Semantics (Part I: Compositional Semantics/ Semantics and Syntax)

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Recap

- Logic: First Order Logic

- Syntax: Phrase Structures

- Computation: Processing

Perspectives for cross-disciplinary dialogues

- Logic and Linguistics (semantics):

- The first-order (predicate) logic helps to describe the meaning of natural language, which is a task of linguistics.

- The logical description of meaning (compositional meaning) further sheds light on how meaning is derived via syntax.

Perspectives for cross-disciplinary dialogues

- Computation & Linguistics (semantics):

- How are the rules of grammar derived, which can be applied for grammaticality judgment in processing?

- Such rules are often meaning/semantics related. cf. *John greeted/ * Greeted Mary/ * John greeted Mary

Predicate Logic and Compositional Semantics

In propositional logic, we treat a single proposition as the atom of the calculation. Now we discompose a single logic, exploring how the meaning of a proposition is formed so that we can make the truth value judgement about it.

For this purpose, we need the predicate logic.

A proposition is basically (roughly) decomposed into two parts: predicate and arguments.

The predicate logic thus does the following two things:
A: assigning meaning to predicate and arguments (individuals/ variables, see later)

B: combining the component meanings into the meaning of a proposition. ("compositional semantics").

Predicate Logic and Compositional Semantics

In modern linguistics/philosophy of language, the insights on sentential meaning are essentially those of Gottlob Frege, whose work in the late nineteenth century marked the beginning of both symbolic logic and the formal semantics of natural languages.

Frege conjectured that semantic composition may always consist in the saturation of an **unsaturated** meaning component.

Saturated and Unsaturated Meanings

A sentence can be imagined to be split up into two parts: one complete in itself, and the other in need of supplementation, or, 'unsaturated.'

(1) a. John slept

   A simplified predicate-logic based representation of the meaning of (1) then is:

 (1) b   sleep (J)

Predicate Logic and Compositional Semantics

On the other hand, the simplified syntactic tree of (1a) is (2)

(2)
```
              S
             / \
            /   \
           /     \
          NP      VP
         John    slept
```
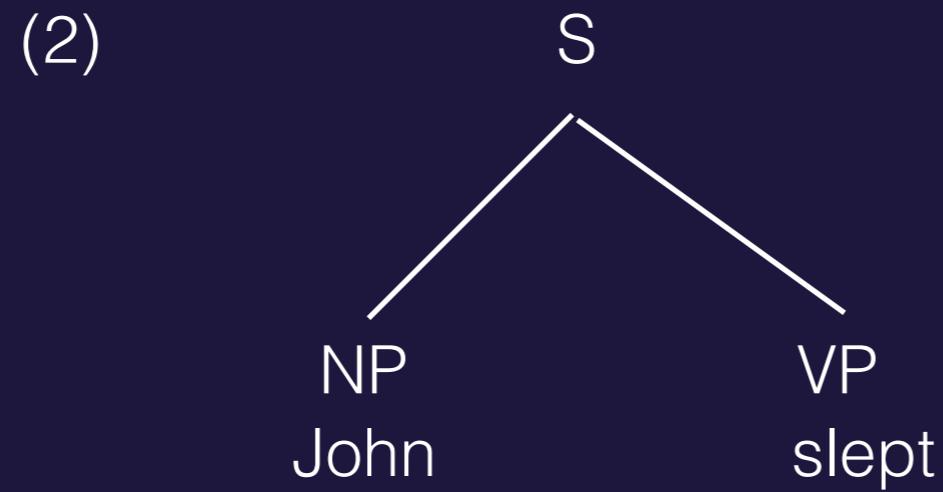
Considering the predicate-logic based representation of the meaning of (1b), and the syntactic tree in (2), can you detect an issue that deserves our exploration?

The issue at stake: how can the syntactic tree (derived from PS rules) in (2) exactly represents the meaning represented in (1b)?

One answer to this question is provided by the so-called "type theory".

Relating Meaning to Syntax (I): Type Theory

Basic types: e and t type
e type: a proper name like Donal Trump has the type of e, because it denotes an entity in the world.

t type: t here refers to truth value. So a proposition is of the <t> type.

