

The Encoding of Knowledge in Linguistic Structures

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Tillmann Pross, Antje Roßdeutscher; prossn;antje@ims.uni-stuttgart.de
Institute for Natural Language Processing, University of Stuttgart

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1 Introduction

- We report on our ongoing efforts to encode insights of lexical semantics in configurations at the syntax-semantics interface
- Our overarching goal is the development of a formal semantics on the basis of the assumption that the same principles of syntax and semantics are at work in words and sentences
- We address the question for the relation between linguistic structures and world knowledge in a root-based account of word meaning.
- Roots are atomic, non-decomposable and category-neutral elements associated with encyclopedic knowledge
- Roots combine with features to build larger linguistic elements according to the same syntactic and semantic principles which are at work above the word level
- The semantics of a root in a particular insertion context is incrementally specified by the semantic interpretation of the syntactic structure of the insertion context
- One and the same root can have different meanings, depending on the syntactic context in which it is inserted and interpreted.

2 Data

- As a topic of discussion, we chose the set of examples in (1)-(3) which involve
 - (i) the root $\sqrt{\text{zieh}}$ (pull, attract, extract, ...)
 - (ii) the prepositional element $\sqrt{\text{an}}$
- (1) a. *den Zahn (*leicht) in 5 Minuten (*für 5 Minuten) ziehen*
the tooth (*slightly) in 5 minutes (*for 5 minutes) pull
extract the tooth in 5 minutes
- b. *den Wagen (*leicht) (*in 5 Minuten) für 5 Minuten ziehen*
the car (*slightly) (*in 5 minutes) for 5 minutes pull
pull the car for 5 minutes
- c. *die Grenze (*leicht) in 5 Minuten (*für 5 Minuten) ziehen*
the border (*slightly) in 5 minutes pull
draw the border in 5 minutes

- (2) a. *die Rübe (*leicht) in 5 Sekunden aus der Erde ziehen*
 the carrot (*slightly) in 5 seconds out the soil pull
 pull the carrot out of the soil in 5 seconds
- b. *für 5 Sekunden leicht (*in 5 Sekunden) an der Rübe ziehen*
 for 5 seconds slightly (*in 5 seconds) at the carrot pull
 pull at the carrot for 5 seconds

- (3) a. *die Schraube leicht anziehen*
 the screw slightly up.prtc.pull
 slightly tighten the screw
- b. *den Schmutz (*leicht) anziehen*
 the dirt (*slightly) up.prtc.pull
 attract the dirt
- c. *den Schuh (*leicht) anziehen*
 the shoe (*slightly) up.prfx.pull
 to put on the shoe

- The root $\sqrt{\text{zieh}}$ is characterized in the examples in two different ways:

- (A) In (1a) vs. (2a) vs. (3a) the meaning of $\sqrt{\text{zieh}}$ in its insertion context is differentiated by linguistic differences of the insertion context: +/- PP +/- $\sqrt{\text{an}}$.
- We take this differences to be induced by differences of the syntactic-semantic insertion context and thus to be determined by linguistic knowledge.
- (B) In (1a) vs. (1b) vs. (1c); (3a) vs. (3c) vs. (3b), $\sqrt{\text{zieh}}$ has a different semantic spell-out although the syntactic-semantic insertion context is the same
- The standard explanation for the different meaning of $\sqrt{\text{zieh}}$ in the same insertion contexts would involve regress to non-linguistic knowledge spelled out in terms of a structured ontology of eventualities that underlies linguistic knowledge.

3 Structured eventuality ontology

- Aktionsart (or aspectual classes or lexical aspect) is a central issue in lexical semantics since at least (Vendler [1957])
 - Aktionsart has been approached in the literature with the help of two central notions:
 - Telicity (Diagnosis: +/- in/for an hour)
 - Having stages (Diagnosis: +/- progressive tense)
 - Aktionsart pertains to the different ways in which verbs can describe change or non-change over time:
- (4) a. States: love someone, hear music [-Stage - Telic]
 b. Activities: push a cart, run (around) [+Stage -Telic]
 c. Achievements: notice a painting, die [-Stage +Telic]
 d. Accomplishments: build a house, eat a pizza [+Stage +Telic]
- The notions of 'telicity' and 'having stages' are commonly related to verbs with relating the verb as linguistic expressions (the object language) with what they describe (the meta language), making use of a scheme as in (5):

(5) Verbs are telic iff what they describe has some property P

- In the Neo-Davidsonian tradition, what verbs describe is events or states
- In the tradition of algebraic approaches to formal semantics (Bach [1986a]), the relevant property of events or states is culmination/non-culmination
- Both the assumption that there *are* events and states and the assumption that they *have* certain properties are motivated on the grounds of natural language metaphysics (Bach [1986b])
- Two prototypical approaches two Aktionsart that involve the explanation scheme in (5) are e.g. Rappaport Hovav and Levin [1998]’s event structure templates (6a) and Krifka [1998]’s incremental arguments (6b).

(6) a. ϕ is telic iff the lexical decomposition of the ontological type of the event described by the verb involves a *BECOME*-predicate ([cp.]Levin [1999]).
b. ϕ is telic iff for any event e it describes it describes no non-final subevent $e' <_E e$ ([Beavers, 2013, cp.], in turn adopted from Krifka [1998])

- The schemes (or conventions) for the use of the term ‘telic’ with respect to verbs in (6) relates a property of a verb to a description in a language of structured event ontology, where the items of this language are not themselves linguistic entities (e.g. non-final events, *BECOME*-predicates).
- In schemes such as (5) the language of structured event ontology is a prerequisite to the explanation of the meaning of a verb being telic but not the product of the explanation of the meaning of the verb.
- We call knowledge of structured event ontology non-linguistic knowledge because
 - (a) structured event ontology is a prerequisite for understanding descriptions of structured events
 - (b) knowledge of structured event ontology is not knowledge of how structured event ontology is described
- In this talk, we would like to present how we think that the insights from structured ontology on Aktionsart can be recast at the syntax-semantics interface, thus exploring how far we can push the idea that language itself has a structure rich enough to accommodate meaning in all its facets.
- To this end, we will reconstruct a generalized Aktionsart ontology at the syntax-semantics-interface in terms of abstract paths resp. forces, where we adopt the general insight that many directional prepositions can be defined by locating the starting point of the path, the end point, or an intermediary point in a particular region relative to the reference object ([Zwarts and Winter, 2000, for an overview])

