

Building method-oriented adverbs

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Introduction

Introduction

- ▶ Classification and analysis of classes of adverbs has been a staple in formal semantics and syntax (Jackendoff, 1972; Geuder, 2002; Schäfer, 2013, and many, many others).
- ▶ What these adverbs mean, and how syntactic position influences their interpretation.
- ▶ Many classes identified. Here's a few:
 - (1) a. arrogantly, idiotically (subject-oriented)
 - b. quickly, clumsily (manner)
 - c. linguistically, economically (domain)
 - d. possibly, occasionally (quantificational)
- ▶ Much still not understood about some classes of adverbs.

Method-oriented adverbs

- ▶ One such ill-understood class is method-oriented adverbials (MOAs), such as in (2).
- ▶ Method-oriented adverbials characterize a method or means by which the event comes about.
 - (2)
 - a. Alma categorized the plants biologically. (Schäfer, 2013)
 - b. Noam evaluated the data linguistically. (ibid.)
 - c. The nations intervened militarily. (ibid.)
 - (3)

Dieses Problem ist nur wirtschaftlich zu lösen
 this problem is only economically to solve
 'This problem can only be solved economically.' (ibid.)

Method-oriented adverbs

- ▶ Paraphrasable:
 - (4) a. Alma used biological methods/principles to categorize the plants.
(Schäfer, 2013)
 - b. Noam analyzed the data with the help of linguistic methods/tests.(ibid.)
 - c. The nations used their militaries to intervene.
 - (5) This problem can only be solved using economic means.
-
- ▶ Methods are mentioned explicitly, in a way that differs from the paraphrases with the more well-known class of manner adverbs (e.g. *the way* paraphrases).
 - ▶ These adverbs primarily modify “abstract” predicates such as *categorize*, *arrange*, *evaluate*, *solve*, or *intervene*.

Goals for this talk

- ▶ Clarify the properties of method-oriented adverbs, especially with an eye towards distinguishing them from manner adverbs.
- ▶ Relate the semantics of these adverbs to relational adjectives (*maternal*, *presidential*, *nuclear*).
- ▶ Propose that method-oriented adverbs share semantic features with instrumentals.
- ▶ Stake out a claim regarding the syntax of method-oriented adverbs.
- ▶ Sketch a formalization that ties this together.
- ▶ Work in progress!

Roadmap

- ▶ Properties of method-oriented adverbs
- ▶ Brief discussion of previous accounts of adverbs
- ▶ Brief discussion of my account of relational adjectives (Anderson & Löbner, to appear)
- ▶ The proposal, focusing on the semantics

Properties of method-oriented adverbs

Manner adverbs: paraphrases

- ▶ *The way* paraphrases are a relatively good diagnostic for manner adverbs in English.
- ▶ Method-oriented adverbs are often marginal with *the way* paraphrases in English, although Schäfer (2013) notes that they are ok in German.
 - (6)
 - a. The way John fell was clumsy.
 - b. The way Noam evaluated the data was slow.
 - (7)
 - a. ??The way Noam evaluated the data was linguistic.
 - b. ??The way Alma categorizes the plants is biological
 - (8)

Noam hat die Daten auf linguistische Art und Weise ausgewertet.
 Noam has the data on linguistic manner evaluated.

Paraphrasability

- ▶ In German, they do not allow *wie-das-ist* paraphrases, which Schäfer (2013) takes to be a better diagnostic for manner adverbs.
- ▶ This sets them apart from manner adverbs, which do allow for *wie-das-ist* paraphrases.
 - (9) ??Wie Noam die Daten auswertet, das ist linguistisch.
 how Noam the data evaluates, that is linguistic
 ‘The way Noam evaluates the data is linguistic.’ (Schäfer, 2013)
 - (10) ??Wie Alma die Pflanzen kategorisiert, das ist biologisch.
 how Alma the plants categorizes, that is biological
 ‘The way Alma categorizes the plants is biological.’ (ibid.)
- ▶ No equivalent test in English, as far as I am aware.

Paraphrasability

- ▶ Paraphrased as below, with methods mentioned explicitly.
 - (11)
 - a. Alma used biological methods/principles to categorize the plants.
 - b. Noam analyzed the data with the help of linguistic methods/tests.
 - c. The nations used their militaries to intervene.
 - (12) This problem can only be solved using economic means.