A predicate like *smart* is of the <e, t> type: you apply this predicate to something of an e type, what you will get is something of <e> type:
smart: <e, t> (i.e. λx [smart (x)])
John: <e>
Apply *smart* to *John*:
smart (John): <t> (you can judge whether "John is smart" is true or false)

With the type theory, we can see how the meaning of a sentence is derived via composition, and hence compositional semantics.

NB. Adjectives are in fact much more complicated than we might have assumed. I am taking a very simple understanding of adjectives here just for my illustration. In addition to adjective, intransitive verbs like sleep are also obviously of type <e, t>.

Relating Meaning to Syntax (I): Type Theory

A puzzle of adjectives (just for fun :))

a. This elephant is small.
b. An elephant is an animal.

With the propositional logic we have learnt so far, it seems we will come to a conclusion as follows:

This animal is small (You point at the elephant in (a) example).

??

How can we solve this problem?

Relating Meaning to Syntax (I): Type Theory

With the type theory, we can understand why the following semantic composition is not attainable/interpretable:

(4) John laughed Mary.
    Mary: <e>
    laugh: <e, t>
    John: <e>

If we combine "laugh" and "Mary" first, we can get an interpretable result of composition by apply the function "laugh" <e, t> to the entity "Mary" <e>, and the result is <t>. When this <t> is further combined with "John" (<e>), nothing will happen, as neither is a function.

So far, the type theory tells reason for semantic uninterpretability.

It is further argued that ungrammaticality is in fact derived from semantic unterpretability, and thus all grammatical structures should be interpretable within the framework of type theory.

We therefore need some rules to map the semantic interpretation to syntactic structure.

Relating Meaning to Syntax (I): Type Theory

(5) Terminal Nodes
If α is terminal node, then α is in the domain of ⟦ ⟧ if ⟦α⟧ is specified in the lexicon.

NB: here ⟦ ⟧ is an interpretation function

(5) Non-Branching Nodes
If α is a non-branching node, and β is its daughter node, then α is in the domain of ⟦ ⟧ if β is. In this case, ⟦α⟧ = ⟦ β⟧.

(6) Functional Application
If α is a branching node and {β, γ} is the set of α's daughters, then α is in the domain of ⟦ ⟧ if both β and γ are, and ⟦β⟧ is a function whose domain contains ⟦γ⟧. In this case, ⟦α⟧ = ⟦ β⟧ (⟦γ⟧).

(7) Principle of Interpretability
All nodes in a phrase structure tree must be in the domain of the interpretation function ⟦ ⟧.

Heim and Kratzer (1998: 48-49)

Relating Meaning to Syntax (I): Type Theory

An illustration
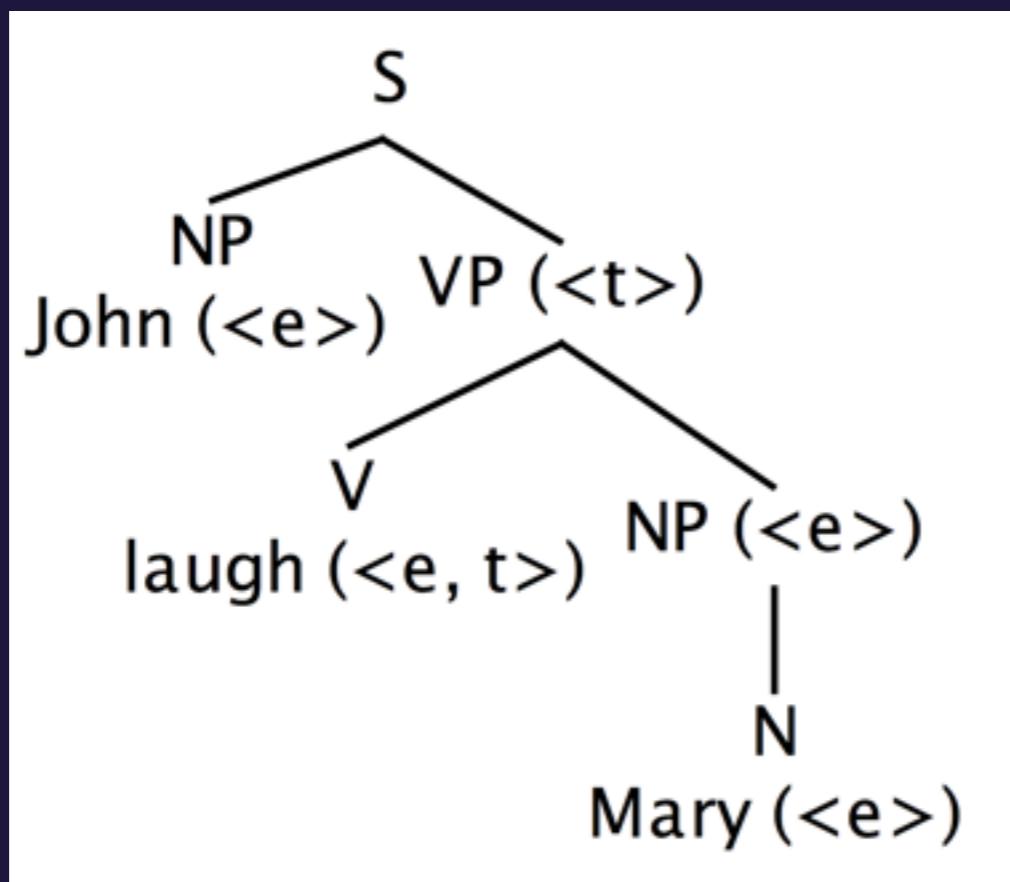
(7) *John laughed Mary.

