Part-Whole Modifiers and the *-Operator

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The Idea

- German part-whole-modifiers (PWMs) as exemplified by 'ganz' ('whole') exhibit an interesting pattern of ambiguity
- German PWMs co-occur with singular count nouns (SCN)

(1) *Er aß den ganzen Brotlaib.*
he ate the *ganz* loaf.of.bread

- but also mass nouns:

(2) *Er aß das ganze Brot.*
he ate the *ganz* bread

- and plural count nouns (PCN):

(3) *Er aß die ganzen Brote.*
he ate the *ganz* breads

The Issue

(4) a. *Er aß den ganzen Brotlaib.*
he ate the *ganz* loaf.of.bread
'He ate the whole loaf of bread'

b. *Er aß das ganze Brot.*
he ate the *ganz* bread
(i) 'He ate all the bread.'
(ii) 'He ate the loaf of bread which was whole.'

c. *Er aß die ganzen Brote.*
he ate the *ganz* breads
(i) 'He ate all the bread.'
(ii) 'He ate the loaves of bread which were whole.'

- mass & plural cases are ambiguous, singular case is not
- Proposal: Ambiguities due to syntactic scope interaction between 'ganz' and the plural operator * (cf. Link 1983).

Parallel ambiguities

Mass noun:

(5) *das ganze Brot*
the whole bread.sg
a) all the bread'
b) 'the whole loaf of bread'

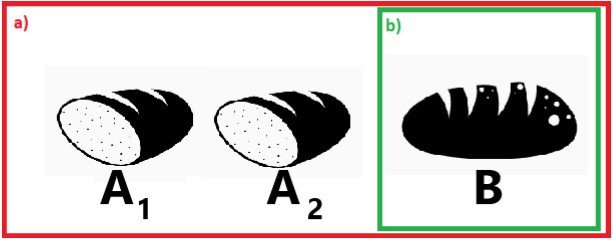


Figure 1: Context 1

Introduction - Parallel ambiguities

Plural:

(6) *die ganzen Brote*
the whole bread.pl
a) 'all the bread'
b) 'the whole loaves of bread'

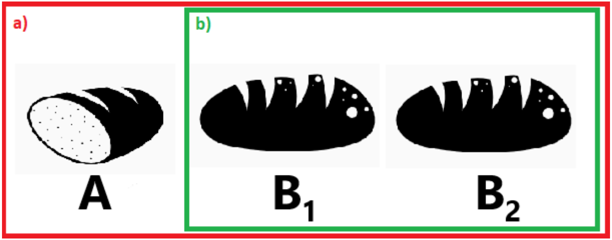


Figure 2: Context 2

Parallel ambiguities

- refer to the readings where ‘ganz’ is cognate with ‘all’ as **universal readings** and the ones where ‘ganz’ makes references to ‘wholeness’ as **integrity readings**.

(7) *das ganze Brot*
the whole bread
a) ‘all the bread’ (**universal**)
b) ‘the whole (loaf of) bread’ (**integrity**)

(8) *die ganzen Brote*
the whole bread.pl
a) ‘all the bread’ (**universal**)
b) ‘the whole (loaves of) bread’ (**integrity**)

Framework

- Context: exactly three heroes exist; $[\![\text{hero}]\!] = \{\textit{Allison, Klaus, Vanya}\}$
- Mereology (Champollion & Krifka 2016)
  - parts, single entities and pluralities are all type $\langle \boldsymbol{e} \rangle$
  - D_e is **closed** with regards to a 'join'-operation$\oplus$:
    $\forall x, y \in D_e : x \oplus y \in D_e$
  - D_e is partially ordered according to 'part of'-relation $<$:
    Vanya's arm $<$ *Vanya* $<$ *Vanya*$\oplus$*Klaus*
- Plural Predication:
  - *-Operator, restricted by a cover (Schwarzschild 1996, Brisson 2003)
  - $[^*{}_{\text{Cov}}]_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}.\forall P \in D_{\langle e,t\rangle}, x \in D_e : [^*P](x) = 1$ **iff**
    $[P](x) = 1$ **or** $\exists x_1, x_2 \in \text{Cov}$ s.t. $x = x_1 \oplus x_2, [^*P](x_1) = [^*P](x_2) = 1$
  - Assuming A,K,V $\in [\![\text{Cov}]\!]$:
    $[\![{}^*\text{hero}]\!] = \{\textit{Allison; Klaus; Vanya; } A \oplus K; A \oplus V; K \oplus V; A \oplus K \oplus V\}$