4 Framework

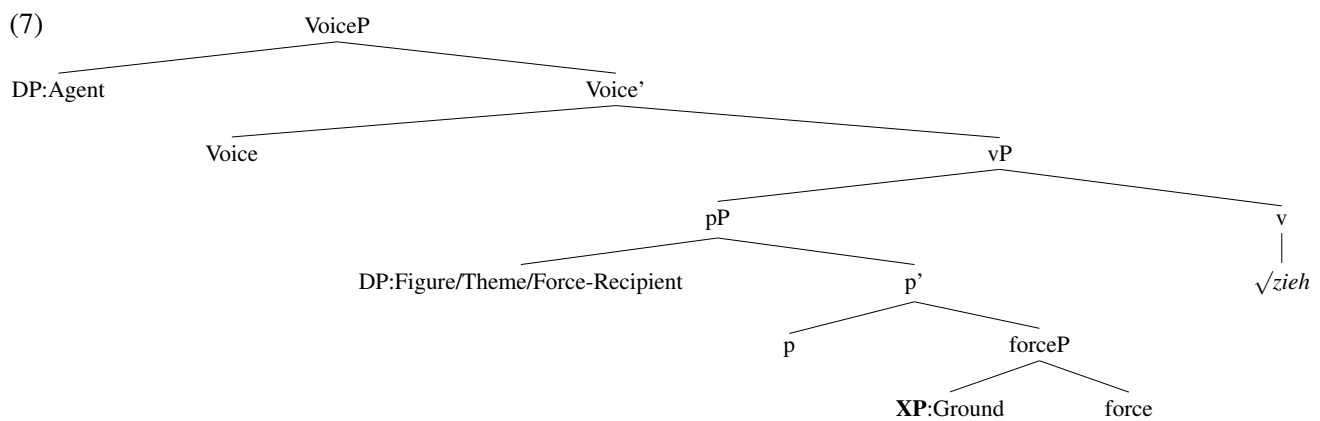
4.1 Syntax-Semantics Interface

- Minimalist syntax of phrase structure + move and merge (e.g. Chomsky [1995], Adger [2003]), incorporation is governed by the head movement constraint (Travis [1984]).
- Conceptual relations such as an event causing another event or a figure moving relative to a ground are introduced by functional layers of the structure as predications between XPs
- Functional heads in the syntax are responsible for the introduction and predication of a particular sort of discourse referents (“ontological building blocks”)
 - v introduces events: e
 - P introduces states: s
 - n introduces individuals: x
 - f introduces forces: f
 - *Place* introduces regions (sets of bounded directed vectors): r

- *PathP* introduces paths (directed bounded or unbounded vectors): *p*
- *AxPart* introduces directions (sets of vectors): *v*
- Functional heads in the syntax are responsible for the introduction and modification of argument slots according to minimalist approach to argument structure (creation of argument slots in the syntax, Hale and Keyser [1993]) and parallelism across N/V/P domains (Alexiadou [2001], Harley [2011], Svenonius [2003])

4.2 The verbal and prepositional spine

- Although all “of the interrelated factors in any force-dynamic pattern are necessarily copresent wherever that pattern is involved”, descriptions “pick out different subsets of the factors for explicit reference – leaving the remainder unmentioned” [Talmy, 1988, p. 61].
- Consequently, we reconstruct the variation in the meaning of the root \sqrt{zieh} in terms of differences in the
 - realization of the Figure-Ground Relation, where the figure is a force-recipient (adopting a notion from Beavers [2011])
 - contribution of the complement **XP** of force

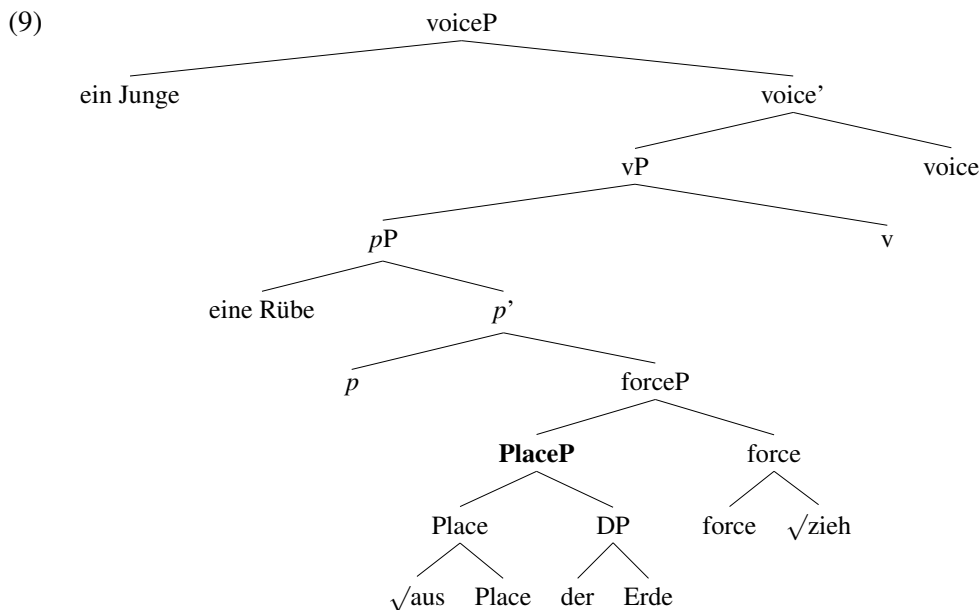


5 Aktionsart and Force Patterns

5.1 Change of Location: Overt Figure and Ground

(8) *ein Junge zog (*für 5 Minuten) in 5 Minuten eine Rübe (*leicht) aus der Erde*
 a boy pulled a carrot (*for 5 minutes) (in 5 minutes) (*slightly) out of the soil

- In (8), both the force-recipient (the carrot) and the ground relative to which force is exerted (the soil) are overtly realized.
- In change of location descriptions with force roots the force projection selects a directional (i.e. source or goal) prepositional description **PlaceP**
- The force head introduces a force f .
- When force combines with **PlaceP**, **PlaceP** contributes a spatial ground r relative to which f is exerted.
- p in turn relates r with the recipient x of f , the carrot, in that the carrot ends up in r if f is exerted: the carrot bears the figure role relative to the ground (the soil).
- The description is telic; it is the figure of motion that is the predicate bearer, — *leicht*, ('slight') doesn't find a target of modification.