- ▶ Differs from the paraphrases with the more well-known class of manner adverbs (e.g. *the way* paraphrases).

- ▶ Paraphrase is reminiscent of instrumentals (important point later).
 - (13)
 - a. Alma used a knife to cut the cake.
 - b. Noam opened the lock with a key.

Coordination

- ▶ Adverbs of the same type can often be coordinated.
- ▶ Possible with manner adverbs.
 - (14) a. He evaluated the data slowly and deliberately.
 - b. They categorized the plants quickly and carefully.
- ▶ Manner adverbs and method-oriented adverbs cannot be coordinated, however.
 - (15) a. *evaluate the data slowly and linguistically
 - b. *evaluate the data deliberately and linguistically
 - c. *categorize the plants thoroughly and biologically
- ▶ Suggests that manner adverbs and method-oriented adverbs form two distinct classes of adverb.

Abstract/complex events

- ▶ Not been explicitly noted that method-oriented adverbs require predicates that intuitively deal with more abstract or complex events.

 - ▶ Manner adverbs, in contrast, are able to more easily modify basic events.
- (16) a. run clumsily
b. dance quickly
- (17) a. evaluate linguistically
b. categorize biologically
- (18) a. *run biologically
b. *dance linguistically

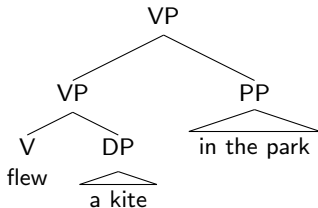
Low in the clause

- ▶ MOAs take a position low within the clause.
- ▶ Preference to be post-verbal in active sentences, suggesting VP-internal.
- ▶ VP constituency tests (*do so* test) point towards the adverb being within the VP.
- ▶ Locative PPs (for instance) adjoin to the right of the VP, based on tests.

(19) The boy [[flew_k a kite]_i in the park]_j

- ...and the girl did so_{i/j}, too
- ...and the girl did so_i at the beach.
- *...and the girl did so_k a model plane.

(20)



Low in the clause

- ▶ Constituency test with a method-oriented adverb:

(21) Noam [[evaluated the data]_{*i*} linguistically]_{*j*}

- ... and Darwin did so_{*j*}, too.
- ??... and Darwin did so_{*i*} biologically.

- ▶ Failure of test shows that *evaluated the data* is not a constituent.
- ▶ The VP is *evaluated the data linguistically*.

Confined to VP

- Haumann (2007) notes that method-oriented adverbs are confined to the VP layer, and cannot be fronted.
- (22) a. They removed brain tissue surgically.
b. They sent the message telepathically.
c. They opened the door manually.
- (23) a. *Surgically, they removed brain tissue.
b. *Telepathically, they sent the message.
c. *Manually, they opened the door.

Non-gradability

- ▶ These adverbs are also non-gradable (on the relevant reading), unlike many manner modifiers.
 - (24)
 - a. *Noam evaluated the data very linguistically.
 - b. *The nations solved the problem more diplomatically than the citizens wanted.¹
 - (25)
 - a. Noam evaluated the data very quickly.
 - b. Local braggarts now crow that the Americans are following in our footsteps, albeit more clumsily. (Google)

¹Note: *Diplomatically* has a manner reading as well (*in a diplomatic way*).

Method-oriented adverbs are not manner adverbs!

- ▶ Number of diagnostics show that method-oriented adverbs behave differently from manner adverbs.
- ▶ **Conclusion:** method-oriented adverbs simply aren't manner adverbs.
- ▶ Need a different analysis in order to account for their behavior!

Some properties inherited from relational adjectives

- ▶ Some of these properties can be derived from the relational adjectives method-oriented adverbs are built from.
- ▶ Non-gradability, inability to predicate are both general properties of relational adjectives.
- ▶ Relational adjectives also do not coordinate with property adjectives easily.
(26) a. *a black and presidential motorcade
b. *expensive and nuclear power plant
- ▶ Suggests unifying approach to method-oriented adverbs with that of relational adjectives.

Distinguish method-oriented adverbs from other domain adverbs!

- ▶ **Note:** Other types of domain adverbs appear low.
- ▶ These do not relate to a method, but to some domain within which the event occurs.
(27) We treat the whole person — emotionally, physically, and spiritually.
(≠ treat using emotional/physical/spiritual methods)
- ▶ **Note:** Domain adverbs also appear high in the clause.
- ▶ Specify domain within which the proposition expressed by the sentence should be evaluated.
(28) Physically, he's sore. Emotionally, he's traumatized.
(≠ Using physical methods, he's sore.)
- ▶ Set these domain adverbs aside for this talk.