A more complicated example:

(8) *It is not the case that killed the tiger

(9)


```
                              S
                   _____|_____
                  /                       \
        It is not the case that (<t, t>)   VP (<e, t>)
                                        ____|____
                                       /         \
                                      V           NP
                              kill (<e, <e, t>)   the tiger (<e>)
```
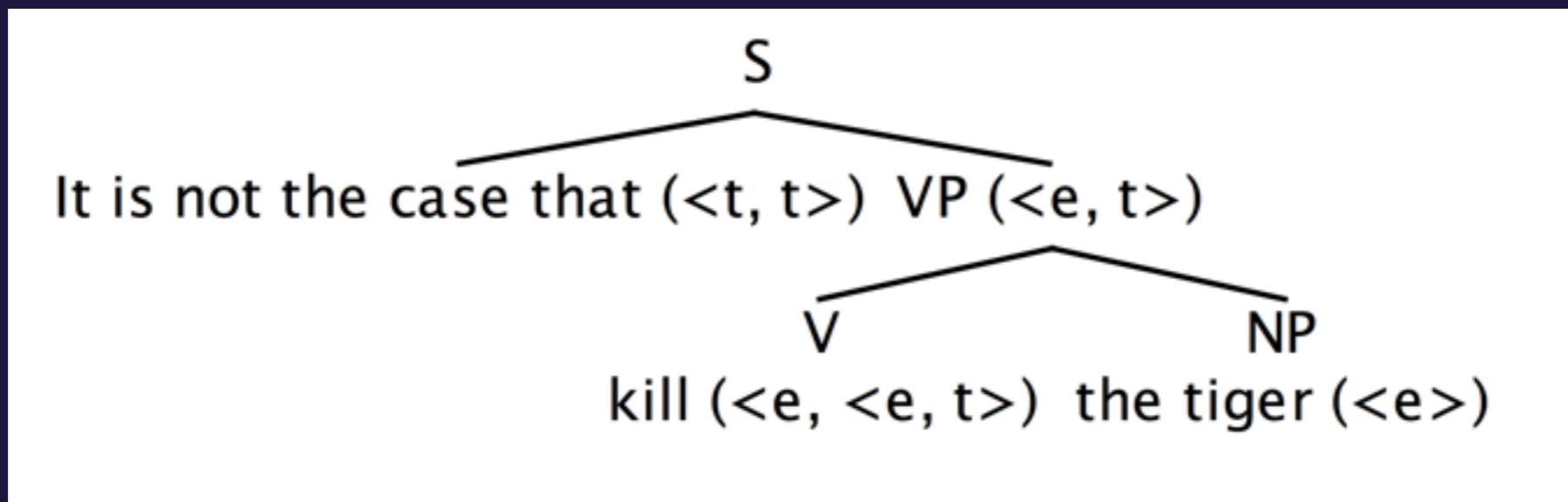
Relating Meaning to Syntax (I): Type Theory

For semantic description and processing, maybe type theory is a very good framework, which is actually widely accepted in one way or another in syntactic studies, generative syntax in particular.

