I) Force Verbs

1) Definition:
   „A force verb is any verb of which the root can occur in a sentence that describes a situation
   in which an object A exerts a physical force through contact on another object B without
   necessarily implying a change in the properties of B, yet while allowing for that change.“
   (Goldschmidt 2018: 114)

2) Examples:
   schlagen (to hit), drücken (to push/press), ziehen (to pull), berühren (to touch):
   NOT legen (to lay), werfen (to throw) or stehen (to stand)

3) Rich lexical structure:
   - aspectual distinctions: schlagen versus drücken
   - directional distinctions: drücken versus ziehen
   - intensity distinctions: schlagen versus berühren

4) Compositional behaviour:
   a) Joanne schlägt auf den/*an dem Nagel. (Joanne hits on/*on the nail.)
   b) Joanne zieht an/*auf der Wurzel. (Joanne pulls on/*on the root.)
   c) Joanne berührt Maria leicht/*hart an der Schulter.
      (Joanne touches Maria lightly/*hard on the shoulder.)

II) Model-theoretic building blocks and meaning components (Goldschmidt 2018: 143-152)

5) Forces:
   There is a full set of located force vectors that have an (i) origin, (ii) magnitude, and (iii)
   direction. This set includes zero vectors. Each set of force vectors with the same spatial
   origin constitutes a vector space, with the appropriate properties.
   We access space exclusively through located force vectors. A zero force vector is equivalent
   with an ‘old-fashioned’ point in space; a non-zero force vector $f$ can be used to represent a
   force with magnitude $|f|$ working at point $\text{ORIGIN}(f)=0f$. 

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1 This paper is based largely on Goldschmidt & Zwarts (2016), Goldschmidt, Gamerschlag, Petersen, Gabrovska &
6) Paths:
For every moment $t$ of the run time of an event $e$: $p(t)$ is the force vector representing the force exerted by the force exerter of $e$ on the force recipient of $e$ at time $t$.

7) Events in time and space:
   a) For every event $e$, there is the interval $\text{TIME}(e)$ that represents the run time of $e$.
   b) For any event $e$, $\text{PATH}(e)$ is the path that corresponds to $e$, if defined, and that has $\text{TIME}(e)$ as its domain.

8) Participants of events:
   a) If $\text{PATH}(e)$ is a force path, then there is a participant $\text{FORCE EXERTER}(e)$ that is the exerter of the force and a participant $\text{FORCE RECIPIENT}(e)$ that is the recipient of the force. Every non-zero force vector of the path must be located on the boundary of the eigenspace of $\text{FORCE RECIPIENT}(e)$.
   b) If $\text{PATH}(e)$ is a force path, then $\text{INSTRUMENT}(e)$ is that part of $\text{FORCE EXERTER}(e)$ that is in forceful contact with $\text{FORCE RECIPIENT}(e)$.
   c) If $\text{PATH}(e)$ is a force path, then $\text{ZONE}(e)$ is that part of $\text{FORCE RECIPIENT}(e)$ on which the non-zero force vectors are located.
   d) For any event $e$ with $\text{PATH}(e)$, there is a participant $\text{FIGURE}(e)$ that occupies subsequent positions of $\text{PATH}(e)$ during the run time of $e$. This may be $\text{INSTRUMENT}(e)$.
   e) For any event $e$ with $\text{PATH}(e)$, $\text{GROUND}(e)$, if present, is the reference object, that object with respect to which the movement of the $\text{FIGURE}(e)$ is located. If $\text{PATH}(e)$ is a force path, $\text{GROUND}(e)$ is the $\text{FORCE RECIPIENT}(e)$.

9) Objects and space:
For every (material) object, there is a set $\text{SPACE}(x)$ of spatial points that represents the eigenspace of $x$ with a proper subset $\text{BOUNDARY}(x)$ of boundary points and $\text{INTERIOR}(x)$, the complement of the boundary with respect to the eigenspace.