Previous adverbial accounts of manner adverbs

Standard neo-Davidsonian approach

- ▶ “Standard” neo-Davidsonian story about manner modifiers (*clumsily*, *quickly*) is that they are properties of events (e.g., Parsons (1990)).
- ▶ Interpreted intersectively.

$$(29) \quad \begin{array}{l} \text{a. } \llbracket \textit{fix the car clumsily} \rrbracket = \lambda e \left[\begin{array}{l} \mathbf{fix}(e) \wedge \\ \text{THEME}(e) = \iota x.\mathbf{car}(x) \wedge \\ \mathbf{clumsy}(e) \end{array} \right] \\ \text{b. } \llbracket \textit{change the oil (in the car) quickly} \rrbracket = \\ \lambda e \left[\begin{array}{l} \mathbf{change}(e) \wedge \\ \text{THEME}(e) = \iota x.\mathbf{oil}(x, \iota y.\mathbf{car}(y)) \wedge \\ \mathbf{quick}(e) \end{array} \right] \end{array}$$

Standard neo-Davidsonian approach

- ▶ Method-oriented adverbs represented in this way would be indistinguishable from manner adverbs.

$$(30) \quad \llbracket \text{remove John's nose surgically} \rrbracket = \\ \lambda e. \text{remove}(e) \wedge \text{THEME}(e, \iota x. \text{nose}(x, \mathbf{j})) \wedge \text{surgical}(e)$$

- ▶ Not so clear what it means to be a *quick* or *clumsy* event.
- ▶ Possible (at least in some cases) to use meaning postulates or other means to clarify the adverb–verb relationship.

$$(31) \quad \text{quick}(e) \leftrightarrow \text{speed}(e) = d\text{-quick}$$

Manners in the representation

- ▶ Some proposals for adding manners as a type of individual in the semantic ontology (Schäfer, 2013; Piñón, 2007).
- ▶ Manner adverbs can then predicate of manners rather than events.
- ▶ Example (from Schäfer (2013)):
 - (32) Peter sang the song loudly.
 - (33) $\exists e[\mathbf{subject}(e, \mathbf{peter}) \wedge \mathbf{sing}(e) \wedge \exists m[\mathbf{manner}_{\text{sound-volume}}(e, m) \wedge \mathbf{loud}(m)]]$
- ▶ Danger of adding entities that still aren't well understood.
- ▶ But, more importantly, doesn't distinguish methods and manners.

Ernst (2002)

- ▶ Ernst (2002) briefly discusses means-domain adverbs, which seem to be equivalent to Schäfer (2013)'s method-oriented adverbs.

- (34) a. They classified all the samples morphologically.
 b. The aliens expressed themselves telepathically.

- ▶ These have a representation like in (35), which use a **means** predicate (slightly reformatted).

- (35) $\exists e[\mathbf{express}(e) \wedge \mathbf{agent}(e, a) \wedge \exists x[\mathbf{means}(e, x) \wedge \mathbf{telepathic}(x)]]$

- ▶ Not clear what means are, although said to parallel semantics of a means PP (*by means of a new process*).

Maienborn (2003)

- ▶ Maienborn (2003) takes up the challenge of “event-internal” locative modifiers.
- ▶ Relate PP to a part of an event, rather than the full eventuality.

(36) Der Bankräuber ist auf dem Fahrrad geflohen.
The bank robber has on the bicycle escaped.

(37) Der Koch hat das Hähnchen in einer Marihuana-Tunke zubereitet.
The cook has the chicken in a marijuana-sauce prepared

- ▶ A **part-of** relation relates an eventuality to a part of an event.

(38) $\exists e \left[\begin{array}{l} \mathbf{escape}(e) \wedge \mathbf{theme}(e, \mathbf{r}) \wedge \mathbf{robber}(\mathbf{r}) \wedge \\ \mathbf{part-of}(e, v) \wedge \mathbf{loc}(v, \mathbf{on}(\mathbf{b})) \wedge \mathbf{bike}(\mathbf{b}) \end{array} \right]$

- ▶ Conceptual structure resolves the indeterminacy of **part-of**.