Problems:
(a) Where does the type come from?
    Types are from the lexicon. So an intransitive verb is of type <e,t>, while a transitive verb is of type <e, <e,t>>. But, think of the following examples:
    A vase broke. vs. John broke a vase.
    The same verb "break" are of different types in these examples.

(b) Types do not match categories.
    Adjectives and intransitive verbs are of the same type ,but transitive verbs are of a different type.

Relating Meaning to Syntax (II):Argument Structure Theory

Linguists are concerned with how the information of an event is mapped onto the syntactic structure. Or put it in a simple way, we want to know how the information of an event can be denoted by our language.

Firstly, we want to know what participants are involved in an event. So we have thematic roles, such as agent/causer, patient/theme, instrument, locative, etc.

(10)
a. John kissed Mary. (Agent: John; Patient/Theme: Mary)
b. The wind broke the vase. (Causer: The wind; Patient/Theme: the vase)
c. The vase broke in the morning. (Theme: vase)
d. John gave Mary a book. (Agent: John; Theme: a book; Goal: Mary)
e. John opened the door with the golden key. (Agent: John; Theme: the door; Instrument: the golden key)
f. John put a piece of cake on the table. (Location: the table)

Argument Structure

The second issue is why some thematic roles are required for some verbs, but not for others.

(11) John kissed Mary.

(12) *John laughed Mary.

The lexicalist approach: each verb takes its own argument structure, including the specific arguments/event participants. (12) is ruled out because argument structure of "laugh" only involves an agent.

Thematic Hierarchy

- The third issue: even if we have all the information about the thematic roles of a verb, how can we decide which one is to be inserted in the subject position?

To address this question, various versions of Thematic Hierarchy are proposed. Possibly the first thematic hierarchy was implicitly invoked by Fillmore (1968) in the service of stating a SUBJECT selection principle:

If there is an A [= Agent], it becomes the SUBJECT; otherwise, if there is an I [= Instrument], it becomes the SUBJECT; otherwise, the SUBJECT is the O [= Objective, i.e. Patient/Theme]. (Fillmore 1968: 33)

So we have the following hierarchy:

(13) Agent>Instrument>Patient/Theme

(14)
a. John opened the door with the golden key.
b. The golden key opened the door.
c. The door opened.

Linking Principles

Linking: the mapping of the lexical information (such as event structure) onto syntactic/structural representation.

The Theta Criterion
Each argument bears one and only one θ-role, and each θ-role is assigned to one and only one argument.
Chomsky (1981: 36)

The Uniformity of Theta Assignment Hypothesis (UTAH)
Identical thematic relationships between items are represented by identical structural relationships between those items at the level of D-structure.

(Baker 1988: 46)

Linking Principles

This principle (UTAH) can be interpreted in many ways depending on the number and fine-grainedness of the thematic roles assumed. In a recent version of the UTAH and the roles that go along with it (Baker 1997), a very pared down set of abstract roles is correlated directly to particular syntactic positions at the bottom of the verbal phrase structure:

```
                VP
              /    \
         Agent       \
                    /    \
                   V       \
                         /    \
                    Theme      \
                              /    \
                             V    Goal/Path
```
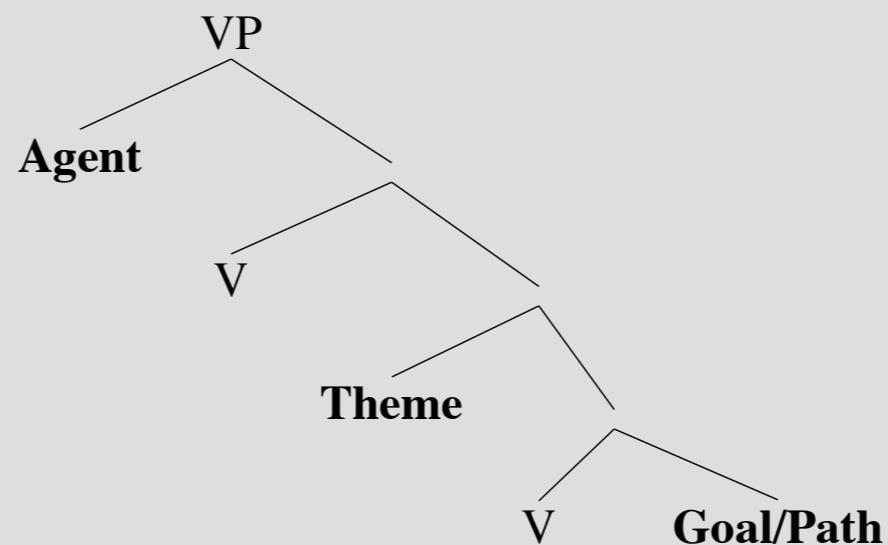
Linking Principles