Framework

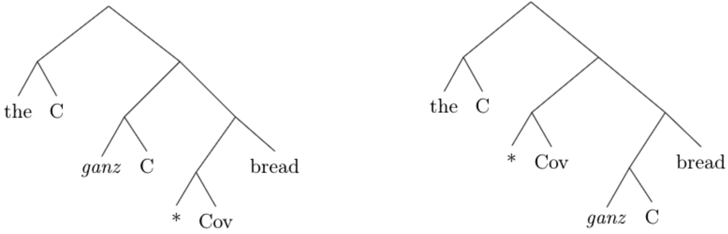
- Definite Determiner has a maximal interpretation (Sharvy 1980, Link 1983, this version modeled on Schwarz 2013):
  - maximizing function σ picks out the maximal element of a given set: $\sigma = \lambda P_{\langle e,t \rangle}.\lambda x_e.P(x) \& \forall y : P(y) = 1 \rightarrow y < x$
  - Def.Det. presupposes existence of unique maximum and picks it out $[\llbracket \text{the}_{\text{pl}} \rrbracket] = \lambda P_{\langle e,t \rangle} : \exists ! x[\sigma(P)(x) = 1].\iota x[\sigma(P)(x) = 1]$
  - $\llbracket$*hero$\rrbracket$ = $\{Allison; Klaus; Vanya; A \oplus K; A \oplus V; K \oplus V; A \oplus K \oplus V\}$
  - $[\textit{the heroes}]$
    $= [\textit{the}[^{*}\textit{hero}]]$
    $= \iota x[\sigma([^{*}\textit{hero}])(x)]$
    $= \iota x[[^{*}\textit{hero}](x) \& \forall y [^{*}\textit{hero}](y) \rightarrow y < x]]$
    $= \boldsymbol{A} \oplus \boldsymbol{K} \oplus \boldsymbol{V}$
- For further background on plurality cf. Lasersohn (1989), for PWMs cf. Brisson (2003), Morzycki (2002), Wagiel (2018)

A Lexical Entry

- Lexical entry for ‘ganz’ requires several ingredients:
  - **Contextual restriction C** (Moltmann 1997, Brisson 2003): part structures and perception of ‘wholeness’ vary situationally
  - **Accessible Parts Requirement ACC** (Moltmann 1997) ‘ganz’ (like ‘whole’) with SCN is odd in contexts where ‘wholeness’ is not in question (cf. (9))
    - ACC(x)(C) = 1 iff $\exists x_1 \ldots x_n \in C : x = x_1 \oplus \ldots x_n$
    - (9) ?He plucked the whole flower.
  - the **actual semantic contribution** of what it means for an entity X to be ‘ganz P’ in a context C is encoded as [*whole*](C)(P)(x); and left deliberately vague for now
- (10) ganz $= \lambda C \in D_{\langle e,t \rangle}.\lambda P \in D_{\langle e,t \rangle}.\lambda x_e$:ACC(x)(C). $[P(x)\&[whole](C)(P)(x)]$