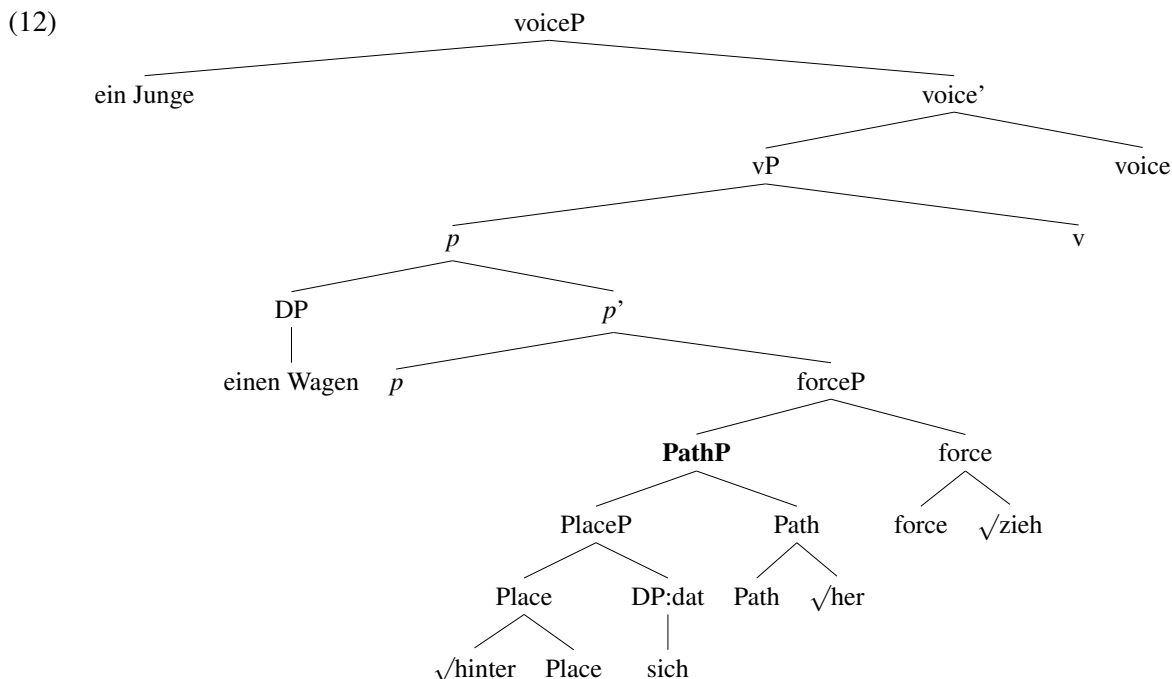


5.2 Transitive Construction: Overt Figure, Ground accomodated

(10) *ein Junge zog (für 5 Minuten) (*in 5 Minuten) einen Wagen (hinter sich her)*
 a boy trailed (for 5 minutes) (*in 5 minutes) a car (behind)

- In descriptions of the type (10), no overt ground is described relative to which the boy pulls the car.
- But according to Talmy, the full force pattern is nevertheless present in (10), i.e. a ground has to be accomodated in order to make sense of (10).
- We distinguish two types of ground accomodation identified by the acceptability of aspectual modification, compare (10) with (11).
- For force-recipients/figures with a typical location such as a tooth (11d), the analysis is essentially the same as for change of location descriptions in which the ground XP contributes the goal region in which the tooth ends up.
- For force-recipients/figures which do not have such a strong association with a typical location, such as cars, the accomodation of the ground can proceed in two ways.
 - If the ground is not accomodated to a typical location but to a path relative to the Agent such as *hinter sich her* in (10), the description is an atelic motion description, with the analysis in (12).
 - If the ground is accomodated to a typical location, we end up with a change of location description (11b) whereas no ground can be accomodated for the atelic motion description (11c).
 - The examples suggest that the acceptability of aspectual modification with *in/für*-PPs and the acceptability of goal-PPs divides the class of direct objects of *ziehen* into objects with a typical location and objects with no typical location, thus providing a linguistic basis to justify the different analyses we propose.

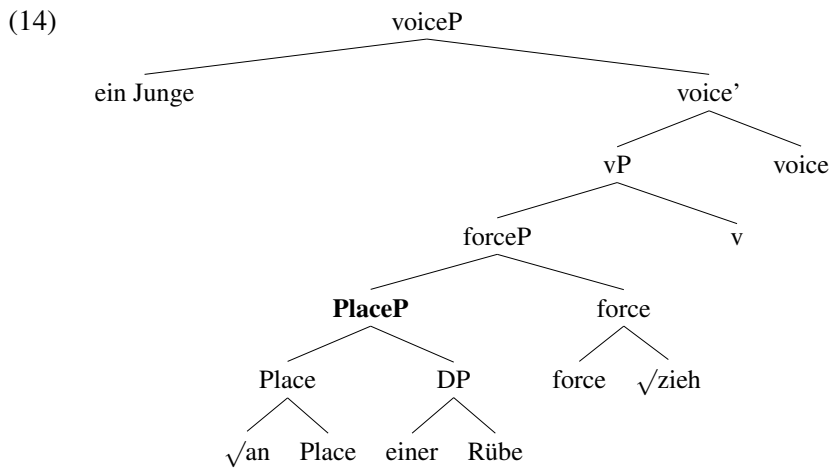
(11) a. *ein Junge zog für 5 Minuten einen Wagen (*aus der Garage)*
 a boy pulled for 5 minutes a car (*out of the garage)
 b. *ein Junge zog in 5 Minuten einen Wagen aus der Garage*
 a boy pulled in 5 minutes a car out of the garage
 c. *ein Junge zog (*in 5 Minuten) einen Wagen*
 a boy pulled (*in 5 minutes) a car
 d. *der Arzt zog (*for 5 minutes) in 5 Minuten einen Zahn (aus dem Kiefer)*
 the doctor pulled (*for 5 minutes) (in 5 minutes) a tooth (out of the jaw)



5.3 Defective Force Pattern: The Conative Construction

(13) *ein Junge zog (für 5 Minuten) (*in 5 Minuten) an einer Rübe*
 a boy pulled (for 5 minutes) (*in 5 minutes) at _{dat} carrot

- In the conative alternation the direct object of a transitive verb appears as the argument in a prepositional phrase headed by locative *an*. The conative alternate is commonly understood as describing an " 'attempted action' without specifying whether the action was actually carried out or not." [Levin, 1993, p. 41].
- We propose that the conative construction is perceived as a description of a 'defective' action because it describes the attachment point or direction of a force but not the recipient of the force exerted.
- In the conative construction only the ground is overtly realized but no figure is overtly realized or can be accommodated.
- This is because the preposition *at* does not describe the goal region in which the force recipient ends up but instead describes the attachment region of the force with respect to the carrot (13)
- The conative construction differs from the analysis in (7) in that it lacks a p head projecting the force-recipient
- In turn, the lack of a p projection and consequently of a syntactic position to accommodate the force-recipient/figure makes the conative construction 'defective' because the force pattern cannot be reconstructed via accommodation.
- Finally, because there is no figure in which the outcome of the exertion of force would manifest, conative constructions are atelic.



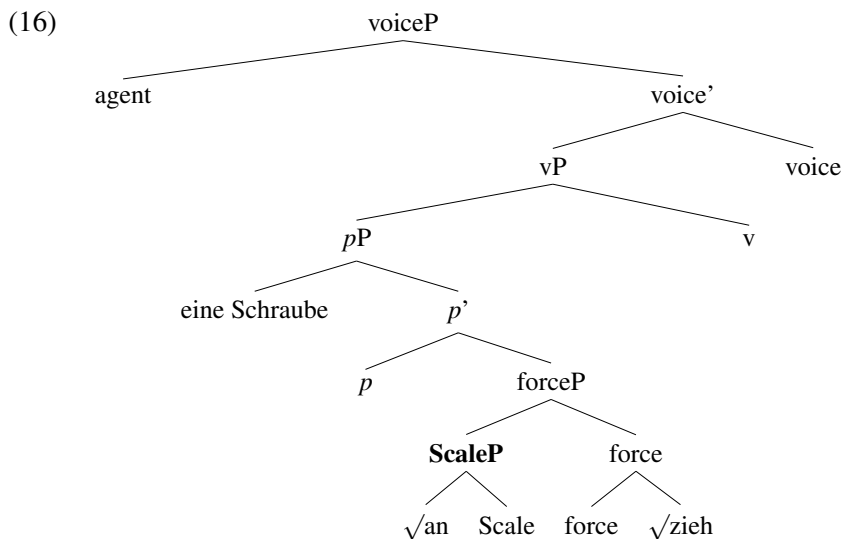
5.4 Particle Construction: Overt figure, Ground is a scale

