# Generative Lexicon and Semantic Theory

James Pustejovsky

Department of Computer Science
Brandeis University

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- How do verbs select their arguments?
- How do words change their meanings?
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# Starting Assumptions

- Language meaning is compositional.
- Compositionality is a desirable property of a semantic model.
- Many linguistic phenomena appear non-compositional.
- Generative Lexicon exploits richer representations and rules to enhance compositional mechanisms.
- Richer representations involve Lexical Decomposition.
- Richer rules involve Coercion, Subselection, Co-composition.

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1. The meaning of a complex expression is determined by its structure and the meanings of its constituents.

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- Homonymy: unrelated senses of a word
  bank vs. bank
  chair vs. chair
- Polysemy: conceptually related senses of a word
  book vs. book
  door vs. door

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- Iraqi Head Seeks Arms
- Juvenile Court to Try Shooting Defendant
- Teacher Strikes Idle Kids
- Kids Make Nutritious Snacks
- British Left Waffles on Falkland Islands
- Red Tape Holds Up New Bridges
- Bush Wins on Budget, but More Lies Ahead
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# Two Types of Polysemy

- Inherent polysemy: where multiple interpretations of an expression are available by virtue of the semantics inherent in the expression itself.
- selectional polysemy: where any novel interpretation of an expression is available due to contextual influences, namely, the type of the selecting expression.

1. a. John bought the new Obama book.
   b. John doesn't agree with the new Obama book. (inherent)
2. a. Mary left after her cigarette. (selectional)
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# Systematic (Logical) Polysemy

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2. We'll have a water and two beers.
3. Roser finished her thesis.
4. Mary began the novel.
5. Mary believes John's story.
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# Underspecified Meanings: 1

How many meanings for good?

1. good car
2. a good meal
3. a good knife

What does noisy select for?

1. a noisy$_1$ car
2. a noisy$_1$ dog
3. a noisy$_2$ room
4. a noisy$_2$ cafeteria

1. a fast typist
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# Underspecified Meaning2: 2

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- My neighborhood is flat.
- My country is flat.

- The water is boiling.
- The pot is boiling.

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# Compositionality is usually Function Application

1. What is the nature of the function?
2. What does it apply to; i.e., what can be an argument?

1. John loves Mary.
2. love($Arg_1$,$Arg_2$)
3. Apply love($Arg_1$,$Arg_2$) to Mary
4. $\Longrightarrow$ love($Arg_1$,Mary)
5. Apply love($Arg_1$,Mary) to John
6. $\Longrightarrow$ love(John,Mary)

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# Challenges to Simple Compositionality

- Flexibility of Subject Interpretation
- Flexibility of Object Interpretation
- Flexibility of Experiencing
- Flexibility of Perceiving
- Flexibility of Aspectuals

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# Flexibility of Subject Interpretation

Subject of kill:

- John killed Mary.
- The gun killed Mary.
- The shot killed Mary.
- The bullet killed Mary.
- John's pulling the trigger killed Mary.
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# Flexibility of Subject Interpretation

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# Causation and Intention

- John rolled down the hill as fast as he could.
- John cooled off with an iced latte.

Subject Rule (Wechsler, 2005): Optionally interpret subject as AGENTIVE.

kill vs murder:

- John killed the flowers accidently / intentionally.
- John murdered Mary.
- *John murdered Mary intentionally / accidentally.

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Fillmore (1985), Levin (1993), Levin and Rappaport (1998), Jackendoff (1990), Pustejovsky and Busa (1995)

- John swept [the dirt]$_{material}$.
- John swept [the room]$_{region}$.

- The man shoveled [the snow]$_{material}$.
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# Flexibility of Arguments: Experiencers

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# Flexibility of Arguments: Perception

- The boy heard a cat / a dog.
- They heard a bang / cry / rumor / shout / rain.
- !John heard the cloud/star/light.
- The crowd listened to the poem/speaker/speech.

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- Mary believes the rumor.
- No one believes the newspaper.
- She found the book hard to believe.
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# Flexibility of Arguments: Aspectuals

The verb begin is syntactically polymorphic:

- Mary began [to eat her breakfast].
- Mary began [eating her breakfast].
- Mary began [her breakfast].

but semantically underspecified:

- Mary began
  her beer/thesis/dinner/class/homework/bath
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# A Flexible Strategy of Selection

Arguments can be viewed as encoding pretests for performing the action in the predicate.

If the argument condition (i.e., its type) is not satisfied, the predicate either:

- fails to be interpreted (strong selection);
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# Co-compositionality

- Bilateral functional application:
- Both predicate and argument act functionally to build the resulting meaning

## Three Kinds of Co-composition

- Predicate Coercion:
  Subject acts functionally over its own predicate
- Predicate Cospecifcation:
  Verb and object create a new meaning
- Argument Cospecification
  Two arguments of the verb are related independently of the selecting predicate

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# Lexical Data Structures

(1) a. LEXICAL TYPING STRUCTURE: giving an explicit type for a word positioned within a type system for the language;
b. ARGUMENT STRUCTURE: specifying the number and nature of the arguments to a predicate;
c. EVENT STRUCTURE: defining the event type of the expression and any subeventual structure it may have;
d. QUALIA STRUCTURE: a structural differentiation of the predicative force for a lexical item.

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# Qualia

(5) a. FORMAL: the basic category of which distinguishes the meaning of a word within a larger domain;
b. CONSTITUTIVE: the relation between an object and its constituent parts;
c. TELIC: the purpose or function of the object, if there is one;
d. AGENTIVE: the factors involved in the object's origins or "coming into being".