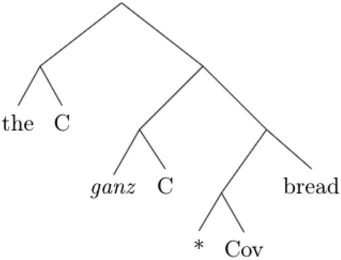
Solving the Issue via Scope Ambiguity

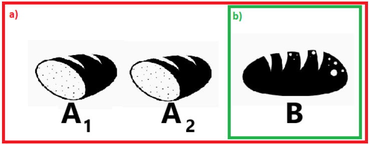
- (11) a. $[\![\text{ganz}]\!] = \lambda C \in D_{\langle e,t \rangle}.\lambda P \in D_{\langle e,t \rangle}.\lambda x_e$:ACC(x)(C).$[P(x) \& [\mathit{whole}](C)(P)(x)]$
  b. $\forall P \in D_{\langle e,t \rangle}, x \in D_e : [*P](x) = 1$ **iff** $[P](x) = 1$ or $\exists x_1, x_2 \in \text{Cov}$ s.t. $x = x_1 \oplus x_2, [*P](x_1) = [*P](x_2) = 1$
- both $[\![\text{ganz}_C]\!]$ and $[^*{}_{\text{Cov}}]$ are of type $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$
- * is a covert operator, its position in the LF is unclear
- e.g. for the singular case ‘das ganze Brot’:



(a) *ganz* >* (b) * >*ganz*

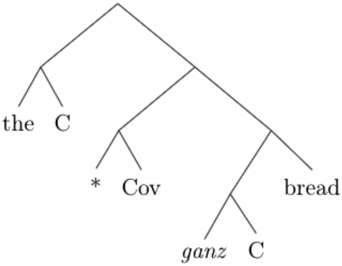
Example Calculation (*universal, singular*)

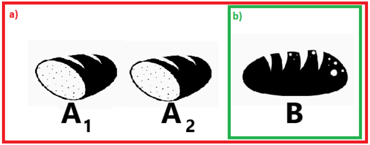




(12) $[\text{the}][\text{ganz}[{}^{*}\text{bread}]] =$
$[\text{the}][\lambda x.[{}^{*}\text{bread}](x) \& [\textit{whole}](C)([{}^{*}\text{bread}])(x)]] =$
the unique individual x s.t. $[{}^{*}\text{bread}](x) \& [\textit{whole}](C)([{}^{*}\text{bread}])(x)$
$\& \forall y \in C[[{}^{*}\text{bread}](y) \rightarrow y < x]$
'the unique individual x s.t. x is a quantity of bread, is whole as a quantity of bread, and contains all other quantities of bread in C'
$\triangleq \boldsymbol{A_1 \oplus A_2 \oplus B}$ (**universal reading**)

Example Calculation (*integrity, singular*)

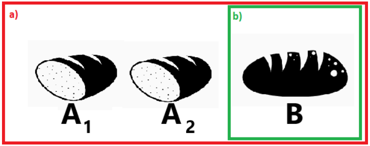


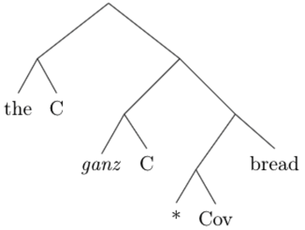


(13) $[\text{the}][{}^{*}[\text{ganz}[\text{bread}]]] =$
$[\text{the}][{}^{*}[\lambda x.[\text{bread}](x)\&[\textit{whole}](C)([\text{bread}])(x)] =$
the unique individual x s.t. $[{}^{*}[\text{bread}](x)\&[\textit{whole}](C)([\text{bread}])(x)]$
$\&\forall y \in C[[{}^{*}[[\text{bread}](y)\&[\textit{whole}](C)([\text{bread}])(y)]]] \rightarrow y < x]$
'the unique individual x s.t. x is a plurality of whole loaves of bread, and any other such plurality is contained in x'
$\triangleq$ ***B*** **(integrity reading)**