(15) a. *eine Schraube, eine Mutter, ein Seil (in 5 Minuten) (*für 5 Minuten) (leicht) anziehen*
 a bold, a nut, a rope (in 5 minutes) (*for 5 minutes) (slightly) an.prtc.zieh
 '(slightly) tighten a bold, a nut, a rope in 5 minutes'

b. *eine Schraube überziehen*
 a screw over.pfx.pull
 'to overwind a screw'

- In (15a), the ground is an open scale of magnitudes of the force of exerted on the force-recipient.
- The magnitude scale is induced by the particle *an*, which specifies a scale of values as *increasing*, a regular semantic contribution of the root $\sqrt{\text{an}}$ which contributes 'upwards' as opposed to $\sqrt{\text{ab}}$, meaning 'downwards' in German.

- (15a) describes an activity of applying more and more force to the nut; or else (15a) describes an accomplishment of applying the appropriate amount of force.
- a related construction is (15b), which is an achievement description to the effect that the nut or screw receives too much force.
- The particle constructions under consideration share structural properties with de-adjectival verbs such as *lengthen a rope* (discussed in Hay et al. [1999], Kennedy and Levin [2008]).
- We take *leicht* to diagnose a scale which can be made explicit in German with *um*-phrases, e.g. *die Schraube um einige Newton anziehen* (to tighten the screw a few Newton) and which we take to diagnose a scale
- Whether (15a) describes an accomplishment depends on whether the scale of magnitudes of the force is assumed to be bounded or open.
- We represent this two-faced nature of scale-based particle constructions in that the introduction of a scale as a complement selected by the functional force head specified by $\sqrt{\text{zieh}}$ is decisive for Aktionsart, i.e. the screw either becomes tighter and tighter or else the screw becomes completely tight depending on the value of the underlying scale.



- The question arises whether (17) is an instance of the same construction. We believe that this is indeed the case. We understand the forces that must be applied to the car to be strong enough as to undo the counter-forces acting on the car in context. Gravitation and friction are responsible for the car to stay put.

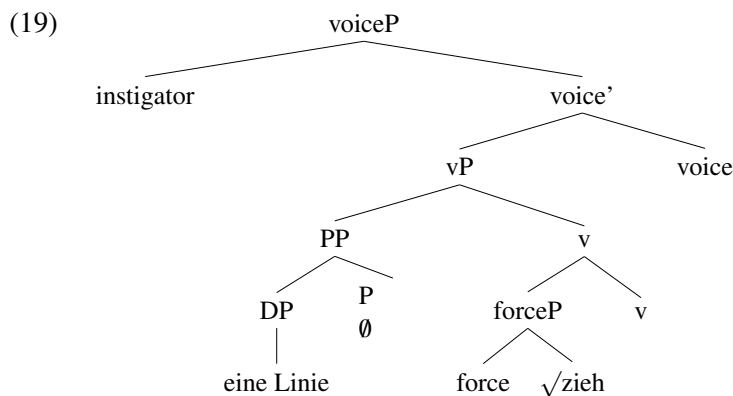
(17) *einen Wagen anziehen* (vs. *anschieben*)
 a cart an.prtc.pull.v (vs. an.prtc.push)
 'to set a cart into motion by pulling (pushing)'

6 Beyond Figure-Ground Force Patterns

6.1 Non-core transitive construction: force bringing objects into existence

- (18) a. *(in 5 Minuten) (?für 5 Minuten) eine Grenze / eine Linie ziehen / eine Schnute ziehen*
 (in 5 minutes) (?for 5 minutes) a line / a line draw / a face pull
 'draw a border', 'draw a line', 'make a face' in 5 minutes
- b. *eine Spur ziehen, eine Furche ziehen*
 a trail drag, a drill drag

- In (18) the direct object doesn't play the role of a force-recipient and there is no overt ground.
- Instead, we analyze (18) as an instance of a non-core transitive construction (cf. Marantz [2005], ?).
- The direct object enters the representation as a participant of a state *s* that is brought about by the event in the vP-description.
- A silent *P* introduces the resultant state and relates it with the denotation of the accusative DP such that the DP's denotation is a participant of the state
- The ZIEH-force introduced in the force-projection functions as a modifier of the event *e* introduced by little *v*. It contributes that the event *e* is of the type of *zieh*-force exertion.
- As regards Aktionsart, examples such as (18) exhibit the same well-known problems with respect to classification as other non-core transitive construction (e.g. *write* vs. *write a letter*), so we leave this question open for now.

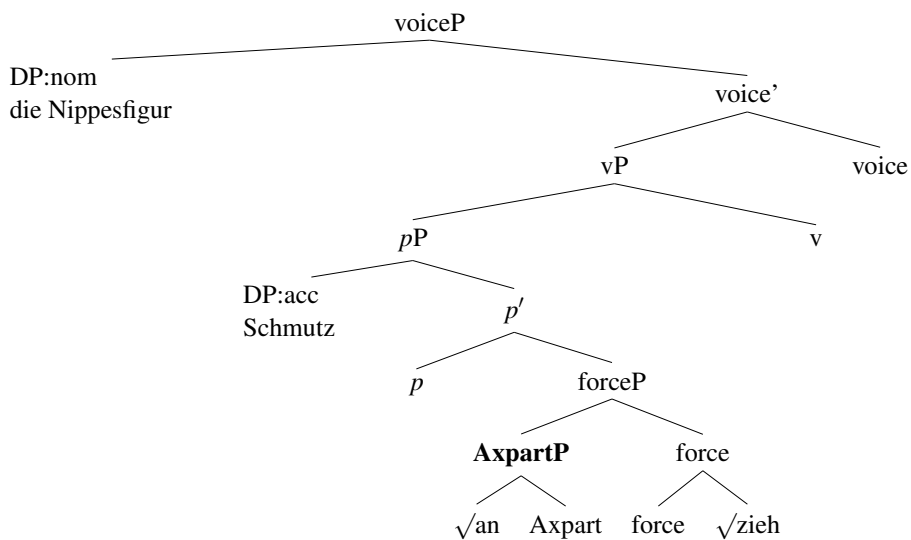


6.2 The Force Pattern of Attraction

- (20) a. *weil die Nippesfigur leicht (?in 5 Minuten) (?für 5 Minuten) Schmutz anzieht*
 because the knick-knack easily (?in 5 minutes) (?for 5 minutes) dirt an.prtc.zieh
 because the knick-knack easily (\neq slightly) attracts dirt
- b. *die Füße anziehen*
 the feet an.prtc.zieh
 to tuck up one's legs

- Examples such as (20a) and (20b) describe a potential of attraction with respect to two or more object for which the traditional talk of figure and ground falls short of capturing.
- we think that the source of the attraction force is the centre towards which the force is directed in that the particle $\sqrt{\text{an}}$ contributes a field of vectors *v* which attached at the periphery of the attractor.
- If an object moves into *v* it becomes subject to the force exerted by the attractor.
- The force introducing head selects for a constituent that describes such a vector field of attraction. For historical reasons at the syntax-semantics-interface in the prepositional domain (cf. Svenonius [2008], Roßdeutscher [2013]) heads introducing vector sets are named 'A_{xpart}'.
- *leicht* does not indicate a scale but modifies the manner of force exertion
- *p* selects forceP and relates the vector field with the force recipient in the periphery. For instance any dust-particle located at the origin of a vector which points to the centre of force is a recipient of the ZIEH force. (In the case of (20b) the force also points from the periphery to the centre.)

