Causation, Event Structure and Process Specifying Adverbials

Tavs Bjerre


Based on data from Danish, this article examines various linguistic means of expressing causation. It is argued that *inchoatives*, *causatives* and *accomplishments* all denote situations in which one situation – *subevent*$_1$, is construed as causing another – *subevent*$_2$. *Inchoatives* and *causatives* are described as having different kinds of underspecified *subevent*$_1$. The bulk of the article is concerned with an analysis of prepositional phrases of a type termed *Process Specifying Adverbials*, (PSAs). It is argued that PSAs serve to specify *subevent*$_1$, and their behaviour is seen as corroborating the proposed analysis for *inchoatives* and *causatives*. The analysis is formalized within the framework of HPSG.

*Tavs Bjerre, University of Southern Denmark, Engstien 1, DK-6000 Kolding, Denmark. E-mail: tavs@sitkom.sdu.dk*

1. INTRODUCTION

Causation is a fundamental notion to human beings. This is reflected in language by the numerous – and frequently used – means we have at our disposal to describe situations involving causation.

In this article I start out by considering what it is the Danish sentences in (1) have in common, and what sets them apart.

(1) a. Marie vågnede. Mary woke up
    b. Bo vækkede Marie. Bo awakened Mary
    c. Bo ruskede Marie vågen. Bo shook Mary awake

In order to do that, I sketch a proposal for an event structure with sub-events, building on and further developing ideas from the work of Dowty (1979); Jackendoff (1983, 1990); Levin & Hovav (1995); Parsons (1990) and Pustejovsky (1988, 1991, 1995).

In the second part of the article the focus is on prepositional phrases like those shown in (2).
I examine the interaction of these PPs with VPs expressing various event structures and thereby try to establish on the one hand what licenses the PPs and on the other if the proposed event structure is tenable.

2. EVENT STRUCTURE

(3) through (6) are examples of the possibilities of expressing causation in Danish:

(3) a. Marie vågnede.  
    Mary woke up

b. Peter kom ud i haven.  
    Peter came out in garden-the

(4) a. Bo vækkede Marie.  
    Bo awakened Mary

b. Bo fik Peter ud i haven.  
    Bo got Peter out in garden-the

(5) a. Ane byggede et hus.  
    Ane built a house

b. Peter løb ud i haven.  
    Peter ran out in garden-the

(6) a. Bo spiste sin mor ud af huset.  
    Bo ate his mother out of house-the

b. Bo ruskede Marie vågen.  
    Bo shook Mary awake

The verbs in (3) and (4) belong to the class of achievement verbs, those in (5) and (6) are accomplishments (Vendler 1957), my definition of these terms differs somewhat from Vendler’s, though. Verbs like those in (3) are often called inchoatives (cf. (Levin 1993: 27–33) and references there) while those in (4) are called causatives. VPs like those in (6) have been much discussed recently under the name of resultatives.
(e.g. Hoekstra (1988); Carrier & Randall (1992); Goldberg (1995); Verspoor (1997)).

It is my claim that causation is part of the semantics of all of the sentences above. They all denote complex situations in which one situation is construed as causing another. The causing situation I term \textit{subevent}_1. It must be a process, as only processes may cause change.

The resulting situation is termed \textit{subevent}_2. It may be a state, as in the sentences above, or it may be a process (plus possibly a state). All of the sentences above have a CONTENT-value of the type \textit{result-psoa}.

The difference, I claim, between the semantics of the VP-types exemplified in (3) through (6) lies in the specificity of \textit{subevent}_1. In (3), \textit{subevent}_1 is totally underspecified, any process may satisfy the description, provided it can be construed as the cause. Figure 1 shows the representation of the semantics of inchoatives, as exemplified by (3a).

\begin{figure}[h]
\centering
\begin{tabular}{l}
\textbf{CONTENT} \\
\textbf{inchoative-psoa} \\
\textbf{E1} abs-unspec-rel \\
\textbf{E2} awake-rel \\
\textbf{E-REL} cause \\
\end{tabular}
\caption{CONTENT value of \textit{vågne} ‘wake up’.}
\end{figure}