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# GL Feature Structure

$$\begin{bmatrix} \alpha \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = x \\ \dots \end{bmatrix} \\ \text{EVENTSTR} = \begin{bmatrix} \text{EVENT1} = e1 \\ \text{EVENT2} = e2 \end{bmatrix} \\ \text{QUALIA} = \begin{bmatrix} \text{CONST} = \textbf{what } x \textbf{ is made of} \\ \text{FORMAL} = \textbf{what } x \textbf{ is} \\ \text{TELIC} = e_2\textbf{: function of } x \\ \text{AGENTIVE} = e_1\textbf{: how } x \textbf{ came into being} \end{bmatrix} \end{bmatrix}$$

# Type Composition Logic (Asher and Pustejovsky, 2006)

1. $e$ the general type of entities; $t$ the type of truth values.
   ( $\sigma$, $\tau$ range over all simple types, and subtypes of $e$.)
2. If $\sigma$ and $\tau$ are types, then so is $\sigma \rightarrow \tau$.
3. If $\sigma$ and $\tau$ are types, then so is $\sigma \otimes_R \tau$; $R$ ranges over $A$ or $T$.
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# Natural Types

Entities formed from the application of the FORMAL and/or CONST qualia roles:

1. For the predicates below, $e_N$ is structured as a join semi-lattice, $\langle e_N, \sqsubseteq \rangle$;
2. *physical*, *human*, *stick*, *lion*, *pebble*
3. *water*, *sky*, *rock*

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# Natural Predicate Types

Predicates formed with Natural Entities as arguments:

1. *fall*: $e_N \rightarrow t$
2. *touch*: $e_N \rightarrow (e_N \rightarrow t)$
3. *be under*: $e_N \rightarrow (e_N \rightarrow t)$

a. $\lambda x : e_N[fall(x)]$

b. $\lambda y : e_N \lambda x : e_N[touch(x,y)]$

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# Artifactual Entity Types

Entities formed from the Naturals by adding the AGENTIVE or TELIC qualia roles:

1. Artifact Entity: $x : e_N \otimes_a \sigma$
   $x$ exists because of event $\sigma$
2. Functional Entity: $x : e_N \otimes_t \tau$
   the purpose of $x$ is $\tau$
3. Functional Artifactual Entity: $x : (e_N \otimes_a \sigma) \otimes_t \tau$
   $x$ exists because of event $\sigma$ for the purpose $\tau$

a. *beer*: $(liquid \otimes_a brew) \otimes_t drink$
b. *knife*: $(phys \otimes_a make) \otimes_t cut$
c. *house*: $(phys \otimes_a build) \otimes_t live\_in$

# Artifactual Predicate Types

Predicates formed with Artifactual Entities as arguments:

1. *spoil*: $e_N \otimes_t \tau \rightarrow t$
2. *fix*: $e_N \otimes_t \tau \rightarrow (e_N \rightarrow t)$

a. $\lambda x : e_A[spoil(x)]$

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- The beer spoiled.
- Mary fixed the watch.

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1. *spoil*: $e_N \otimes_t \tau \rightarrow t$
2. *fix*: $e_N \otimes_t \tau \rightarrow (e_N \rightarrow t)$

a. $\lambda x : e_A[\textit{spoil}(x)]$

b. $\lambda y : e_A \lambda x : e_N[\textit{fix}(x,y)]$

- The beer spoiled.
- Mary fixed the watch.

# Complex Entity Types

Entities formed from the Naturals and Artifactuals by a product type between the entities, i.e., the dot, •.

1. a. Mary doesn't believe the book.
   b. John sold his book to Mary.
2. a. The exam started at noon.
   b. The students could not understand the exam.

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# Copredication with Dot Objects: 1

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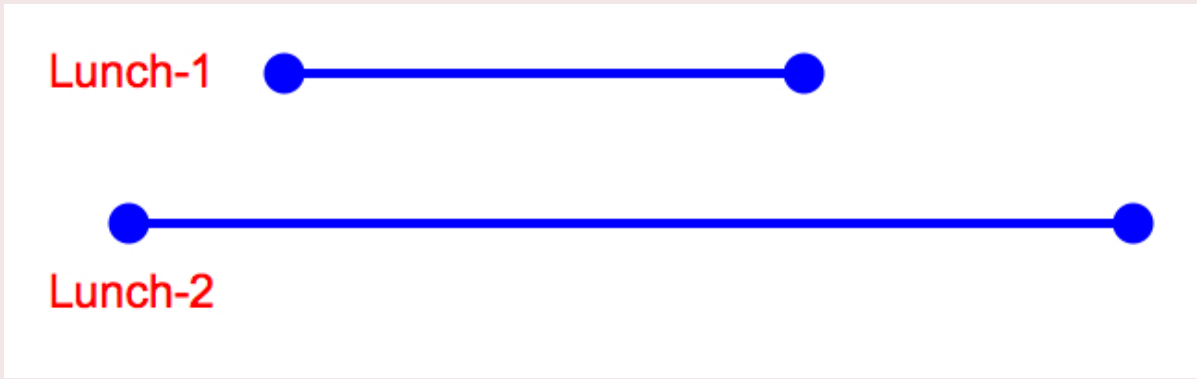

