
 John greeted him.

I propose that in such cases, the absence of event identity is a consequence of implicature cancellation. Recall that Exhaustification is a kind of conversational implicature, so its effect should be cancellable if it is inconsistent with some part of hard-core semantics or the general common knowledge of the interlocutors. In (13), event identity conflicts with the relation of temporal sequence, stated explicitly by the phrase *after that*. In (14), it conflicts with the information that Max standing up and John greeting him cannot be the same event, which is part of world knowledge.

To sum up, a part-whole relation between events induced by Exhaustification is cancelled whenever it is implausible, but if it is plausible, as in (1a/2a) or (10), it also *must* be inferred, unless there are overt intonational or lexical indications that Exhaustification does not apply.

4 Exhaustification vs. SDRT

In the previous section it was shown how the mechanism of Exhaustification can be applied to the inference of part-whole and identity relations between events in discourse, as well as their temporal consequences. Part-whole relations constitute the semantic effect associated with the SDRT relation of *Elaboration*, while event redescription can be considered a special case of *Elaboration*. The proposed analysis accounts for the influence of rising vs. falling intonation as well as presence vs. absence of *and* on the inference of these relations.

In contrast, previous formal accounts have

either ignored the semantic difference between juxtaposed and conjoined clauses (Kamp and Rohrer, 1983; Lascarides and Asher, 1993); or attributed this difference to the semantics of *and* directly (Txurruka, 2003). For instance, Txurruka's SDRT-based proposal assigns the following semantics to the English conjunction *and*:

$$(15) \text{and}(\alpha, \beta) \rightarrow \text{Coordinator}(\alpha, \beta)$$

The rule says that if two clauses are connected by *and* then at the level of conceptual structure they must be connected by a *coordinating* discourse relation. This bars connecting α and β by *Elaboration*, since *Elaboration* is a *subordinating* relation, and the lists of coordinating and subordinating relations are mutually exclusive, cf. (16) and (17).

(16) *List of Coordinators:*
 Narration, Result, Parallel, Conditional, ...

(17) *List of Subordinators:*
 Explanation, Instance, Background,
 Elaboration, Evidence, Generalization,
 Reformulation, ...

Here the predictions of Txurruka's and the current analysis coincide, but there are also differences in empirical coverage. On the one hand, Txurruka only handles the effect of the conjunction *and*, but not that of rising intonation. On the other hand, Txurruka's rule for *and* also excludes all other discourse relations listed in (17). Such relations as *Instance*, *Generalization*, *Reformulation*, and possibly *Background* could be argued to involve part-whole relations on events, and therefore fall within the scope of the current Exhaustification-based proposal. But *Explanation* and *Evidence* do not seem to involve such relations, so their tendency to co-occur with bare sentence juxtaposition rather than conjunction *and* is not covered. This tendency is illustrated in (18):

- (18) a. Max fell.
 He slipped on a banana peel.
- b. Max fell
 and he slipped on a banana peel.

According to Txurruka and other authors, the second clause in (18a) is most naturally interpreted as the *cause*, i.e. the *Explanation* of Max'

falling, whereas in (18b) this is not the case. The discourse suggests rather that Max fell first, and then slipped on the banana.

Thus the domains of natural language facts covered by Txurruka's (2003) and the current analysis intersect, but neither contains the other. It is outside the scope of the present paper to extend the notion of Exhaustification to treat causal relations. Neither was this paper intended to handle *structural* properties of *Elaboration & Co.*, such as the impact on referential accessibility associated with the distinction between discourse coordination and subordination (see Asher and Vieu (2003) for discussion). However, the *semantic* consequences of *Elaboration* were covered completely and adequately.

To summarize, we proposed an account of the impact of intonation and conjunction on part-whole relations between events in discourse as well as temporal consequences of such relations. The proposal is cast in terms of Gricean conversational implicature and the notion of Question under Discussion, without any reference to discourse relations as ontological primitives. This result is important in light of the following. First, one of Asher and Lascarides's (2003) arguments against approaches based on weaker notions of discourse structure is that they are not able to account for the whole variety of semantic relations that may hold between sentences in discourse. The proposed analysis can be seen as part of the programme to show that this argument does not hold. Second, since the Gricean approach was criticized for its limitation to the treatment of individual sentences and hence (*sic*) its inability to handle relational meaning, it is particularly remarkable that Exhaustification—one kind of Gricean implicature—can be shown to play a central role in an account of semantic *relations* in discourse.

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