Following UTAH, in the following sentences, the phrase "a vase" should take the same initial position in the structure. The surface differences are due to some syntactic operations, such as "movement":

(15)
a. John broke a vase today.
b. A vase was broken by John today.
c. A vase broke today.

Originally, *a vase*, due to its role as Theme, is in the post-verbal position, which is moved to the subject position in b and c for some reasons that we do not explore here.

Now you can perhaps understand the following sentences better:
(16)
a. There broke a vase in the room. (a vase: Theme)
b. *There ran a man in the village. (a man: Agent)
c. There arrived a man in the village. (a man: Theme)

Potential Problems

The argument structure theory involves the following parts:
a. A verb takes a fixed number of theta roles. If one role is missed or an extra role is added, the sentence will be ungrammatical.
   cf. *John hit.
      *John smiled Mary.
      * John put a book.

b. A theta role has its fixed structural position. If a theta role is placed in the wrong position, the sentence will be ungrammatical.
   cf. *John gave a book Mary.
      *A book reads John
      * There ran a boy.

So far so good.

But…

Potential Problems

The account of linking and argument structure I introduced encounter problems when the following examples are considered:

    a. The factory horns sirened throughout the raid
    b. The police car sirened the Porsche to a stop
    c. The police car sirened up to the accident site. (Borer 2005)

    a. John walks (every day).
    b. John walks his dog (every day).
    c. John walked his way to a slimmer self (this year).
    d. John walked his shoes ragged.   (Marantz 2013)

Now, can you detect what problem about the lexcialist approach is revealed by the above examples?

Potential Problems

More puzzles from Chinese:
a. 我今天不吃那家饭店了。
b. 我今天走复古风，既不用电脑打字，也不用圆珠笔，偏偏要写毛笔。
c. 张三是个勤劳的出租车司机，既开白天也开晚上。
d. 我不喜欢睡硬板床。

What is the puzzle exhibited by the above examples?

Against the Lexicalist Approach: The Constructivist Approach to Argument Structure

In the history of generative syntax, the lexicalist approach had taken a prominent position. It was (and still is) assumed that argument structure is part of the lexical information, and the syntactic structure is projected from the verb. This approach is problematic when the argument structure alternation cases are considered, as shown by the siren/walk examples

a. If argument structure projects from the lexicon, the distinct syntax of unaccusatives and unergatives means that there are two entries for variable-behaviour verbs, together with lexical mapping rules which modify argument structure configurations.

b. If we wish to reject the systematic existence of two distinct entries for variable-behaviour verbs, then it follows that at least the syntax of variable-behaviour verbs, and by extension, the syntax of argument structure, cannot project from the lexicon.

Borer (2005: 45)

The constructivist approach: Over the last decade or so, the majority of work on verbal argument structure has endorsed the general approach of Hale & Keyser, DM researchers, Ramchand, Borer and others.

The basic principles relating verbal meanings to syntactic structure transcend the idiosyncrasies of individual lexical items. What we know about the semantics of the root of this verb should help account for the availability of these structures for verbs like "walk," but the verb itself in no way projects these structures or is responsible for the semantic interpretation of the structures themselves.