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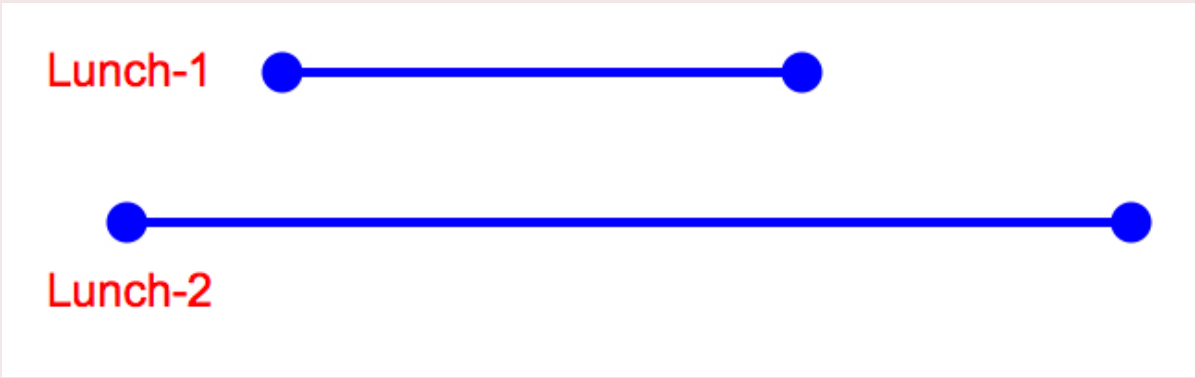

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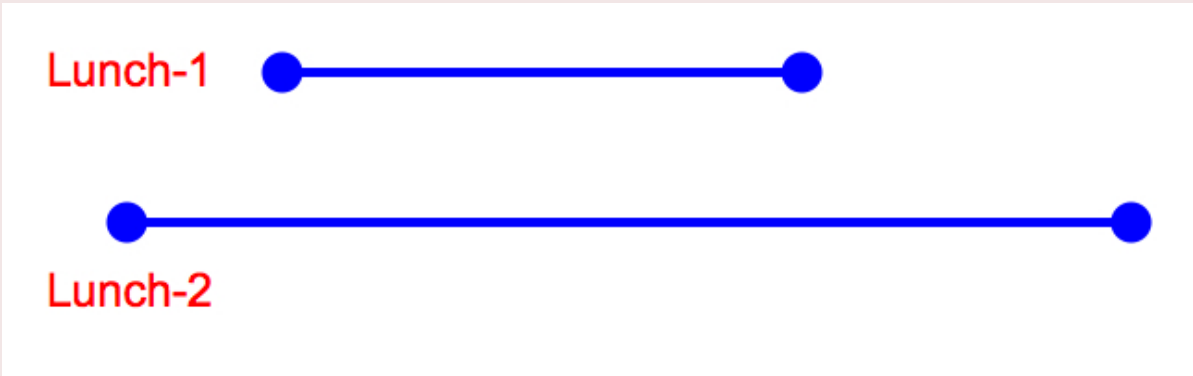

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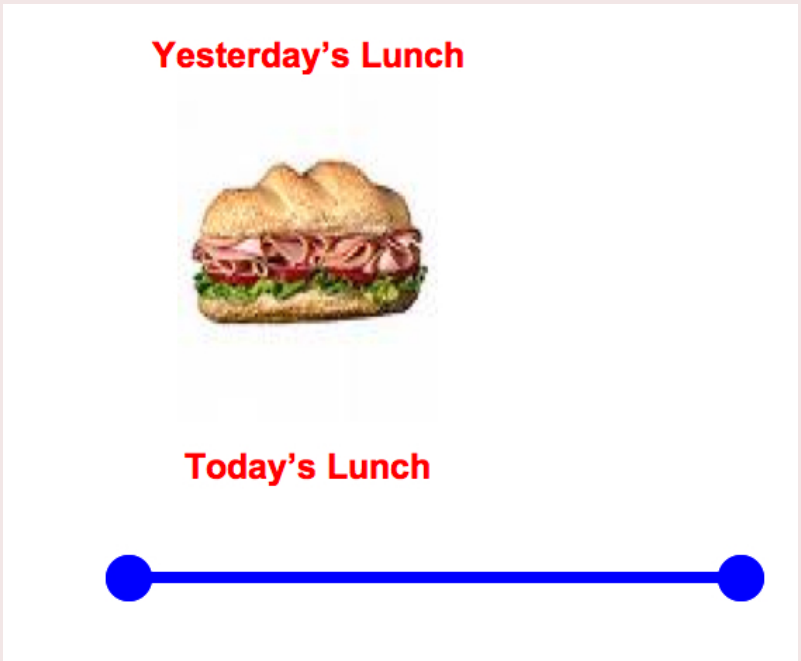

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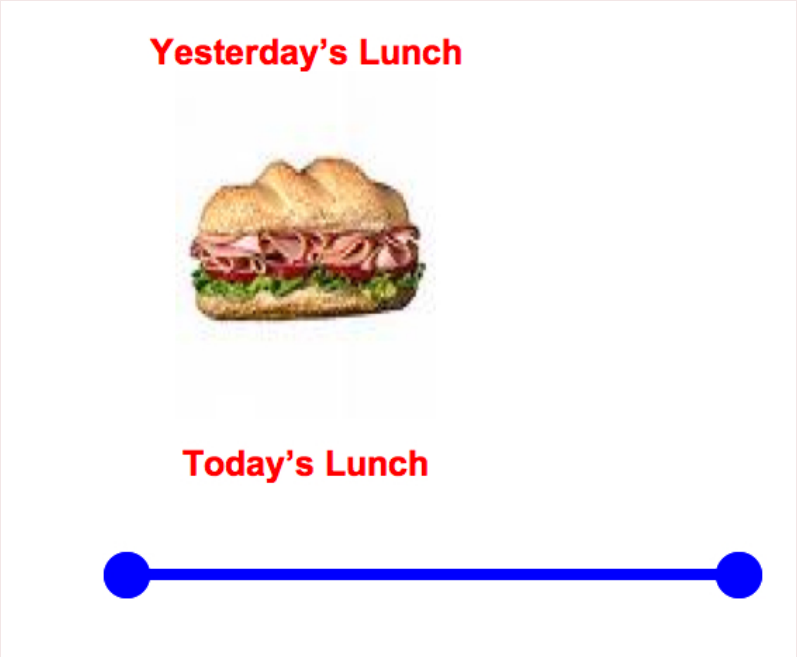