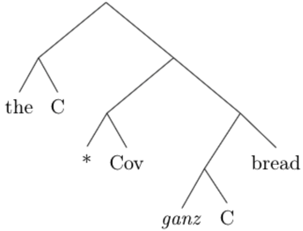
Taking Stock

(2) *das ganze Brot*
the whole bread.sg
a) 'all the bread'
b) 'the whole (loaf of) bread'





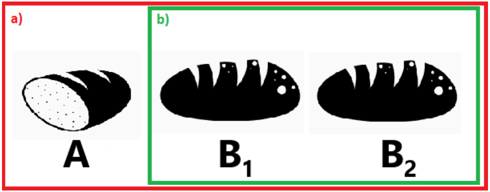
(a) universal reading



(b) integrity reading

The Plural Case

(14) *die ganzen Brote*
the whole bread.pl
a) ‘all the bread’ (**Universal**)
b) ‘the whole (loaves of) bread’ (**integrity**)



As long as both NPs are defined, the analysis predicts identical truth conditions for the singular and plural case - the calculations remain the same.

The Plural Case

(15) $[\![\text{the}]\!][\![\text{ganz}[{}^{*}\text{bread}]]\!] =$
$[\![\text{the}]\!][\![\lambda x.[\![{}^{*}\text{bread}]\!](x)\&[\![\textit{whole}]\!](C)([\![{}^{*}\text{bread}]\!])(x)]\!] =$
the unique individual x s.t. $[\![{}^{*}\text{bread}]\!](x)\&[\![\textit{whole}]\!](C)([\![{}^{*}\text{bread}]\!])(x)$
$\&\forall y \in C[[\![{}^{*}\text{bread}]\!](y) \rightarrow y < x]$
'the unique individual x s.t. x is a quantity of bread, is whole as a quantity of bread, and contains all other quantities of bread in C'
$\triangleq \boldsymbol{A} \oplus \boldsymbol{B_1} \oplus \boldsymbol{B_2}$ **(universal reading)**

(16) $[\![\text{the}]\!][\![{}^{*}[\text{ganz}[\text{bread}]]]\!] =$
$[\![\text{the}]\!][\![{}^{*}[\lambda x.[\![\text{bread}]\!](x)\&[\![\textit{whole}]\!](C)([\![\text{bread}]\!])(x)]\!] =$
the unique individual x s.t. $[{}^{*}[\![\text{bread}]\!](x)\&[\![\textit{whole}]\!](C)([\![\text{bread}]\!])(x)]$
$\&\forall y \in C[[{}^{*}[[\![\text{bread}]\!](y)\&[\![\textit{whole}]\!](C)([\![\text{bread}]\!])(y)]]] \rightarrow y < x]$
'the unique individual x s.t. x is a plurality of whole loaves of bread, and any other such plurality is contained in x'
$\triangleq \boldsymbol{B_1} \oplus \boldsymbol{B_2}$ **(integrity reading)**

Predictions

- parallel analyses for singular and plural, particularly for universal readings, predict that there should be overlap
- the following pattern can be observed:

		
singular 'das ganze Brot'	Universal (a) ✓ Integrity (b) ✓	Universal ✓ Integrity X
plural 'die ganzen Brote'	Universal ✓ Integrity ?	Universal ✓ Integrity ✓

- as seen in the calculations above, the analysis correctly predicts the outcomes in the green cells
- the remaining universal cases are also predicted by the analysis, as singular and plural case have identical truth conditions
- it remains to be shown that the cases marked with X and ? are also predicted

Testing Predictions

- tackle the stronger case first:

(17) ‘das ganze Brot’

- In this context, (17) only allows for the universal reading. Analysis predicts this, as the integrity reading would lead to PSP failure:

(18) a. $[\text{the}_C][\text{ganz}[*_{\text{Cov}}[\text{bread}]]]$ **Universal**
b. $[\text{the}_C][*_{\text{Cov}}[\text{ganz}_C[\text{bread}]]]$ **Integrity**

  - PSP of [the] in (18-a): a unique maximal quantity of bread exists ✓
  - PSP of [the] in (18-b): a unique maximal loaf of bread exists X