Kinds in relational adjectives: McNally & Boleda (2004)

- ▶ Carlson (1977): Natural language ontology includes individuals corresponding to kinds (e.g., DOG-KIND, ALLIGATOR-KIND).
- ▶ McNally & Boleda (2004): Suppose common nouns have an argument for a Carlsonian kind in addition to an argument for an ordinary individual. Kinds and individuals related via Carlson's R(realization) relation.

$$(39) \quad \llbracket \textit{architect} \rrbracket = \lambda x_k \lambda y_o. R(x_k, y_o) \wedge \mathbf{architect}(x_k)$$

- ▶ Treat RAs as being properties of kinds rather than of individuals.

$$(40) \quad \llbracket \textit{technical} \rrbracket = \lambda x_k. \mathbf{technical}(x_k)$$

- ▶ RAs are then interpreted intersectively via the kind argument.

$$(41) \quad \llbracket \textit{technical architect} \rrbracket = \lambda x_k \lambda y_o. R(x_k, y_o) \wedge \mathbf{architect}(x_k) \wedge \mathbf{technical}(x_k)$$

Kinds in method-oriented adverbs?

- ▶ Not so clear that kinds would help us much.

$$(42) \quad \llbracket \textit{communicate telepathically} \rrbracket = \\ \lambda e \exists k [R(e, k) \wedge \mathbf{communicate}(k) \wedge \mathbf{telepathic}(k)]$$

- ▶ Have to explain what a telepathic kind is, and why it is a method.
- ▶ Might be possible to add additional relations clarifying this.
- ▶ See Anderson & Löbner (to appear) for additional discussion and criticism regarding this basic approach with relational adjectives.

Relational adjective semantics

Frame Semantics

- ▶ Assuming Frame Semantics, a theory of meaning representation (Petersen, 2007; Löbner, 2014, 2017; Kallmeyer & Osswald, 2014).
 - ▶ Argument structure frames are familiar in linguistics from Fillmore (1968).
 - ▶ Petersen/Löbner frames descended from concept frames in cognitive psychology (Barsalou, 1992).
- ▶ These frames represent lexical and compositional semantics, context, and world knowledge in the same representation.
- ▶ Structure:
 - ▶ Frames are recursive attribute-value structures.
 - ▶ Attributes can have other frames as their values.
 - ▶ Attributes are functions. (We could think of them as thematic roles.)
 - ▶ Values are typed in a type-feature hierarchy (Carpenter, 1992).
- ▶ Composition via unification (not type-driven function application). Unification only possible with compatible types.
- ▶ Represented via directed graphs, attribute-value matrices, or first-order logic with lambda calculus.

Relational adjectives

- ▶ Characterize a subtype of the modified noun. Examples:

(43) nuclear power, dental instrument, medical school, presidential visit, mental stamina, thermal insulator

- ▶ Cannot always be used predicatively.

(44) a. ??The power this plant makes is nuclear.
 b. ??The visit to Canada was presidential.
 c. ??This insulator is thermal.

- ▶ Non-gradable.

- ▶ No binding.

(45) a presidential pardon of Richard Nixon/*himself

- ▶ Can relate to thematic argument of modified noun, especially with deverbal nouns.

(46) a. presidential visit (agent, theme)
 b. mayoral election (theme)

Co-nominality

- ▶ Many RAs are denominal (*presidential, mayoral, parental*).
- ▶ Of those that are not denominal, there is often a noun with a closely related sense (*thermal* and *heat*, *dental* and *tooth*, *maternal* and *mother*).
- ▶ In Anderson & Löbner (to appear) we introduce the notion of **co-nominality** to cover this semantic relationship between RAs and certain nouns.
- ▶ Co-nominal adjectives are in a particular relationship with the semantics of a noun. Share same semantics.