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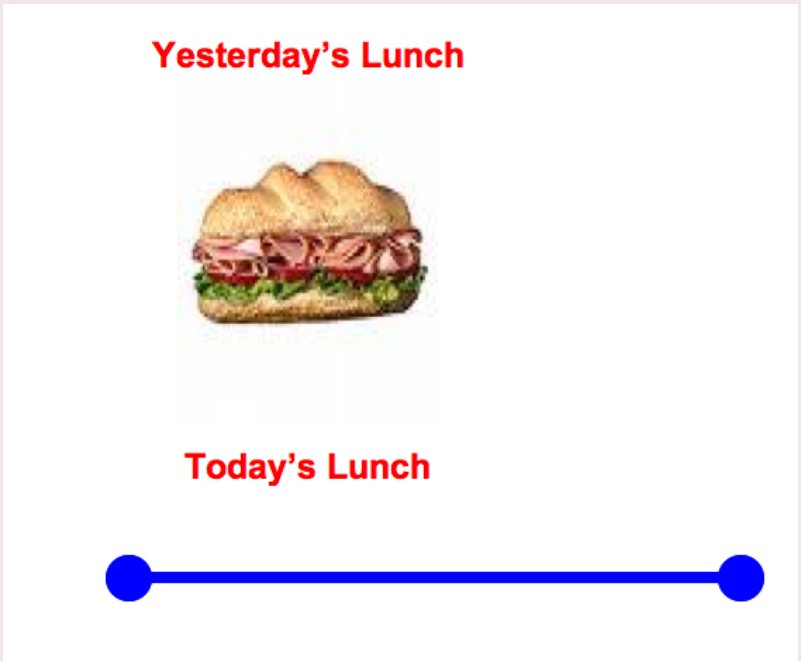

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If all you have for composition is function application, then you need to create as many lexical entries for an expression as there are environments it appears in. (Weak Compositionality)

Two ways to overcome this:

1. Type Shifting Rules: Geach rule, Rooth and Partee (1982), Partee (1987), Groenendijk and Stokhof (1989).
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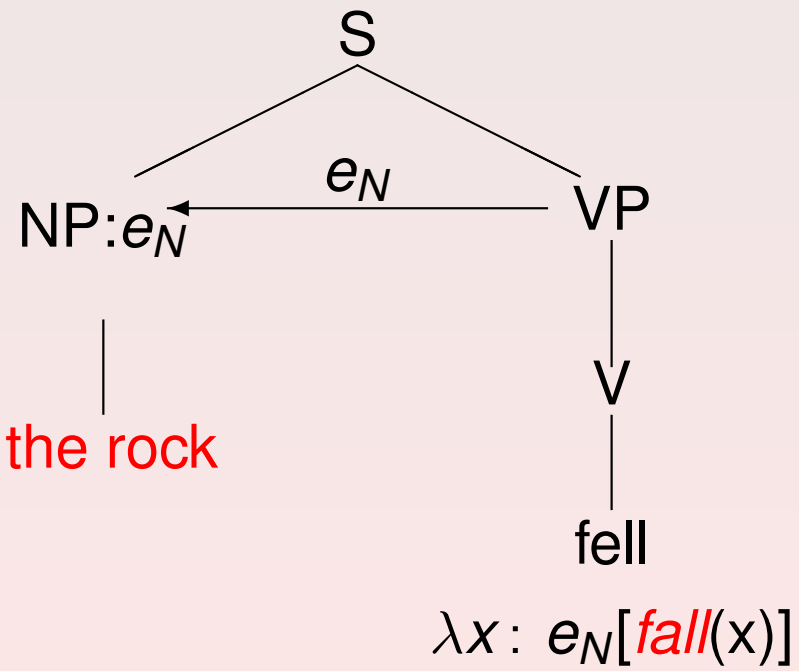
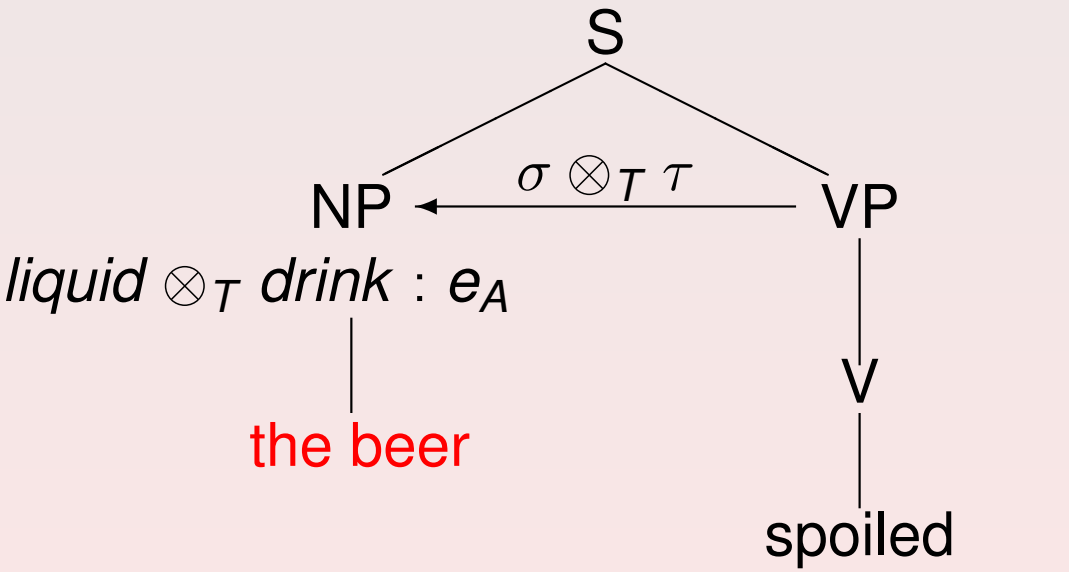
# Natural Selection