(21)



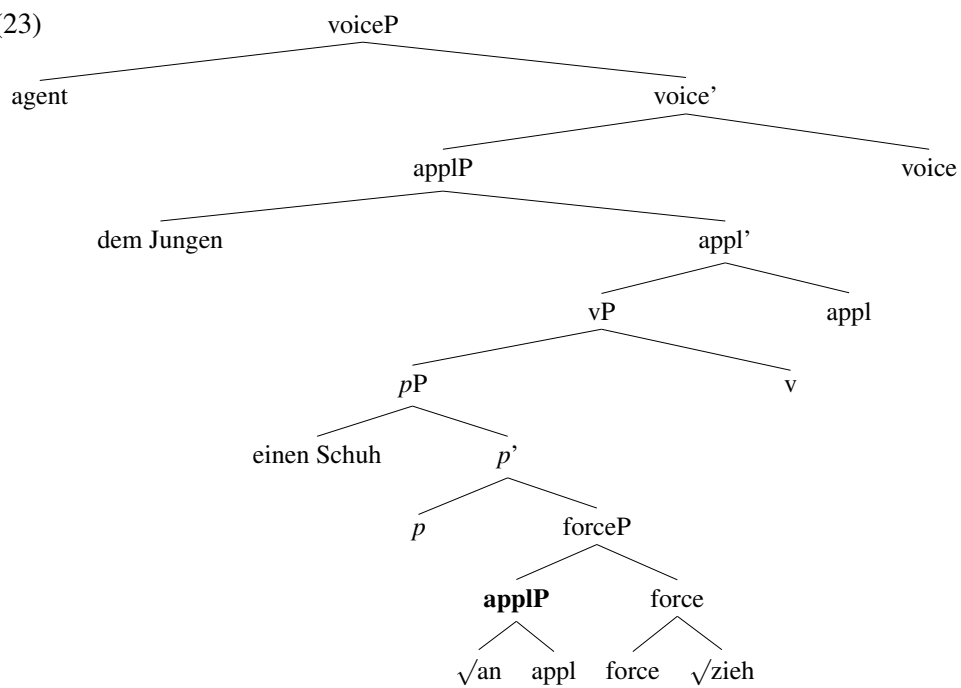
Focusing the result of force application

- (22a) and (22b) describe dressing activities to the effect that the boy wears a shoe or is fully dressed, respectively.
- The descriptions are instances of a pattern of 'application'. Application and removal makes itself felt in HAVE-paraphrases: 'the boy has a shoe on'. Application is a relation between a 2D- or 3D-region of space and entities or stuff that those regions *have* in or on them.
- As shown elsewhere (cf. Rossdeutscher [2014]) application constructions have alternative ways of expressing an event where *all* parts of the region have stuff in or on them. (22b) is an instance of such alternative expression: all relevant parts of the boy's skin have garments on them.
- Because application descriptions focus on the *have*-state, they are telic and no scalar modification with *leicht* is possible

(22)

- dem Jungen (*für 5 Minuten) (in 5 Minuten) (*leicht) einen Schuh anziehen*
the boy_{dat} (*for 5 minutes) (in 5 minutes) (*slightly) a shoe at.prtcl.zieh.v
'dress the boy with a shoe in 5 minutes'
- einen Jungen anziehen*
a boy at.prtc.zieh.v
'fully dress a boy'

(23)



References

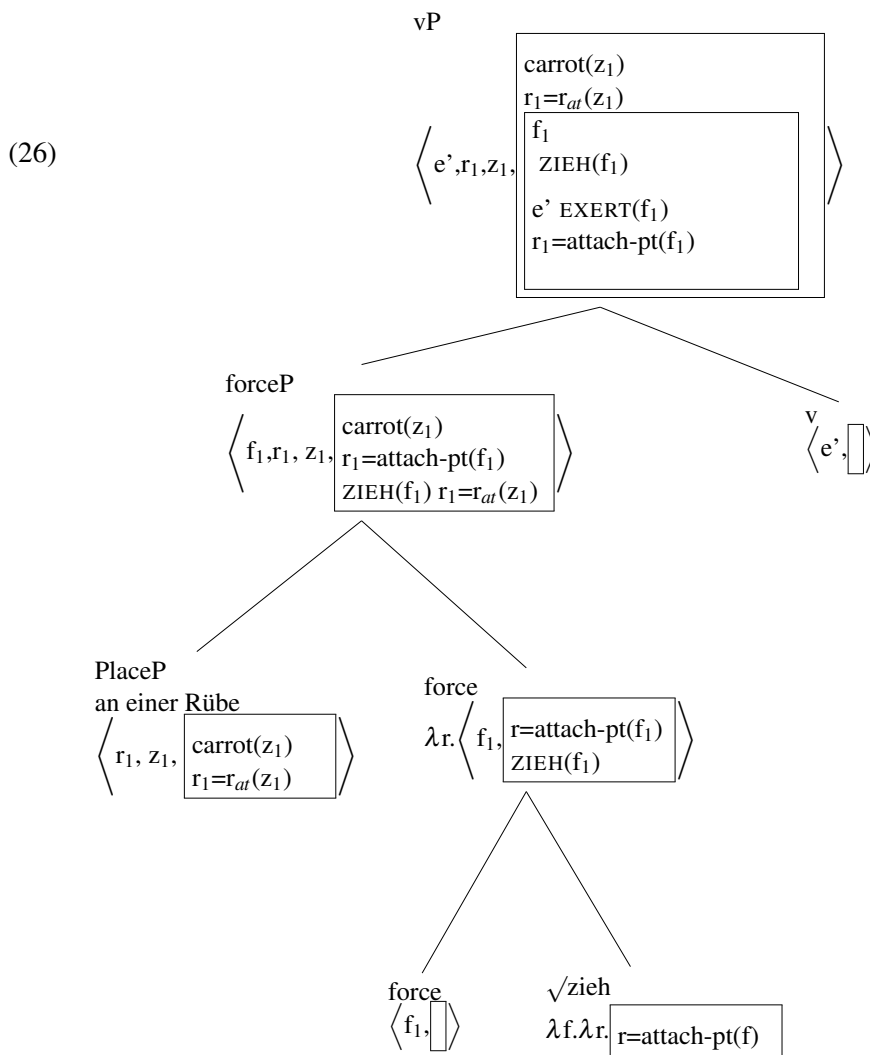
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7 Appendix