Co-nouns and co-adjectives

N → A	<i>president – presidential</i> <i>Canada – Canadian</i>	<i>parent – parental</i>
A → N	<i>electricity – electric</i> <i>semantics – semantic</i> <i>civilian – civil</i>	<i>municipality – municipal</i> <i>electronics – electronic</i>
A = N	<i>military – military</i> <i>public – public</i>	<i>official – official</i>
A, N	<i>pope – papal</i> <i>mother – maternal</i> <i>mind – mental</i>	<i>lungs – pulmonary</i> <i>king/queen/prince/princess – royal</i> <i>body – physical</i>

Table: Pairs of adjectives and co-nouns, and nouns and co-adjectives

Co-nominality

- ▶ **Our claim:** co-nouns have essentially the same semantics as their co-adjectives, except for two differences:
 - ▶ Co-adjectives do not refer, unlike their co-nouns
 - ▶ Components of the adjectival meaning corresponding to referential arguments (and other arguments) are not arguments with relational adjectives

 - ▶ Same semantics as the noun, but variables are unbound in relational adjective. Contextually determined, or determined through composition.
- (47)
- a. $\llbracket \textit{mother} \rrbracket = \lambda x \lambda y. \mathbf{mother}(x, y)$
 - b. $\llbracket \textit{maternal} \rrbracket = \mathbf{mother}(x, y)$
- ▶ Take modifications with these adjectives to be marriages between frames, rather than examples of predication.

Co-nominality

► Partial example:

(48) *maternal love* (\approx love of a mother (for their child))

$$\begin{array}{l}
 \text{a. } \llbracket \textit{love} \rrbracket = \lambda e_s \left[\begin{array}{l} \mathbf{love}(e_s) \wedge \\ \mathbf{person}(x) \wedge \\ x = \text{HOLDER}(e_s) \wedge \\ y = \text{TARGET}(e_s) \end{array} \right] \\
 \text{b. } \llbracket \textit{materna} \rrbracket = \left[\begin{array}{l} \mathbf{woman}(m) \wedge \\ m = \text{MOTHER}(y') \end{array} \right] \\
 \text{c. } \llbracket \textit{maternal love} \rrbracket = \lambda e_s \left[\begin{array}{l} \mathbf{love}(e_s) \wedge \\ \mathbf{person}(x) \wedge \\ x = \text{HOLDER}(e_s) \wedge \\ y = \text{TARGET}(e_s) \wedge \\ \mathbf{woman}(m) \wedge \\ m = \text{MOTHER}(y') \wedge \\ x = m \wedge \\ y = y' \end{array} \right]
 \end{array}$$

Composition and relational adjectives

- ▶ Composition between an adjective and a nominal frame.
- ▶ Relation between adjective and noun can come from the modified noun or the adjective.
- ▶ Or also via a bridging frame that provides additional information on how to link adjective and noun.

Where do methods come from?

- ▶ How are method-oriented adverbs associated with methods?
- ▶ Methods come from the frame associated with the adjective.
- ▶ Adjective frame either directly supplies methods (e.g., the lexical semantics of the adjective)...
- ▶ ...or a secondary bridging frame provided by context..

Semantics of method-oriented adverbs

Abstractness in verb meanings

- ▶ Different verbal predicates do not seem to have meanings at the same level as others. Some verbs seem to have meanings that are more abstract or underspecified.
- ▶ Kearns (2003), criterion predicates
 - (49) Judas betrayed Jesus by kissing him.
 - (50) do me a favour, keep a promise, obey doctor's orders, retaliate, spell "languor", stand up to injustice, stand out, test my resolve
- ▶ Sæbø (2008), manner-neutral causatives
 - (51) Macbeth killed King Duncan by stabbing him in his sleep.
- ▶ See also Löbner (submitted), cascades (generalizing "level generation" from Goldman 1970)
- ▶ Unifying idea: certain (perhaps many?) verbal meanings are underspecified in how the events they denote come about.

Sæbø (2016)

- ▶ Proposal for semantics of criterion predicates and manner-neutral causatives.
- ▶ Criterion predicates and manner-neutral causatives have an event-type (e.g., properties of events) argument, the method of realization for the event.

$$(52) \quad \llbracket \textit{break the law} \rrbracket^w = \lambda P_{\langle s, vt \rangle} \lambda e. P \textit{ is illegal in } w \textit{ and } P_w(e)$$

- ▶ Event-type argument filled implicitly, or by a *by*-phrase (which denotes a property of events).

$$(53) \quad \llbracket \textit{break the law by driving on the sidewalk} \rrbracket^w = \lambda P_{\langle s, vt \rangle} \lambda e. \textit{drive-on-sidewalk} \textit{ is illegal in } w \textit{ and } \textit{drive-on-sidewalk}_w(e)$$

Instrumental paraphrases provide a clue

- ▶ How to link method-oriented adverb to verb? Paraphrases are a clue.
- ▶ Method-oriented adverbs are often paraphrasable with *use*, *using*, and *with* (Schäfer, 2013).
 - (54)
 - a. Alam categorized the plants biologically.
 - b. Noam analyzed the data linguistically.
 - c. The nations solved their disagreements diplomatically.
 - (55)
 - a. Alma used biological methods/principles to categorize the plants.
 - b. Noam analyzed the data with the help of linguistic methods/tests.
 - c. The nations solved their disagreements using diplomacy.
- ▶ *Use*, *using*, *with* often taken to be diagnostic of instrumentals (Lakoff, 1968).