1. The rock fell.



# Pure Selection: Artifactual Type

1. The beer spoiled.




$\lambda x : e_A[\mathit{spoil}(x)]$

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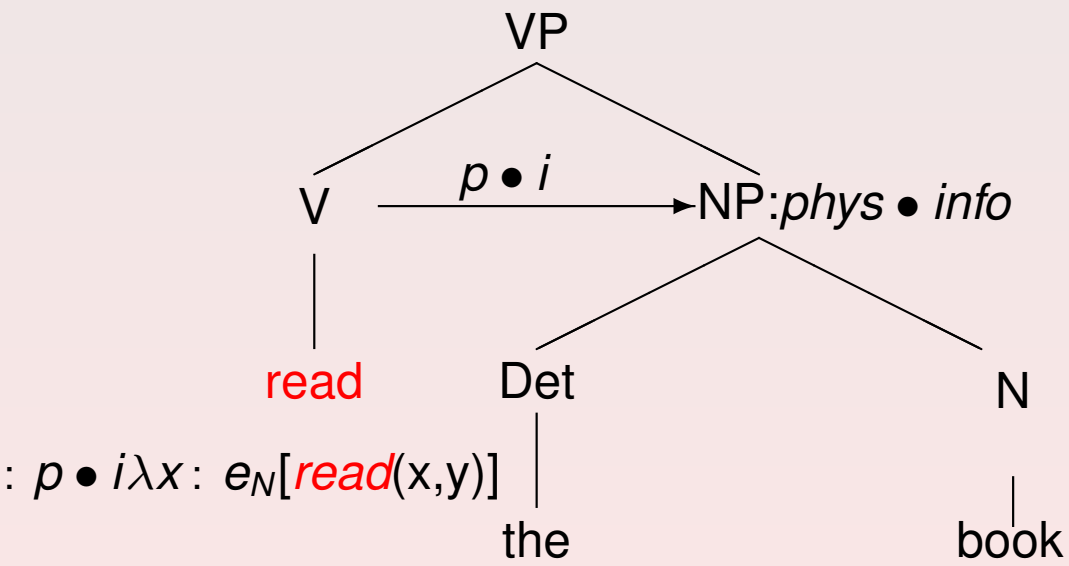

# Coercion of Arguments

- The president denied the attack.
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- The White House denied this statement.
  LOCATION → HUMAN
- This book explains the theory of relativity.
  PHYS • INFO → human
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# Type Coercion: Qualia-Introduction

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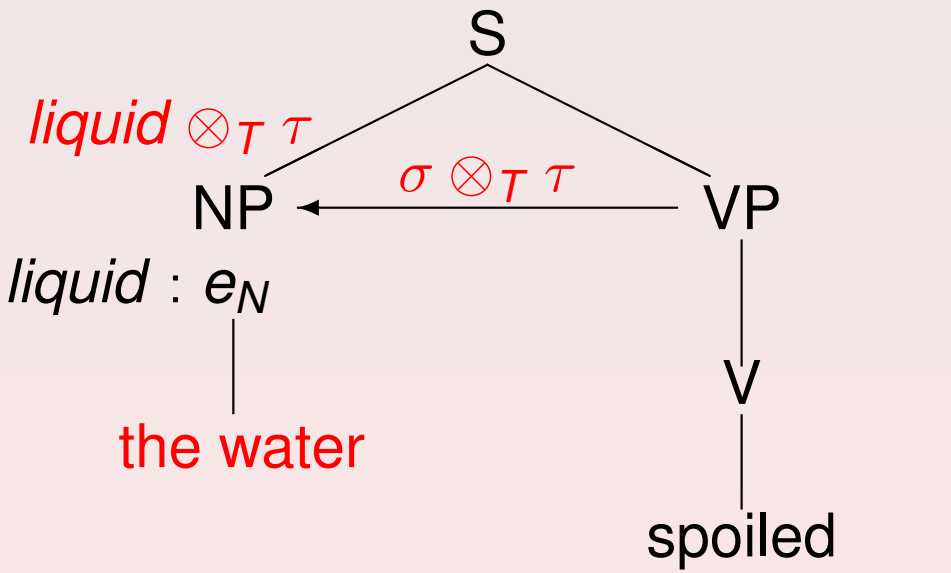
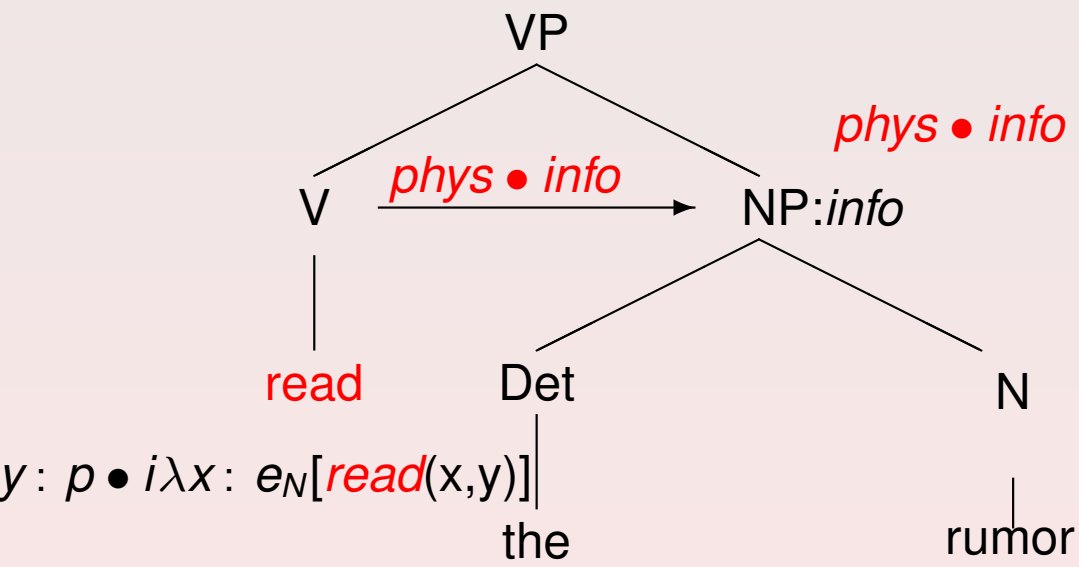



