Analyzing verb polysemy in frames

A case study of German *steigen* ‘rise/climb’

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The German verb *steigen* can be used as a:

1. verb of manner of motion
2. verb of directed motion
3. figurative verb of change
Objectives

• investigate the "anatomy" of the different uses and the relationship between these uses
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• develop an analysis in terms of frames
Polysemy of *steigen* 'climb, rise':
*steigen* as a verb of manner of motion

1. *steigen*$_{\text{manner}}$:

   *Hans steigt auf einen Berg.*
   H. climbs on a mountain
   'Hans is climbing a mountain.'
Polysemy of *steigen* 'climb, rise': *steigen* as a verb of directed motion

2. *steigen$_{\text{directional}}$*:

*Der Ballon steigt.*
the balloon climbs

'The balloon is climbing.'
Polysemy of *steigen* 'climb, rise':
*steigen* as a figurative verb of change

3. *steigen*<sub>figurative</sub>:

*Die Temperatur der Flüssigkeit steigt.*

the temperature of the liquid rises

'The temperature of the liquid is rising.'
Manner of motion vs. direction of motion

steigen\textsubscript{manner} \rightarrow \text{use of legs/feet, ground contact}

a. \checkmark \textit{Die Ziegen steigen aufs Dach.}
   \textit{the goats climb onto the roof}
   'The goats are climbing onto the roof.'
Manner of motion vs. direction of motion

\[ \textit{steigen}_{\text{manner}} \rightarrow \text{use of legs/feet, ground contact} \]

b. ?? \textit{Die Schnecke steigt auf die Pflanze.} 
the snail climbs onto the plant

'\textit{The snail is climbing onto the plant.}'
Manner of motion vs. direction of motion

$\textit{steigen}_{\text{manner}} \rightarrow$ use of legs/feet, ground contact

c. ?? $\textit{Der Zug} \; \textit{steigt auf den Berg}$.  
the train climbs onto the montain  
'The train is climbing the mountain.'
Manner of motion vs. direction of motion

Geuder & Weisgerber (2008): *steigen*\textsubscript{manner} can be instantiated by a single step

Sie stieg über die Pfütze.

'she stepped over the puddle'

'She stepped over the puddle.'
Manner of motion vs. direction of motion

steigen\textsubscript{directional} \rightarrow \text{freely suspended object, no reference to extremities}

a. \textit{Der Ballon stieg höher und höher.}
the balloon climbed higher and higher

'The balloon climbed higher and higher.'
Manner of motion vs. direction of motion

*steigen*<sub>directional</sub> → freely suspended object, no reference to extremities

a. *Der Ballon stieg höher und höher.*
the balloon climbed higher and higher

'The balloon climbed higher and higher.'

b. *Das U-Boot stieg an die Oberfläche.*
the submarine climbed to the surface

'The submarine climbed towards the surface.'
Manner of motion vs. direction of motion

*steigen*\textsubscript{manner} : combination with all kinds of directionals

a. *Die Ziegen stiegen vom Dach.*
the goats climbed from the roof

'The goats climbed (down) from the roof.'
steigen<sub>directional</sub>: only upward direction

b. *Der Ballon stieg tiefer und tiefer.
   the balloon climbed deeper and deeper
   lit.: '*The balloon climbed deeper and deeper.'
steigen\textsubscript{manner}: directional complement necessary

a. *Hans \textit{stieg} \textit{den ganzen} \textit{Tag}.
H. climbed the whole day
lit.: 'Hans climbed the whole day long.'

steigen\textsubscript{directional}: directional complement optional

b. \textit{Der Ballon stieg}.
the balloon climbed
'The balloon was climbing.'
**Manner of motion vs. direction of motion**

\[ \textit{steigen}_{\text{manner}} \]

- use of legs/feet
- ground contact
- all directions
- dir-comp. obligatory

\[ \textit{steigen}_{\text{directional}} \]

- no reference to limbs
- freely suspended
- only upwards
- dir-comp. optional
⇒ Geuder & Weisgerber (2008): The manner component of German *steigen* is more specific than that of the English verb *climb* (cf. the discussion of *climb* by Fillmore (1982), Jackendoff (1985) and Levin & Rappaport (2013) among others)
Gamerschlag, Geuder & Petersen (2014):
There are 2 clearly distinguished variants of steigen referring to movement in space

The restriction of directional steigen to upward movement can perhaps be motivated from a stereotype of upward movement associated with the manner use of steigen (cf. Levin & Rappaport).
Analysis: Framework