\textit{E1} and \textit{E2} take those relations as values that hold for \textit{subevent}_1 and \textit{subevent}_2, respectively. The value \textit{cause} for the attribute \text{E(vent)-REL(a-tion)} expresses that \textit{subevent}_1 precedes \textit{subevent}_2, and that the former is construed as causing the latter. Furthermore, the negation of the state in \textit{E2} must hold prior to \textit{E2}, i.e. for someone to be able to wake up he must have been asleep prior to the coming about of \textit{subevent}_2. I will express this presupposition by the constraint shown in Figure 2 stating that for any sign with a CONTENT-value of type \textit{result-psoa}, it must hold that the negation of the relation in \textit{E2} is in the set of background relations.

\begin{figure}[h]
\centering
\begin{tabular}{l}
\textbf{sign} \\
\textbf{SS} | LOC | \textbf{CONT} \textit{result-psoa} \\
\rightarrow \\
\textbf{SS} | LOC \begin{tabular}{l}
\textbf{CONT} | \textbf{E2} \checkmark \\
\textbf{CONTEXT} | \textbf{BACKGROUND} \{...,-\checkmark,..\}
\end{tabular}
\caption{Result-psoa constraint.}
\end{figure}

In (4), \textit{subevent}_1 is also underspecified, but in this case the relation is constrained to being a process in which the subject plays the role of actor. The representation of the semantics of causatives is shown in Figure 3.
In the accomplishments (5) and (6) on the other hand, subevent 1 is specified. In (5a) it was the building-process of which Ane was the actor that led to the existing of the house, in (5b) Peter ran, and this resulted in his being in the garden. In (6a) Bo ate (something) resulting in his mother being outside the house. And, finally, in (6b) Bo shook (Mary) which led to Mary’s being awake. Figure 4 shows an accomplishment-psoa.

Figure 4. CONTENT value of ruske vågen ‘shake awake’.

Figure 5 summarizes what I have said so far.

A result-psoa is a (conceptualized) complex situation consisting of a process preceding and causing (the coming about of) a state. The two subtypes of result-psoa are distinguished on the basis of the specificity of E1. Achievement-psoa has an underspecified E1 splitting into inchoa-
*tive-psoa* with an absolutely underspecified E1 and *causative-psoa* with an underspecified E1 in which the first argument must play the role of actor. *Accomplishment-psoa* has a specified E1.

The idea of causation as a relation between events is discussed and supported in Dowty (1979). Jackendoff (1990) gives the following formation rule:

![Figure 6. CAUSE (Jackendoff 1990: 43).](image)

adding that if the first argument of CAUSE is a thing, it is an agent, thus in fact saying the same as the present proposal though less precisely. The major difference between the theories of Dowty and Jackendoff and others and the present proposal is the uniform treatment of inchoatives, causatives and accomplishments, the sole difference being the specificity of subevent *f*.

The idea of an underspecified subevent *f* has been advocated by for example Chierchia (1989) cited in Levin & Hovav (1995), and the event structure proposed here has much in common with the proposal in Levin & Hovav (1995). However, what they explain in terms of externally versus internally caused events I would prefer to explain in terms of processes (which are simple events) versus complex events. A discussion of this point is beyond the scope of this article, though.

3. PROCESS SPECIFYING ADVERBIALS

I now turn to a class of adverbials which I term Process Specifying Adverbials. Sentences like (7) have been discussed in the literature at least since McCawley (1971).

(7) a. He made the metal flat by hammering it.
    b. He flattened the metal by hammering it.
    c. He hammered the metal flat.

The problem is to show how these syntactically rather diverse sentences can be given roughly the same interpretation. Dowty (1979: 227–229) discusses the sentences in (8) and (9):
He suggests treating \textit{by} as an expression of category (IV/IV)/T and its translation \textit{by’} as a non-logical constant restricted by the following meaning postulate:

\begin{align*}
\Delta p & \Delta P \Delta Q \Delta x \Box [\textit{by’}(P)(\exists Q[y]\text{CAUSE } \check{\hat{p}})](x) \rightarrow
[\textit{P}[x]\text{CAUSE } \check{\hat{p}}]]
\end{align*}

This specifies that if by doing $P$ $x$ does something ($Q$) that causes some proposition $p$ to obtain, then in this situation $x$’s doing $P$ causes $p$ to obtain. This postulate leaves open the question of just how the events involved are to be individuated; it does not require that the event which $P$ is the property of being ‘involved in’ (however this notion is to be defined) is the same as the event which $Q$ is the property of being involved in, because it does not even require that $P$ and $Q$ be the same property. This is as it should be, since if John hammers the metal flat by pounding it with a pipe wrench, we do not wish to say that the property of hammering the metal is the same as the property of pounding it with a pipe wrench, though the extension of these two properties may be the same in the actual and/or most relatively similar worlds.