$\lambda x : e_A[\mathit{spoil}(x)]$

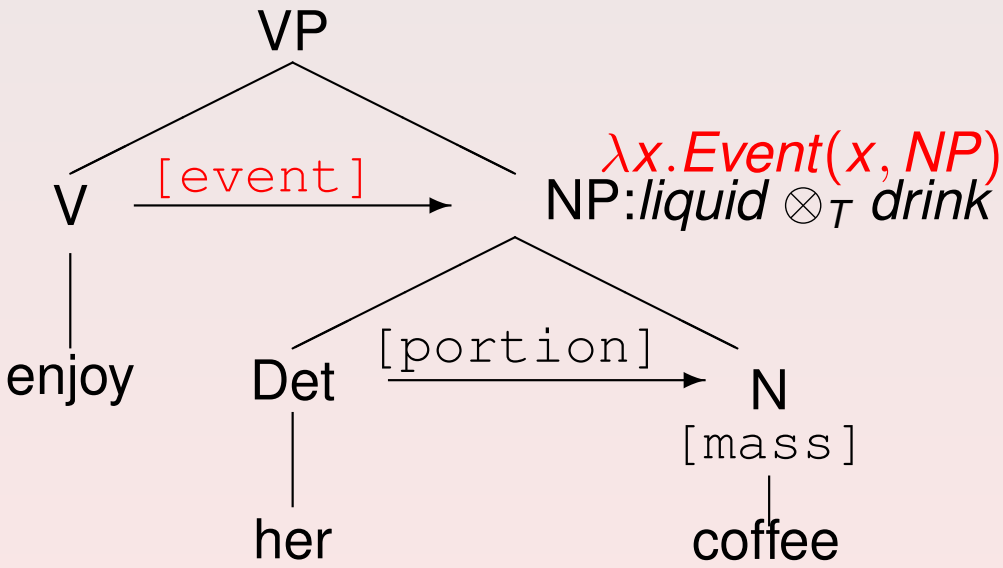
# Type Coercion: Natural to Complex Introduction

John read the rumor.