• Conceptual knowledge is captured in frame representations.
• Frame representations provide an explicit, variable-free, and cognitively plausible format.
• Frames are defined as recursive attribute-value structures (Barsalou 1992).
• The attributes correspond to mathematical functions.
Frames for nominal concepts
(Petersen 2007, Petersen & Osswald 2014)

frame representation of sortal concept 'cherry'
Frames for nominal concepts
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frame representation of sortal concept 'cherry'

'cherry': \( \lambda x. \text{cherry}(x) \land \text{round}(\text{FORM} (\text{STONE}(x))) \land \text{sweet}(\text{TASTE}(x)) \land \text{round}(\text{FORM}(x)) \)
Naumann (2013): *static event frames* (SEFs) represent global properties of the overall event/static dimensions

Frame analysis of *steigen* \textsubscript{manner}

static event frame of *steigen* \textsubscript{manner}  
(Gamerschlag, Geuder & Petersen 2014)
Event structure of \textit{steigen}_manner

(Gamerschlag, Geuder & Petersen 2014)
Zooming into the manner component of \textit{steigen}_{\textit{manner}}
Zooming into the manner component of \textit{steigen}_{manner}
Zooming into the manner component of \textit{steigen}_{manner}
Detailed frame of \textit{steigen}_manner

\begin{itemize}
  \item \textit{path}
  \item \textit{steigen}_mnr
  \item \textit{cycl. phase}
  \item \textit{step}
  \item \textit{forces}
  \item \textit{solid}
  \item \textit{upwards}
\end{itemize}
Extending the analysis to $steigen_{\text{directional}}$

$steigen_{\text{directional}}$:

*Der Ballon steigt.*

the balloon climbs

'The balloon is climbing.'

– no reference to limbs
– freely suspended
– only upwards
– dir-comp optional
Frames of \textit{steigen}_manner vs. \textit{steigen}_directional

\textit{steigen}_manner

\textit{steigen}_directional
Zooming into the "upwards" node of $\text{steigen}_{\text{directional}}$
Zooming into the "upwards" node of \( steigen_{\text{directional}} \)
Die Temperatur der Flüssigkeit steigt.

steigen⁡figurative⁡:

Die Temperatur der Flüssigkeit steigt.
the temperature of the liquid rises
'The temperature of the liquid is rising.'
steigen\textsubscript{figurative} can only express an increase along the respective scale but never a decrease:

\begin{itemize}
  \item[a.] \textit{Die Temperatur steigt von 3 auf 10 Grad.} \\
  the temperature rises from 3 to 10 degrees \\
  'The temperature is rising from 3 to 10 degrees.'
  \item[b.] *\textit{Die Temperatur steigt von 10 auf 3 Grad.} \\
  the temperature rises from 10 to 3 degrees \\
  lit.: 'The temperature is rising from 10 to 3 degrees.'
\end{itemize}
**steigen**\textsubscript{directional} vs. **steigen**\textsubscript{figurative}

**steigen**\textsubscript{directional}

- motion along a path scale
- no manner component
- only upwards
- dir-comp optional

**steigen**\textsubscript{figurative}

- "motion" along a quality scale
- no manner component
- only upwards/increase
- dir-comp optional
Frames of \textit{steigen} \textsubscript{directional} \textit{vs.} \textit{steigen} \textsubscript{figurative}

\textit{steigen} \textsubscript{directional}: 'the temperature is rising'

\textit{steigen} \textsubscript{figurative}: 'die Temperatur steigt'

steigen\textsubscript{figurative}: generalized frame and external attribute realization by the subject

die Temperatur der Flüssigkeit steigt
'\textit{the temperature of the liquid is rising}'

'\textit{the temperature of the liquid}'
steigen_{figurative}: generalized frame and external attribute realization by the subject

die Temperatur der Flüssigkeit steigt
' the temperature of the liquid is rising'

' the temperature of the liquid'
steigen<sub>figurative</sub>: generalized frame and external attribute realization by the subject

die Temperatur der Flüssigkeit steigt
'the temperature of the liquid is rising'
Conclusion

• An adequate analysis of the major uses of *steigen* requires explicit reference to the "anatomical" details of these uses such as subevents, manner, positions and the overall path traversed by the theme argument.

• Frame representations show a flexible degree of complexity (zooming in and out by expanding/not expanding nodes) which allows for easy access to the relevant details of each use.
Conclusion

• The relationships that hold between the different uses can be analyzed by comparing the structures of the corresponding frames.

• The figurative use of *steigen* can be derived from the directional use by a minimal modification of the frame for directional *steigen* which allows for the integration of an attribute contributed externally by the subject.