The Constructivist Approach: The First Phase Syntax (Ramchand 2008)

(16)
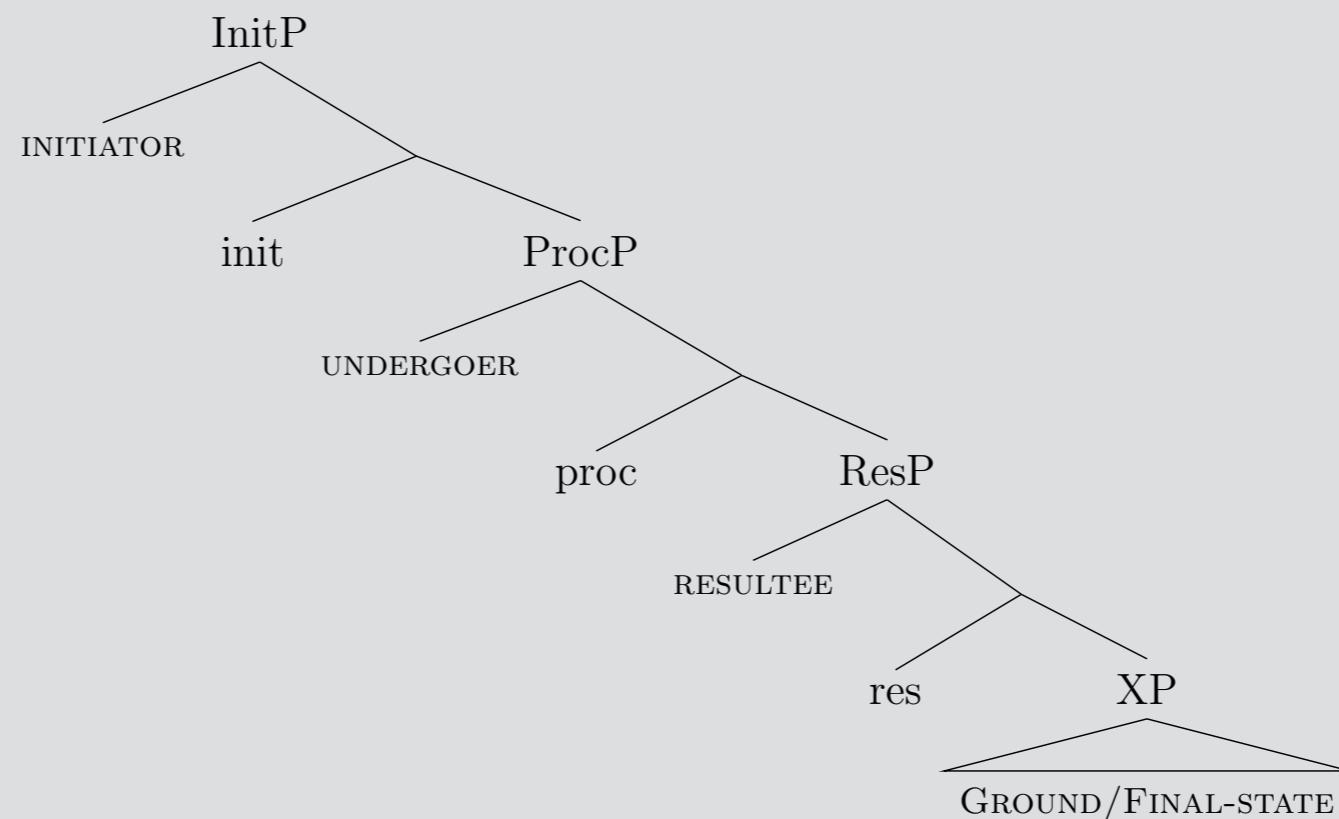
- initP introduces the causation event and licenses the external argument ('subject' of cause = Initiator)
- procP specifies the nature of the change or process and licenses the entity undergoing change or process ('subject' of process = Undergoer)
- resP gives the 'telos' or 'result state' of the event and licenses the entity that comes to hold the result state ('subject' of result = Resultee) .