# Type Coercion: Event Introduction

1. Mary enjoyed her coffee.



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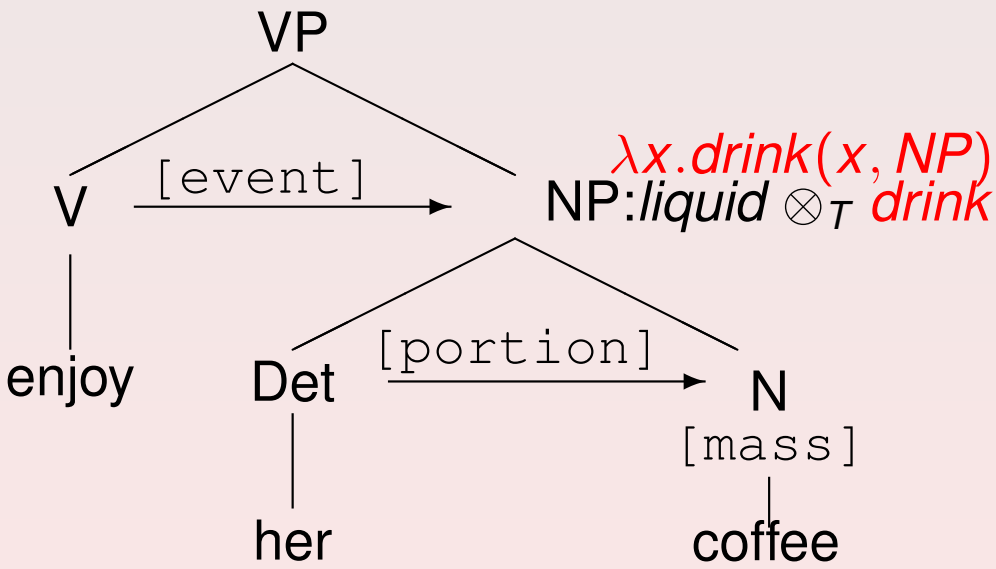
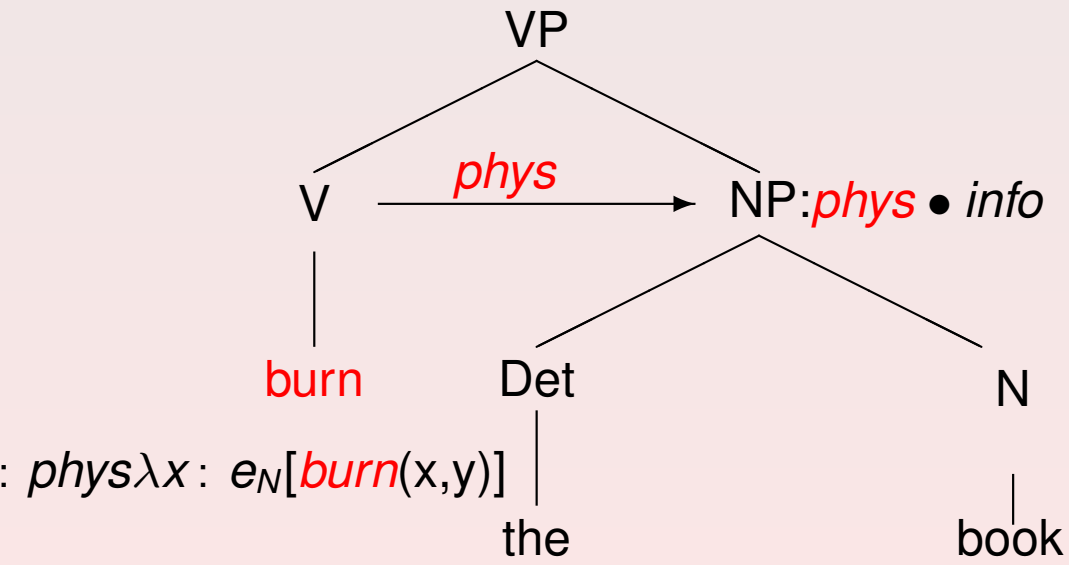


# Type Coercion: Dot Exploitation

1. The police burned the book.
2. Mary believes the book.



# Verb-Argument Composition Table

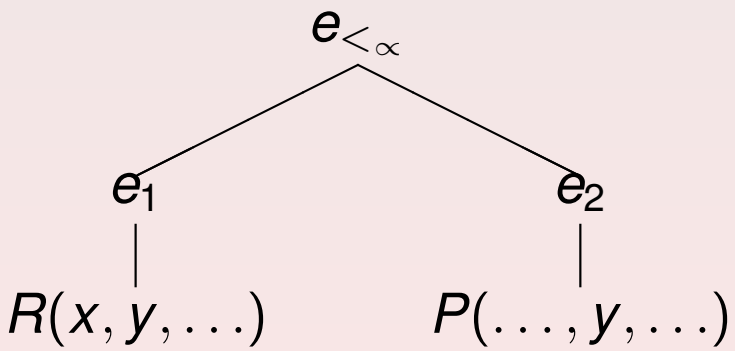
| | Verb selects: | | |
|---|---|---|---|
| **Argument is:** | **Natural** | **Artifactual** | **Complex** |
| **Natural** | Selection | Qualia Intro | Dot Intro |
| **Artifactual** | Qualia Exploit | Selection | Dot Intro |
| **Complex** | Dot Exploit | Dot Exploit | Selextion |

# Interpreting the Subject in Causatives

- Assume a causative (binary) event structure
- Argument selection:
  - subject is event:
    $e \rightarrow (\epsilon \rightarrow t)$
  - subject is entity:
    $e \rightarrow (e \rightarrow t)$

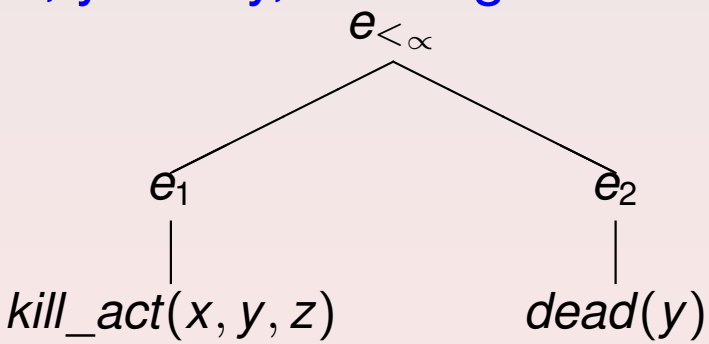
# Causative Argument Coherence

1. The relation identified as the initial event and that identified as the resulting event must refer to at least one argument in common.



# Coercion of the External Argument

1. If the DP is a direct argument to event, $e_1$, then an interpretation is possible through a coercion.
2. $kill\_act(e_1, x, y, z)$
3. x=John, y=Mary, z=the-gun




Satisfaction of event typing is achieved by exploiting the argument and wrapping it with the event it participates in.

# Introducing Agency over Predicates

Wechsler's Subject Rule is a factor of inherent agency of the argument.