10) Aspectual components:
a) $\text{PUNCTUAL}(p)$ iff $\exists t \ [ \ |p(t)| > 0 \ ]$
   b) $\text{CONTINUOUS}(p)$ iff $\forall t \ [ \ |p(t)| > 0 \ ]$
11) Directional components:
   a) \( \text{INTR}(p, x) \) iff \( \exists t. \exists s \left[ \text{ORIGIN}(p(t)) \in \text{BOUNDARY}(x) \land s > 0 \land \text{END}(sp(t)) \in \text{INTERIOR}(x) \right] \)
   b) \( \text{EXTR}(p, x) \) iff \( \exists t. \forall s \left[ \text{ORIGIN}(p(t)) \in \text{BOUNDARY}(x) \land s > 0 \land \text{END}(sp(t)) \notin \text{SPACE}(x) \right] \)

12) Intensity components:
   a) \( \text{INTENSIVE}(p) \) iff \( \exists t \left[ |p(t)| > M_c \right] \)
   b) \( \text{NON-INTENSIVE}(p) \) iff \( \exists t \left[ |p(t)| > 0 \right] \land \forall t \left[ |p(t)| < M_c \right] \)

III) Event Semantics: Lexical entries and derivations (Goldschmidt 2018: 153 - 165)

13) Force verbs:
   a) \( \text{SCHLAGEN} = \lambda e. \exists p \left[ \text{PATH}(e) = p \land \text{PUNCTUAL}(p) \land \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \right] \)
   b) \( \text{DRÜCKEN} = \lambda e. \exists p \left[ \text{PATH}(e) = p \land \text{CONTINUOUS}(p) \land \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \right] \)
   c) \( \text{ZIEHEN} = \lambda e. \exists p \left[ \text{PATH}(e) = p \land \text{CONTINUOUS}(p) \land \text{EXTR}(p, \text{FORCE RECIPIENT}(e)) \right] \)
   d) \( \text{BERÜHREN} = \lambda e. \exists p \left[ \text{PATH}(e) = p \land \text{INTR}(p, \text{FORCE RECIPIENT}(e)) \land \text{NON-INTENSIVE}(p) \right] \)

14) Adverbs:
   a) \( \text{LEICHT} = \lambda p \left[ \text{NON-INTENSIVE}(p) \right] \)
   b) \( \text{HART} = \lambda p \left[ \text{INTENSIVE}(p) \right] \)

15) Prepositions:
   a) \( \text{AUF} = \lambda x. \lambda p \left[ \text{INTR}(p, x) \right] \)
   b) \( \text{AN} = \lambda x. \lambda p \left[ \text{EXTR}(p, x) \right] \)

16) Type shift \( \text{MOD} \):
   \( \lambda P. \lambda E. \lambda e. \exists p \left[ \text{PATH}(e) = p \land P(p) \land E(e) \right] \)

17) Derivation: Joanne berührt Maria leicht an der Schulter.
   (Joanne touches Maria lightly on the shoulder.)
   a) \( \text{berühren} = \lambda e \left[ \text{BERÜHREN}(e) \right] \)
b) an = λx,λp [ AN(p, x) ]
c) an der Schulter = λp [ AN(p, der-schulter) ] → λE. λe.∃p [ PATH(e) = p & AN(p, der-schulter) & E(e) ]
d) an der Schulter berühren = λe.∃p [ PATH(e) = p & AN(p, der-schulter) & BERÜHREN(e) ]
e) leicht = λp [ LEICHT(p) ] → λE. λe.∃p [ PATH(e) = p & LEICHT(p) & E(e) ]
f) leicht an der Schulter berühren = λe.∃p [ PATH(e) = p & LEICHT(p) & AN(p, der-schulter) & BERÜHREN(e) ]
g) Maria leicht an der Schulter berühren = λe.∃p [ PATH(e) = p & FORCE RECIPIENT(e) = maria & LEICHT(p) & AN(p, der-schulter) & BERÜHREN(e) ]
f) Joanne berührt Maria leicht an der Schulter = 3e.∃p [ PATH(e) = p & FORCE RECIPIENT(e) = maria & LEICHT(p) & AN(p, der-schulter) & FORCE EXERTER(e) = joanne ]

18) Derivation: Joanne schlägt auf den Nagel.

(see appendix)

19) Frame for “Joanne berührt Maria leicht an der Schulter.” (see appendix)

20) Frame for “Joanne schlägt auf den Nagel.” (see appendix)

V) Discussion points

- both frameworks can be used to model both the rich lexical structure of verbs and the more “formal” compositional aspects
- Event Semantics offers an easier way to integrate the meaning components/model-theoretic building blocks
- Frame Semantics was originally created with conceptual structure in mind, so represents that very elegantly

References


berühren

Marys Schulter

not expressed

Joanne

force t.-events

move.-events

force vector

force exenter

path

force recipient

force transmission

force vector

PARTICIPANT

AGENT

PETER/RECIPIENT

THEME

INSTRUMENT

AGENT

PATIENT/RECIPIENT

movement

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