Proposal

- ▶ **Proposal:** Method-oriented adverbs relate to the matrix event as instruments do.
- ▶ Common meaning components between instrumentals and method-oriented adverbs.
- ▶ Components partially determined by verbal lexical semantics.
- ▶ What are the pieces of meaning in instrumentals?

Varieties of instrumentals

- ▶ Observations in the literature on instrumentals that not all instrumentals seem to have the same causal force (Koenig et al., 2008; Rissman & Rawlins, 2017, and references therein).
- ▶ Some instruments are causal intermediaries.
 - ▶ A link in a causal chain between the agent of an event and the affected object.
 - ▶ Cause of some part of the event.

(56) John smashed the zombie's head with a club.
(John causes club to come into contact with the zombie, which causes it to be smashed.)

- ▶ Others have a weaker relation to the event. Not causal.

(57) a. Lucy ate the cereal with a spoon.
b. Martha changed the light bulb with a ladder.

Method-oriented adverbs are not causal intermediaries

- ▶ Method-oriented adverbs don't seem to denote intermediate causers.
 - (58) a. The aliens communicated telepathically.
b. Noam evaluated the data linguistically.
 - (59) a. ??The aliens did something using telepathy, which caused them to communicate.
b. ??Noam did something using linguistic methods, which caused the data to be evaluated.

- ▶ Weaker relation to the event, more similar to instruments like *eat with a spoon*.

Weaker instrumentals

- ▶ Koenig et al. (2008) argue for a weaker notion involved with instruments that are not causal intermediaries.
- ▶ Introduce a relation `HELP` that models the idea that certain actions within an event do not cause other actions, but only facilitate them in some way.
- ▶ Verbs are schematized; **pred**₂ is a relation between an agent and an instrument, while **pred**₁ is a change in the patient.

$$(60) \quad \text{HELP}(s_1, s_3) \wedge \text{pred}_2(s_1, \mathbf{A}, \mathbf{I}) \wedge \text{pred}_1(s_3, \mathbf{P})$$

$$(61) \quad \llbracket \textit{eat cereal with a spoon} \rrbracket = \lambda x \lambda e \exists e' \left[\begin{array}{l} \text{HELP}(e', e) \wedge \\ \text{pred}_2(e', x, \text{spoon}) \wedge \\ \text{pred}_1(e, \text{cereal}) \end{array} \right]$$

- ▶ Instrumental relations are provided by the verb.

HELP

- ▶ HELP is defined for Koenig et al. (2008) as in (62).

(62) HELP definition

An eventuality e_1 helps the occurrence of token e_2 of the event category C iff (i) there is an ordering of tokens of C along a pragmatically defined scale (ease of performance, how good the resulting state is, fewer unwelcome 'side effects'); (ii) e_1 caused the token e_2 of C to be higher on that ordering than it would otherwise have been.

- ▶ Helping is a scalar notion.
- ▶ Instrument helps an event if the event is affected in some way.
- ▶ *With a spoon*, for instance, might raise the ease of performance of an *eat* event.

Methods in abstract predicates

- ▶ Adapting this, I assume that the abstract predicates that method-oriented adverbs modify encode a *HELP* relation.
- ▶ These predicates are thus associated with underspecified events (e.g., **act**) that facilitate the completion of the event.
- ▶ **act** is similar to Koenig et al. (2008)'s **pred**₂, but doesn't necessarily involve acting on an instrument.

$$(63) \quad \llbracket \textit{evaluate} \rrbracket = \lambda e \exists e' \left[\begin{array}{l} \textit{evaluate}(e) \wedge \\ \textit{act}(e') \wedge \\ \textit{HELP}(e', e) \end{array} \right]$$

- ▶ **Note:** *HELP* is not functional! (But, Kallmeyer & Osswald (2014) allow for relational attributes.)
- ▶ **Note:** Agent and Theme arguments suppressed.

evaluate the data linguistically

- ▶ *Linguistically* provides a clear case where the methods come from the adjective.