1. John rolled down the hill as fast as he could.
2. John cooled off with an iced latte.

- Human is typed as an acting, rational, animal:
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# Perception Predicates

The verb hear selects for the type SOUND.

- $sound \rightarrow (anim \rightarrow t)$
- Conventionalized Attributes of an object:

1. $sound(dog)$ = barking, whining
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# Classifier Systems in Arrernte (Wilkins, 2000)

1. *thipe*: flying, fleshy creatures;
2. *yerre*: ants;
3. *arne*: ligneous plants;
4. *name*: long grasses;
5. *pwerte*: rock related entities.

# Classifier Systems and Coercion

1. *kere*: game animals, meat creatures;
2. *merne*: edible foods from plants;
3. *arne*: artifact, usable thing;
4. *tyape*: edible grubs.

- *kere aherre*: kangaroo as food;
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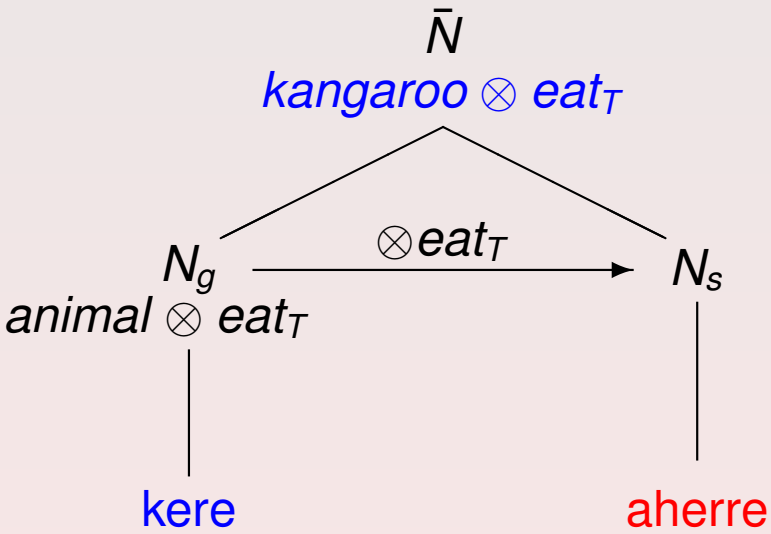
# Natural vs. Artifactual Entity Types

(15) *Iwerre-ke anwerne aherre arunthe-∅ are-ke.*
way/path-DAT 1plERG kangaroo many-ACC see-pc
"On the way we saw some kangaroos."

(16) *the imarte arratye kere aherre-∅ arlkwe-tye.lhe-me-le.*
1sgERG then truly meat kangaroo-ACC eat-GO&DO-npp-SS
'When I got there I ate some kangaroo meat."

# Classifier Construction

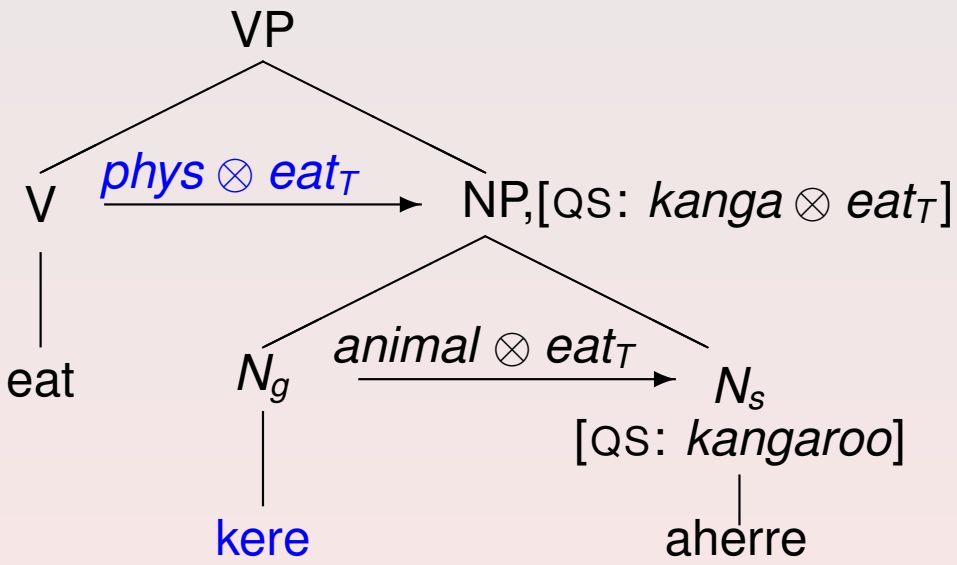
(17)



# Lexical Entries distinguish object types

1. $$\begin{bmatrix} \textbf{see} \\ \text{CAT} = \textbf{verb} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = \textit{animal} \\ \text{ARG2} = \textit{phys} \end{bmatrix} \end{bmatrix}$$
2. $$\begin{bmatrix} \textbf{eat} \\ \text{CAT} = \textbf{verb} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = \textit{animal} \\ \text{ARG2} = \textit{phys} \otimes \textit{eat}_T \end{bmatrix} \end{bmatrix}$$

# Artifactual Selection




$\Theta[kangaroo \sqsubseteq phys] : kangaroo \rightarrow phys$

# Conclusion

1. Polysemy challenges compositionality
   1. inherent polysemy
   2. selectional polysemy
2. Mechanisms of Selection in language involve:
   1. function application
   2. type coercion by exploitation
   3. type coercion by introduction
   4. type accommodation
3. Classifier constructions support the Natural/Artifactual type distinction
4. Accounted for by Coercion

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