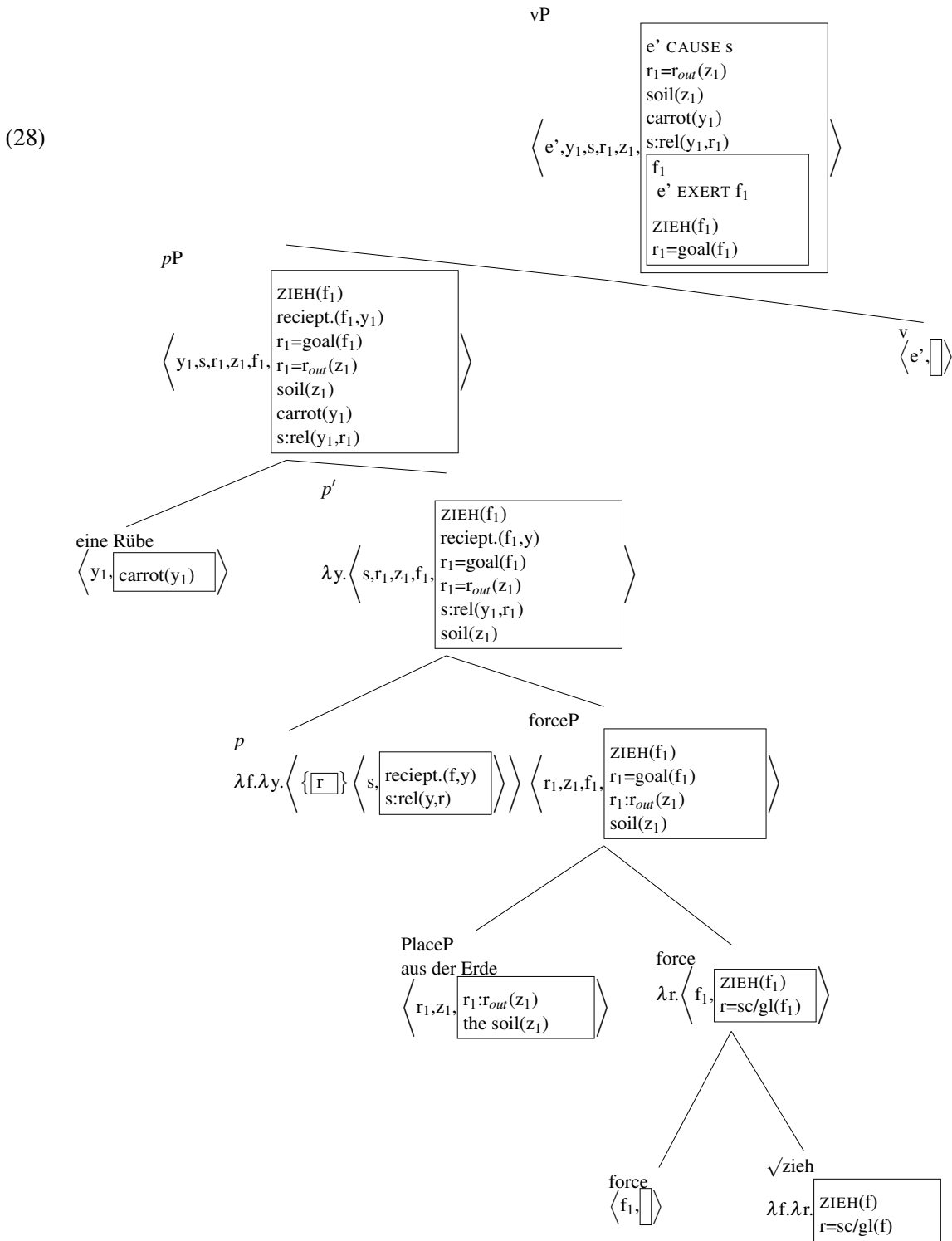
- We use an extension of the basic DRT language (Kamp et al. [2011]) with presuppositions and a λ -calculus for variable stores where λ -conversion selects the leftmost variable from the store
- The storing of variables instead of immediate conversion into discourse referents allows for a greater flexibility in the derivational process when it is necessary to distinguish between the introduction of existentially quantified discourse referents and manipulations of variables for discourse referents. A DRS K with a presupposition P , λ -abstracted variables x, y and a store v, z is represented as in (24).

(24) $\lambda x \lambda y \langle \{P\} \langle v, z \rangle K \rangle$

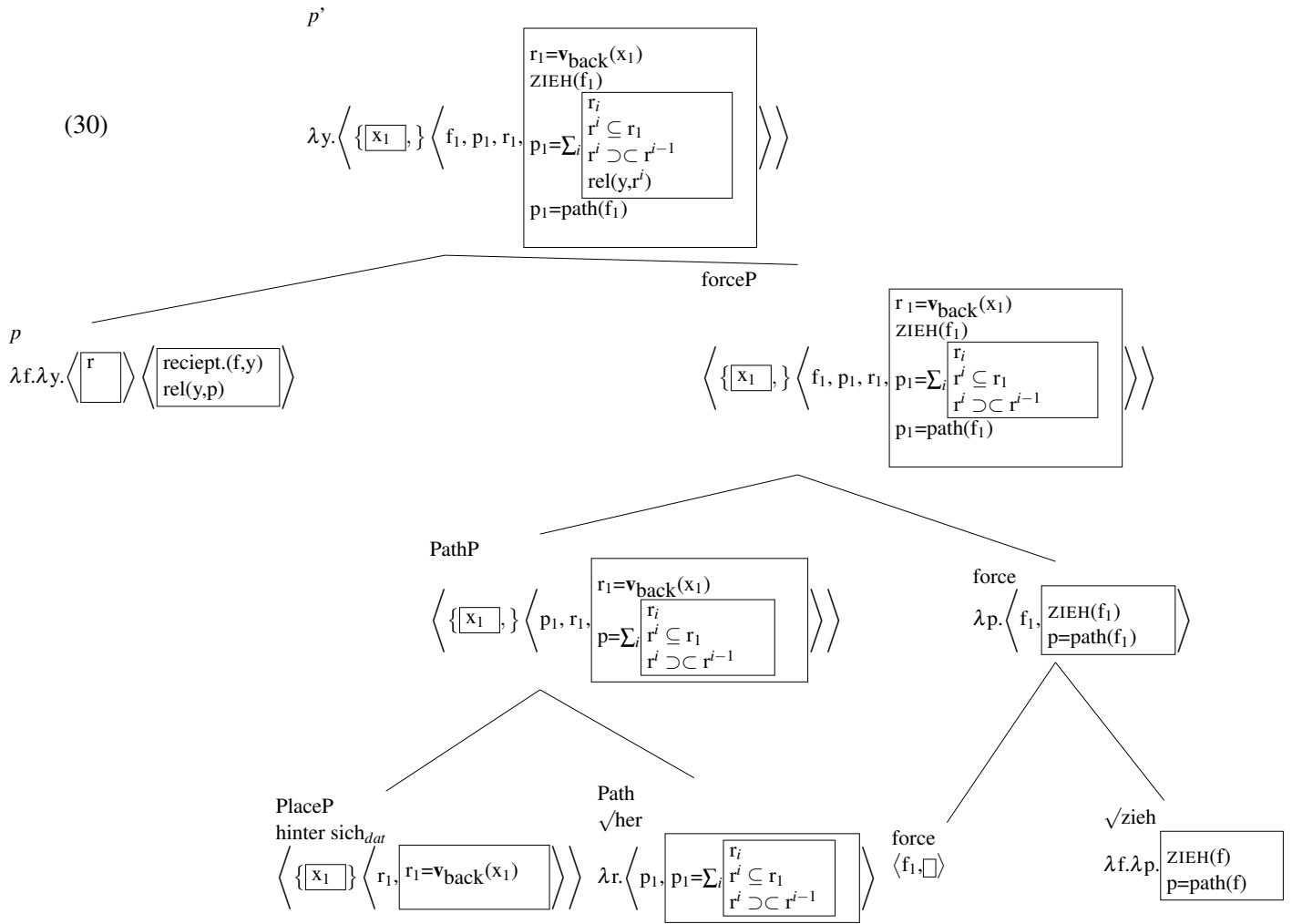
(25) *ein Junge zog an einer Rübe*
 the boy pulled at a carrot