(64) Noam evaluated the data linguistically. (=used linguistic methods)

- ▶ Method-oriented adverb has the same semantics as the adjective *linguistic*.
- ▶ Adjectives for scientific fields encode scientific methods particular to that field (analysis of morphemes, finding minimal pairs, ...)

(65) $\llbracket \textit{linguistic} \rrbracket = \left[\begin{array}{l} \text{science}(x) \wedge \\ \text{language} = \text{OBJECT-OF-STUDY}(x) \wedge \\ \text{linguistic-method} = \text{METHOD}(x) \wedge \\ a = \text{AGENT}(\text{METHOD}(x)) \end{array} \right]$

- ▶ The type **linguistic-methods** will be true of events of analyzing morphemes, finding minimal pairs, constructing arguments based on linguistic data, and so on.

evaluate the data linguistically

- Unification of *linguistically* with *evaluate* identifies the helping act with a linguistic method.

$$(66) \quad \llbracket \textit{evaluate linguistically} \rrbracket =$$

$$\lambda e \exists e' \left[\begin{array}{l} \mathbf{evaluate}(e) \wedge \\ \mathbf{act}(e') \wedge \\ \text{HELP}(e', e) \wedge \\ \mathbf{science}(x) \wedge \\ \mathbf{language} = \text{OBJECT-OF-STUDY}(x) \wedge \\ \mathbf{linguistic-method}(m) \wedge \\ m = \text{METHOD}(x) \wedge \\ a = \text{AGENT}(\text{METHOD}(x)) \wedge \\ e' = m \end{array} \right]$$

- Agent of the method can later be identified with the matrix agent.

solve diplomatically

- *Solve* is an example of another predicate that is underspecified in the methods used.

(67) The 20th century saw new experiments with international peace organizations designed to **solve disputes diplomatically** rather than through war.

$$(68) \quad \llbracket \textit{solve} \rrbracket = \lambda e \exists e' \left[\begin{array}{l} \text{solve}(e) \wedge \\ \text{act}(e') \wedge \\ \text{HELP}(e', e) \end{array} \right]$$

solve diplomatically

- ▶ *Diplomatic* frame inherits from *diplomat*.
- ▶ Specified for what nation the diplomat represents.
- ▶ Diplomats are also agents in events of diplomacy.

$$(69) \quad \llbracket \textit{diplomatic} \rrbracket = \left[\begin{array}{l} \mathbf{person}(x) \wedge \\ n = \text{REPRESENTS}(x) \wedge \\ \mathbf{diplomacy}(e) \wedge \\ x = \text{AGENT}(e) \end{array} \right]$$

solve diplomatically

- ▶ Unification of the verbal frame and the adverbial frame.
- ▶ Diplomacy event is able to be identified with the helping event.
- ▶ Possible due to **diplomacy** being a subtype of **act** (by assumption).

$$(70) \quad \llbracket \textit{solve diplomatically} \rrbracket = \lambda e \exists e' \left[\begin{array}{l} \mathbf{solve}(e) \wedge \\ \mathbf{act}(e') \wedge \\ \text{HELP}(e', e) \wedge \\ e' = e'' \wedge \\ \mathbf{person}(x) \wedge \\ n = \text{REPRESENTS}(x) \wedge \\ \mathbf{diplomacy}(e'') \wedge \\ x = \text{AGENT}(e'') \end{array} \right]$$

- ▶ Further unifications possible; n (nation) can be identified with nation from subject position, for instance.

$$(71) \quad \text{Canada solved its disputes diplomatically.}$$

open manually

- ▶ *Open* differs from *solve* and *evaluate*, in that it seems much less abstract. Is it plausible that the lexical semantics for *open* encodes the possibility for a method event?

(72) Garage doors have a bypass that disconnects the garage door from the powered carriage and allows you to **open the garage door manually**.

open manually

- Availability of *by* adjuncts suggests that it does allow specification of an event interpreted as a method.