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An example: causative alternation

(16) Karena melted the butter.
(17) The butter melted.
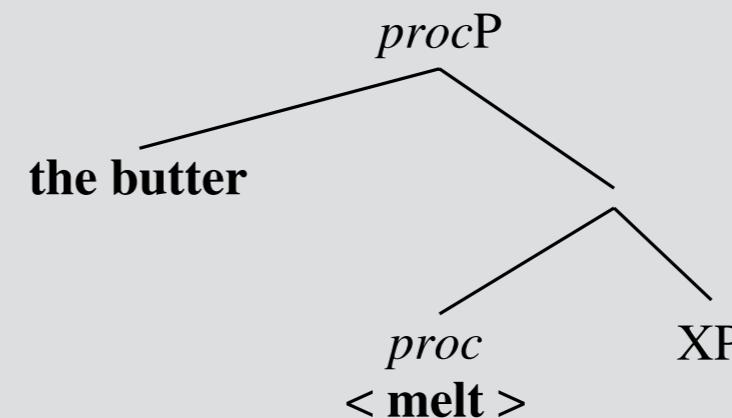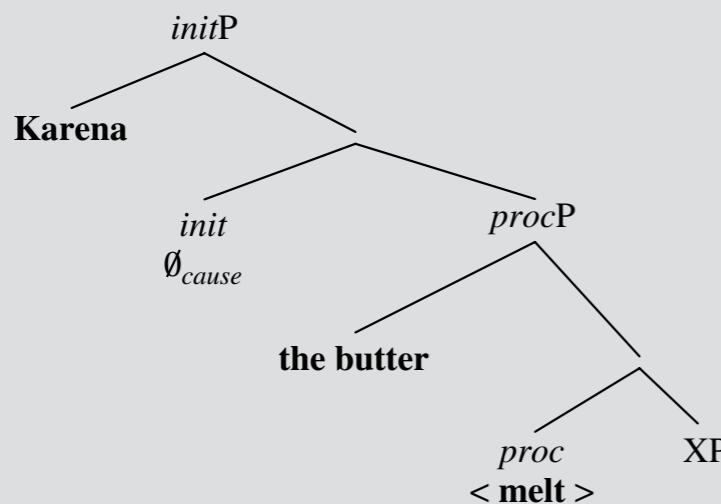
The Syntactic (Functional) Structure of Events in Borer (2015)

The syntactic structure of events is in parallel with the nominal structure (with some modification proposed in Hu 2015):
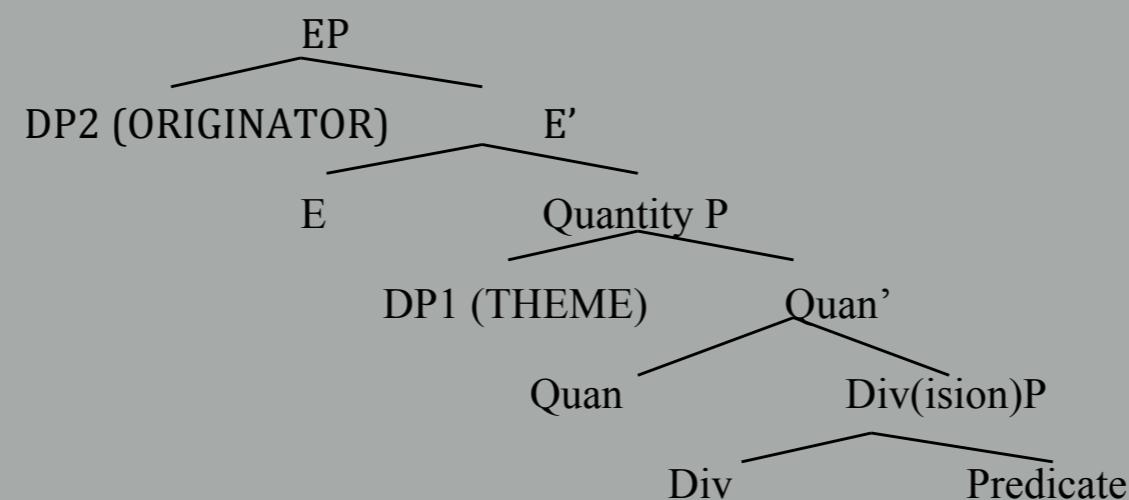
Thank you for your attention!