(27) ein Junge zog eine Rübe aus der Erde
 a boy pulled a carrot out-of the soil



(29) *ein Junge zog einen Wagen hinter sich her*
 the boy pulled a cart behind refl.dat her.prtc.
 'the boy pulled a cart behind'



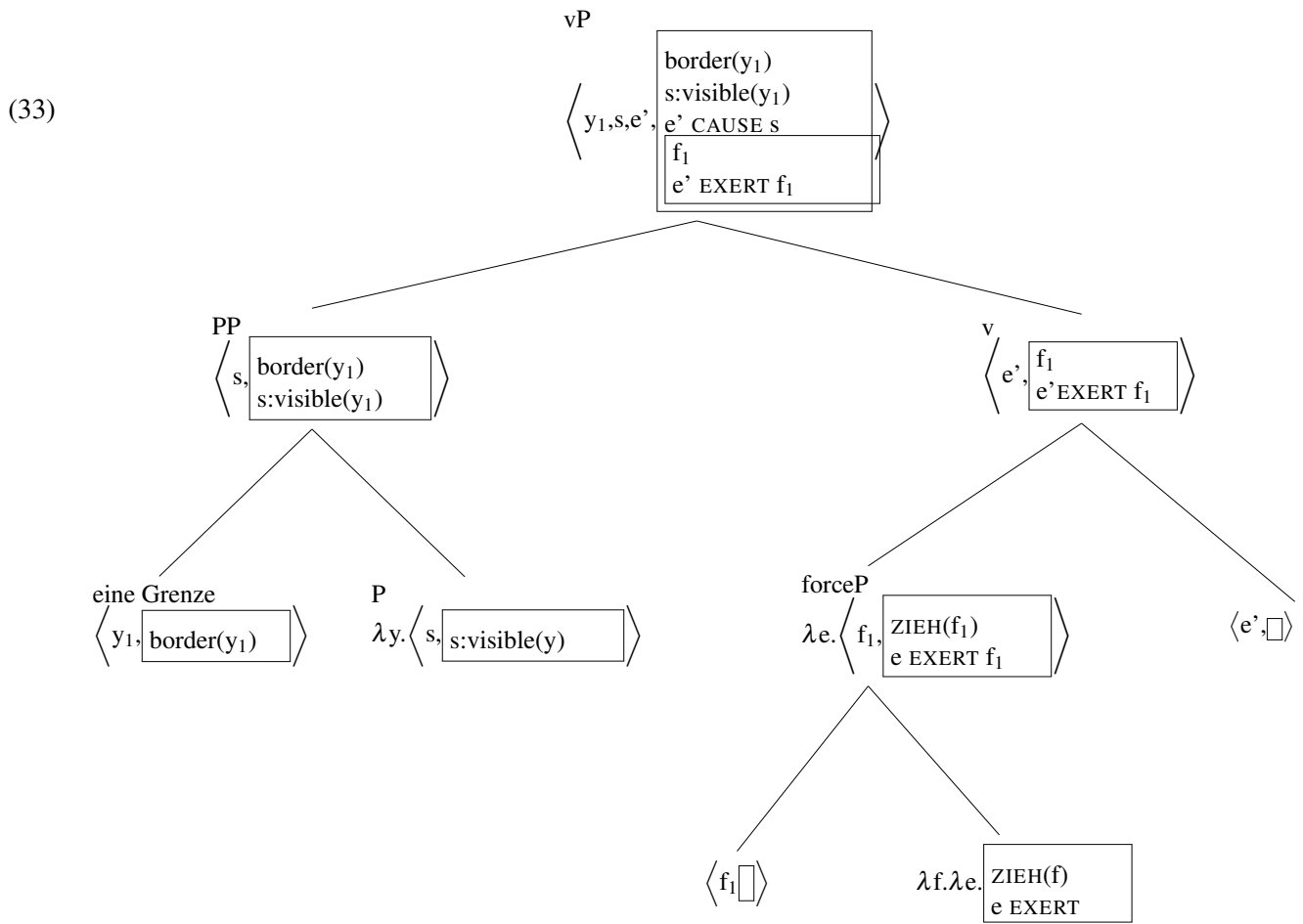
(31) vP

$$\left\langle \left\{ \boxed{x_1} \right\}, \left\langle e', y_1, p_1, r_1, \right. \right. \left. \left. \begin{array}{l} r_1 = v_{\text{back}}(x_1) \\ \begin{array}{l} r_i \\ r^i \subseteq r_1 \\ r^i \supset \subset r^{i-1} \\ \text{rel}(y_1, r^i) \\ \text{rel}(x_1, r^{i+1}) \end{array} \\ p_1 = \sum_i \\ \begin{array}{l} f_1 \\ f_1 = \text{path}(f_1) \\ \text{ZIEH}(f_1) \\ e' \quad \text{EXERT} \quad f_1 \\ p_1 = \text{path}(f_1) \end{array} \end{array} \right\rangle \right\rangle$$