- (73) open the garage door
- ... by lifting it straight up
 - ... by pushing a button
 - ... by pulling on a cord

- *Open* thus also encodes a HELP event in addition to its main event.

$$(74) \quad \llbracket \textit{open} \rrbracket = \lambda e \exists e' \left[\begin{array}{l} \mathbf{open}(e) \wedge \\ \mathbf{act}(e') \wedge \\ \text{HELP}(e', e) \end{array} \right]$$

open manually

- ▶ But what does *manually* contribute?
- ▶ I assume that its co-noun is *hand*. Thus, it has the semantics of *hand*.

$$(75) \quad \llbracket \textit{manually/hand} \rrbracket = \left[\begin{array}{l} \mathbf{hand}(x) \wedge \\ x = \text{HAND}(y) \end{array} \right]$$

- ▶ However, *hand* does not have an event in its frame.
- ▶ Particular way of embedding *hand* in an event frame must come from context.

Manually's method is contextually determined

- ▶ Different methods of realization (from BNC).
 - (76) a. sort and clean the seeds [...] manually, by sieving or blowing away the debris
 - b. silenced manually at any time by operating levers
 - c. This kind of map analysis used to be done manually [...] by overlaying transparent map sheets
 - d. steering would have to be manually done by the operator's feet pushing along the floor
 - e. it was to be driven manually by turning the big wheel

- ▶ Context and world knowledge determine specifics of how *manually* interacts with verbal semantics.

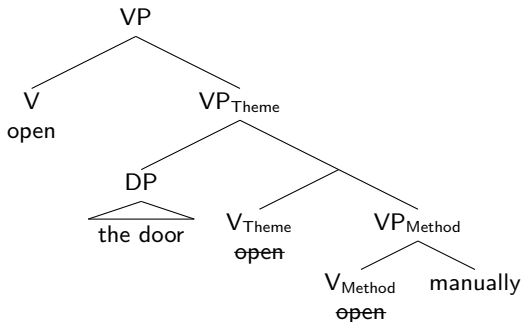
- ▶ Parallels how context and world knowledge determine how relational adjectives and nouns should be unified.

Syntax of method-oriented adverbs

Method-oriented adverbs are low

- ▶ String linear position of method-oriented adverbs and constituency tests suggest they are within the VP. Constituency tests also suggest they are within VP.
- ▶ Position appears to be below the internal argument (!).
- ▶ Adverb as an argument of the verb in a VP shell arrangement (Larson, 1988, 2014)?

(77)



-ly as inflection

- ▶ So far, ignored contribution of *-ly* morphology on method-oriented adverb.
- ▶ **My position:** *-ly* is meaningless and is purely inflection.
- ▶ Adverbs are adjectives with inflectional morphology marking them as modifying verbs rather than nouns.
- ▶ Not a unique position. See e.g. Giegerich 2012
- ▶ Some evidence:
 - ▶ Some languages (like German) do not mark adverbs differently than adjectives.
 - ▶ *-ly* only shows up in verbal environments.
 - ▶ No uniform meaning contributed by *-ly* (manner adverbs, method-oriented adverbs, subject-oriented adverbs, quantificational adverbs, . . .)

Discussion and open questions

- ▶ Many open questions to investigate! Not a complete proposal, but a sketch of how to proceed.
- ▶ Syntax–semantics issues:
 - ▶ Given the syntax I propose, how does the internal argument compose with the verb?
 - ▶ How does the adverb compose with the verb?
 - ▶ The general issue of how frame semantics and syntax work together...
- ▶ Semantic composition issues:
 - ▶ What principles are at work to relate the agent of the matrix event to the agent of the method (e.g., principles of economy regarding variables)?
 - ▶ How are contextually specified methods determined (e.g., *manually*)?
- ▶ Instrumental relation: Is *HELP* sufficient for all method-oriented adverbs? Are some true causers? Are some neither (*categorize morphologically*)?
- ▶ How do method-oriented adverbs differ from other domain adverbs?

Conclusion

Conclusion

- ▶ A step towards explaining how method-oriented adverbs differ from other types of adverbs.
 - ▶ Method-oriented adverbs inherit the semantics of the adjective.
 - ▶ Method-oriented adverbs share a semantics with that of instruments.
 - ▶ Certain predicates are associated with a `HELP` relation.
 - ▶ Method-oriented adverbs specify a helping event.
- ▶ Event can come from the lexical semantics of the adjective.
- ▶ Or, from a bridging relation that incorporates the meaning of the adjective.
- ▶ Unification allows for composition that involves aspects of the meaning of the adverb not projected in the argument structure.
- ▶ Lexical semantics plays an important role in understanding modification.

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