The important thing to note here is that Dowty is unable to characterize the relation between $P$ and $Q$. It is this defect I try to improve on.

Danish has three prepositions that may function as process specifying, \textit{ved}, ‘by’, \textit{af}, ‘of/from’, and \textit{med}, ‘with’. The next sections treat these prepositions one at a time.

3.1. \textit{The preposition ved}

The Danish equivalent of (8a) is shown in (10).

\begin{align*}
\text{(10) } & \text{John vækkede Marie ved at råbe.}
\end{align*}

John awakened Mary by to shout

Given what I have said earlier about causatives having an underspecified $E_1$-value, the obvious thing to say about (10) is that the \textit{ved}-phrase serves to specify the $E_1$-value. This can be formalized as in Figure 7
Figure 7 says that the preposition *ved* modifies a verbal sign with an underspecified subevent \( I \). The \( E_2 \)-value of this sign is identical to the \( E_2 \)-value of the whole phrase (II). *Ved* takes a verbal complement the \( E_1 \)-value of which is identical to the \( E_1 \)-value of the whole phrase (I). The CONTENT-value of the *ved*-phrase is a *result-psoa* which constrains the \( E_1 \)-value to a *process-rel* and the E-REL-value to *cause*.

In accordance with usual practice in HPSG, the adjunct-daughter is considered the semantic head of the phrase, which means that the content-value of a *head-adjunct-phrase* is identical to that of the adjunct-daughter, while the CAT-value is identical to that of the head-daughter. This is shown in Figure 8.

Furthermore, the verbal complement must be *marked*, i.e. the phrase must be introduced by *at*, ‘to’/‘that’ (for the sake of simplicity, I here collapse these two clearly distinct items). However, this constraint seems to be common to all prepositions taking verbal complements, and I thus express it in the constraint shown in Figure 9.
The sentences in (11) show that *ved*-phrases are not restricted to modifying causative VPs.

(11) a. Han døde ved at få en mursten i hovedet.  
He died by to get a brick in head-the  

b. Marie vågnede ved at John råbte.  
Mary woke up by that John shouted

The verbs in (11) are inchoatives, but since the value for $E_1$ is *abs-unspec-rel* in the case of inchoatives, and *abs-unspec-rel* is a subtype of *unspec-rel*, the entry in Figure 7 already makes allowance for this. However, there is an important difference between the two cases.

*Ved*-phrases modifying causatives (and less frequently, accomplishments) only accept as complements infinitives where the unrealized subject is identical to the subject of the verb, or, to a lesser extent, a finite clause the subject of which must be co-referential with the subject of the main clause.

In contrast, in the case of *ved*-phrases modifying inchoatives, the
complement of *ved* may also be a finite clause without any restrictions on the subject (11b).

I consider this a corroboration of the claim that the subject of active causative verbs must have the role of actor in the underspecified process. To handle these differences we add some information to the lexical entry for *ved*.

Figure 11. Lexical entry for *ved*, 'by'.

![Diagram](image)

Figure 11 is identical to Figure 7 except for the following: The SUBJ-list of the complement must either be empty or else contain the same element that is on the SUBJ-list of the modified VP. This handles the fact that the unrealized subject of an infinitive is identical to the subject of the verb, and allows for finite complement clauses. What remains is to make sure that sentences like (12) are ruled out.

(12) * John vækkede Marie ved at Ole råbte.
    John awakened Mary by that Ole shouted

Recall that causatives are characterized by an *unspec-act-rel* as value for E1. This means that John must have the role of actor in the E1-relation, but in (12) that role is already taken by Ole and hence the sentence is not well formed. I shall not try to spell out the technical details here.

3.2. *The preposition af*

As (13) demonstrates, also a phrase headed by the preposition *af*, 'of', may function as process specifying adverbial.
(13) Ole døde af at løbe / overanstrenge sig / feste / læse etc.
Ole died of to run over-exert himself party read

The main difference between *af* and *ved* is that *af* may also take a noun complement, as shown in (14).