pP
den Wagen hinter sich her zieh

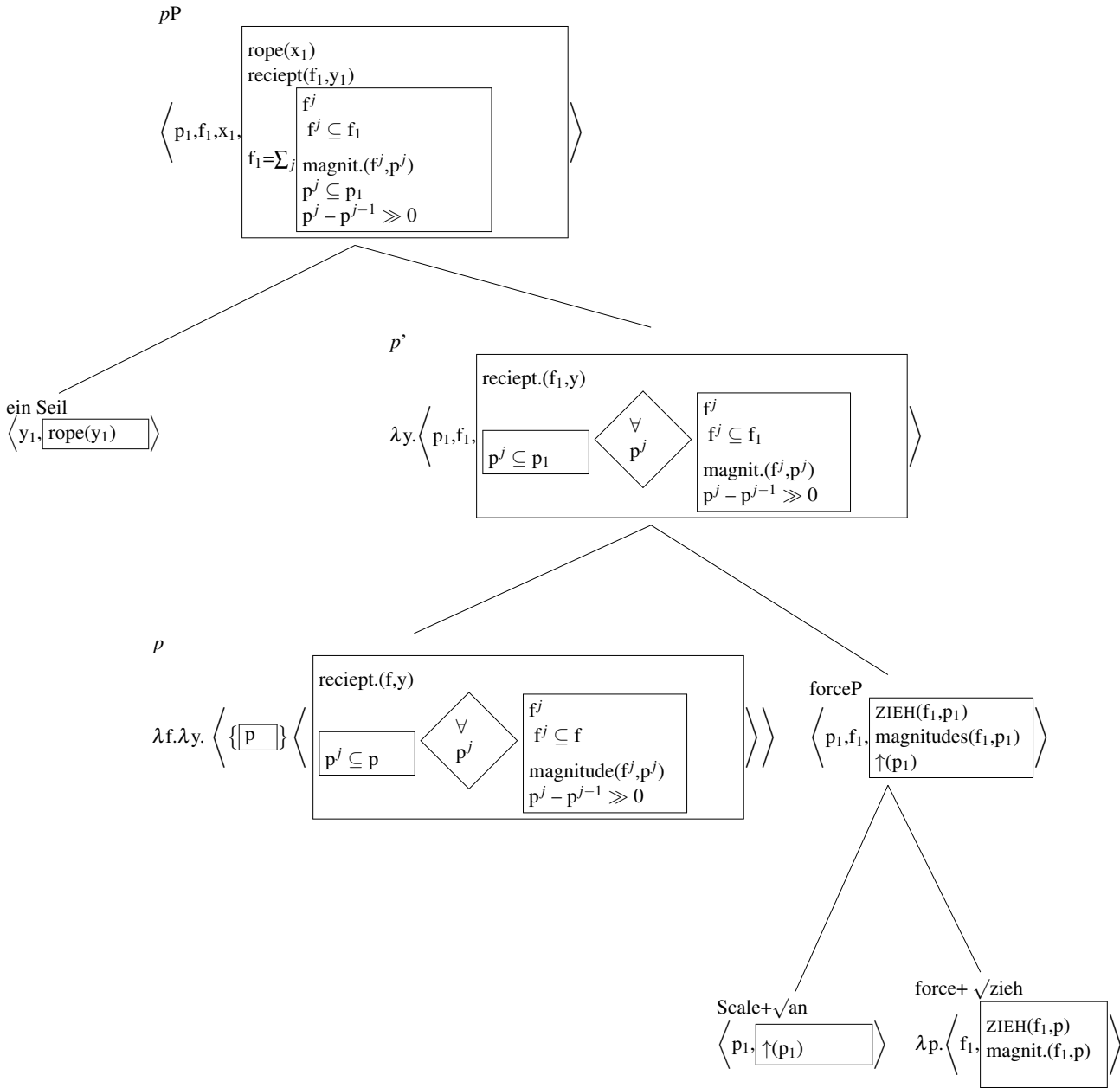
$$\left\langle \left\{ \boxed{x_1} \right\}, \left\langle y_1, f_1, p_1, r_1, \right. \right. \left. \left. \begin{array}{l} r_1 = v_{\text{back}}(x_1) \\ \begin{array}{l} r_i \\ r^i \subseteq r_1 \\ r^i \supset \subset r^{i-1} \\ \text{rel}(y_1, r^i) \end{array} \\ p = \sum_i \\ \begin{array}{l} f = \text{path}(f_1) \quad \text{ZIEH}(f_1) \\ p = \text{path}(f_1) \end{array} \end{array} \right\rangle \right\rangle \left\langle e', \boxed{} \right\rangle$$

- (32) *eine Grenze / eine Linie ziehen / eine Schnute ziehen*
 a line / a line draw / a face pull
 'draw a border', 'draw a line', 'make a face'

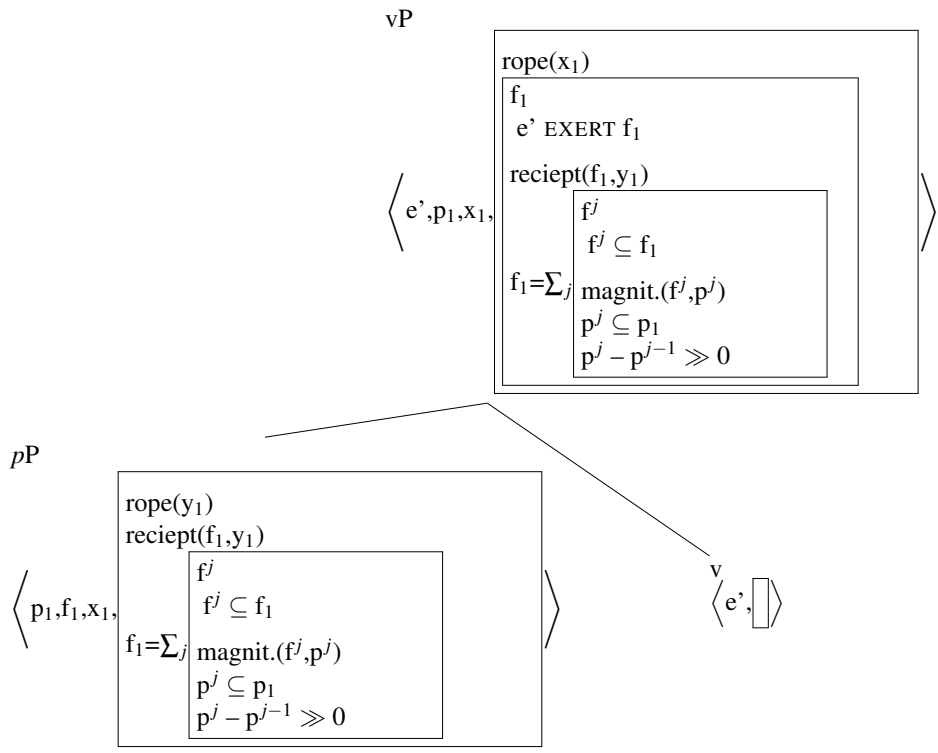


(34) *ein Seil, eine Schraube anziehen*
 a rope, a screw an.prtc.zieh
 'tighten a rope, a screw'

(35)



(36)



(36) weil die Mutter dem Jungen einen Schuh anzog
 because the mother the boy_{dat} a shoe at.prtcl.zieh.v
 'the mother put the boy a shoe on'