(14) Ole døde af druk / overanstrengelse / arsenikførgiftning.
Ole died of drinking over-exertion arsenic poisoning

The noun complement must be a predicative noun, i.e. a noun denoting a situation, or, in technical terms, a noun with a *psoa*-object on its RESTRICTION-list. The noun denotes the causing event, the $E_1$-process, parallel to what verbal complements do. A noun complement denoting the actor of the $E_1$-process is not possible:

(15) * Ole vågnede af ringeklokken.
Ole woke up of doorbell

Figure 12 shows how this can be formalized.

![Figure 12. Lexical entry for \textit{af} (spec), ‘of’.

The lexical entry for the Process Specifying $af_{\text{spec}}$ in Figure 12 resembles that of *ved* with the addition that *af* may take a noun complement. This noun must have a *psoa*-element on its RESTRICTION-list, and the $E_1$-value of this element must be identical to the $E_1$-value of the phrase. An element on the ARG-ST-list of the noun is structure-shared with the subject of the modified verb. Furthermore, as (16) shows, $af_{\text{spec}}$ may only
modify *inchoatives* and so the E1-value of the modified VP is constrained to being an *abs-unspec-rel*.

(16) a. *Søren dræbte Ole af druk / overanstrengelse.*  
Søren killed Ole of drinking over-exertion

b. *Søren dræbte Ole af at drikke / overanstrenge sig.*  
Søren killed Ole of to drink over-exert himself

While the entry in Figure 12 works fine for (14), there still remain a number of problematic cases.

The problem with the sentences in (17) is that the nouns apparently denote states, the state of Ole having pneumonia or being old or injured, and thus cannot be said to directly denote the causing event (recall that the E1-relation in *result-psoas* is constrained to being a process-relation).

(17) a. Ole døde af lungebetændelse.  
Ole died of pneumonia

b. Ole døde af alderdom / sine kvæstelser.  
Ole died of old age his injuries

I claim that in both cases the states are inherently connected to processes. *Lungebetændelse* in (17a) denotes a complex, dynamic situation, consisting of a number of underspecified and possibly unknown relations. Some of these relations are processes and it is eventually one or more of these processes that cause death. In (17b) the states denoted by *alderdom* and *kvæstelser* are inherently connected to the processes that brought them about, and it is those processes that cause death as well.

This is modelled by letting for example *pneumonia-rel* be a subtype of *dyn(amic)-rel*. Part of the type hierarchy for dynamic relations is shown in Figure 13.
Figure 13. Part of the type hierarchy for dynamic relations.

The idea is that while pneumonia is normally conceived of as a state, it may at the same time be conceived of as being dynamic. Furthermore, the constraint on result-psoa must be revised to allow \( E_1 \) to take a dynamic relation as value.

(18) exemplifies another potential problem.

(18) Ole døde af jalousi.

Ole died of jealousy

Jalousi does not denote a dynamic situation. When interpreting (18) we are forced to understand jalousi as the motivation or explanation for whatever it was Ole did, which eventually caused his death. Further arguments in favour of a distinction between specifying and motivating 'af' are found in the sentences (19) through (21).

(19) Ole dræbte hende af jalousi / kærlighed.

Ole killed her of jealousy love

(20) Ole løb / sang / græd af glæde / jalousi / smerte etc.

Ole ran sang cried of joy jealousy pain

(21) a. * Ole hostede af lungebetændelse.

Ole coughed of pneumonia
b. * Ole løb / sang / græd af druk / lungebetændelse etc.
Ole ran sang cried of drinking pneumonia

(19) shows that \( af_{mot} \) as opposed to \( af_{spec} \) may modify causatives, cf. (16). \( af_{mot} \) may modify processes, (20), while \( af_{spec} \) may not, (21).

This means that we must distinguish between static situations that motivate some action and processes – possibly contained within dynamic situations – that cause some change of state. In order to be able to represent this distinction, I introduce a new attribute, MOTIVATION, for the type \( psoa \), the value of which cannot be a dynamic-rel. The lexical entry for the Motivation Preposition \( af \) is shown in Figure 14.

\[ \text{Figure 14. Lexical entry for } \text{af (mot), 'of'}. \]

\( af_{mot} \) may modify any VP. The CONTENT-value of the modified VP is structure-shared with that of the phrase, and the E1-value of the noun complement is structure-shared with the value for the MOTIVATION-attribute within the CONTENT-value.

In both the active sentence (22a) and the passive (22b) it is unambiguously Søren who is jealous.

(22) a. Søren dræbte Ole af jalousi.
Søren killed Ole of jealousy

b. Ole blev dræbt af Søren af jalousi.
Ole was killed by Søren of jealousy

This fact is expressed in Figure 14 by the structure-sharing of the first
element on the ARG-ST-list of the modified verb and that of the complement noun. This element is realized as subject in active and as the complement of *af* in passive clauses.

Even though the complement nouns in (23) denote complex situations more or less in parallel to (17a), the sentence is not well formed.

(23) * Ole døde af sejlads / fest.
    Ole died of sailing party(ing)

A tentative solution is to impose a constraint on this construction to the effect that the subject of the clause must have an explicit role in the relation introduced by the complement noun. While in (17a) it is clear what Ole’s role was, i.e. that he was the one that suffered from pneumonia, this is not the case in (23). One way of modelling this would be to let *pneumonia-rel* but not *party-rel* inherit from *state-rel*, as shown in Figure 15.

![Figure 15. Part of the type hierarchy for dynamic and state-relations.]

This means that while *pneumonia-rel* has a semantic role, the Bearer of the property, for Ole to fulfil, *party-rel* does not.

On the basis of what I have said so far (24) should be alright, but it is only marginally acceptable.

(24) ? Ole døde af svømming.
    Ole died of swimming

The explanation may be that if some meaning is expressible by means of an infinitive, *af spec* prefers the infinitive as complement. But then it must be explained why (14), here repeated as (25a), is preferred to (25b).

    Ole died of drinking over-exertion
b. Ole døde af at drikke / at overanstrenge sig.
Ole died of to drink to over-exert himself

In the case of *druk* we could say that it has a conventionalized meaning which is not expressible with the infinitive, *druk* meaning an excessive consumption of alcohol. On the other hand, in the case of *overanstrenge* and *at overanstrenge sig* there does not seem to be any (substantial) difference. I shall leave the question for further research.

3.3. *The preposition med*

A third preposition that should be mentioned in this connection is *med*, ‘with’. The use of *med* with a process specifying meaning is severely restricted compared to that of *af* and *ved*. As the sentences in (26) demonstrate, *med* as a specifying preposition takes only noun complements and modifies only causative VPs.

(26) a. John vækkede Marie med (sit) råb / (sin) råben.
   John awakened Mary with his shout his shouting

b. * John vækkede Marie med at råbe.
   John awakened Mary with to shout

   Mary woke up with John’s shout shouting

d. * Marie vågnede med at John råbte.
   Mary woke up with that John shouted

The noun complement must denote the process directly and the complement of *med* is thus the nominal counterpart of the verbal complement of *ved*, compare (26a) with (10).

Figure 16 gives the lexical entry for *med*. 
Note that the sentence in (27) exemplifies another use of *med*. In this case the screaming is not the causing event, but rather an accompanying circumstance.

(27) Marie vågnede *med* et skrig.
Mary woke up *with* a cry

4. SUMMARY
In this article various linguistic means of expressing causation have been examined. I have argued that *inchoatives*, *causatives* and *accomplishments* all denote situations in which a process, *subevent*$_1$, is construed as causing a state or a process, *subevent*$_2$. *Inchoatives* and *causatives* are
described as having different kinds of underspecified $subevent_1$, inchoatives having an absolutely underspecified process as $subevent_1$ – an abs-unspec-rel, while causatives have an unspec-act-rel with an actor as argument.

The analysis of prepositional phrases of a type termed Process Specifying Adverbials seems to corroborate this analysis of event structure. I have argued that PSAs serve to specify $subevent_1$, and this is why they normally modify inchoatives and causatives but not accomplishments or simple processes or states, which already have a specified $subevent_1$. There is a constraint on PSAs modifying causatives to the effect that the first argument of the relation expressed by the complement of the preposition and the first argument of the causative must be structure-shared, thus underpinning the claim that the first argument of causatives must be an actor.

Table 1 gives an overview of Process Specifying Prepositions. It shows that both $ved$ and $med$ but not $af$ may modify causatives, $ved$ taking infinitival complements and $med$ noun complements. $Af$ modifies inchoatives taking noun complements as well as verbal complements. $Ved$ may also modify inchoatives, though to a lesser extent than $af$.

Furthermore, I have argued for the existence of another type of adverbial termed Motivation Adverbials. These differ from PSAs in taking a complement denoting a state, not a process, and serve to express the motivating state for some process.

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