Testing Predictions

(19) 'die ganzen Brote'

- strongly favors universal reading, but allows for integrity reading (e.g. if the speaker is ignorant regarding the number of whole loaves)
- suggests that knowing use of the plural where the singular would be felicitous is odd due to pragmatic effects

Testing Predictions

(20) 'die ganzen Brote'

- a closer look at (20)'s PSP (particularly of the definite determiner) shows how this is predicted by the analysis[1]
  - PSP of (20) under the integrity reading: $\exists! x \in C[{}^{*}[\text{ganz bread}](x)] \& \forall y[[{}^{*}[\text{ganz bread}]](y) \rightarrow y < x]]$
  - $[{}^{*}[\text{ganz bread}]](x) = 1$ *iff* $[[\text{ganz bread}](x) = 1$ **or** $\exists x_1, x_2 \in C \text{s.t.} x = x_1 \oplus x_2, [{}^{*}[\text{ganz bread}]](x_1) = [{}^{*}[\text{ganz bread}]](x_2) = 1]$
- recall PSP in the singular case: a unique whole loaf of bread exists
- the plural case allows for *either* a unique loaf **or** a unique quantity of loaves
- the plural PSP is strictly entailed by the singular's, if the latter is felicitous, the former is a violation of max-PSP (Heim 1991)

[1] ACC is trivially met in plural and mass noun constructions and can safely be ignored

What it means to be ‘whole’

- vague notion of ‘wholeness’ in the analysis is doing a lot of work, while at the same time being hard to pinpoint
- what is considered ‘whole’ varies from situation to situation - as such, any definitive definition has to leave room for vagueness
- Assumption: an entity x is perceived as a ‘whole P’ if it is not recognized as part of some larger P-entity

(21) $[[\![whole]\!](C)(P)(x)] = 1$ iff $\nexists y \in C'[x < y \& P(y)]$

- C' is a superset of the restrictor C, derived by ‘completing’ all things with missing pieces and closing the set with regards to $\oplus$. E.g., If C contains a table leg x, C' contains the other legs and the table top, as well as the entire table and x itself.

Semantic Contribution of 'ganz'

- the actual semantic contribution of 'ganz' has not been discussed so far
- completeness markers such as 'whole' and 'all' are generally analyzed in terms of (non-)maximality. Classic example from Lasersohn (1999):

(22) a. The townspeople are asleep.
b. All the townspeople are asleep.

- (21-a) can still be judged true if a few townspeople are still awake (non-maximality), (21-b) allows no exceptions
- Previous approaches to non-maximality include influencing the cover variable (Brisson 2003, Morzycki 2002), or intensional approaches (Moltmann 1997, Križ 2016)

Semantic Contribution of ‘ganz’

(23) $[\llbracket whole \rrbracket(C)(P)(x)] = 1$ iff $\nexists y \in C'[x < y \& P(y)]$

- Analysis correctly predicts blocking of non-maximal interpretation:
  - Definition of C’: contains ‘missing parts’; *closed* w.r.t $\oplus$
    A set S is *closed* w.r.t $\oplus \Leftrightarrow \forall a, b \in S : A \oplus B \in S$

    (24) *Die ganzen Bürger schlafen.*
    the whole citizens sleep
    ‘All the citizens are asleep.’

  - Assume non-sleeping citizen x, let S$=$ $s_1 \oplus \ldots s_n$ all the sleepers.
  - $S \oplus x \in C'$ (C’ is closed w.r.t $\oplus$)
  - Non-maximal interpretation (applying the predicate only to S) is not available:
    - S $<$S $\oplus x$
    - S $\oplus x \in C'$
    - $[^{*}\text{citizen}](S \oplus x) = 1$
  - Calculation only returns true if every last citizen is asleep

Conclusion

- Concession: satisfactory definition of 'ganz' requires the assumption of a naturally understood/understandable concept of 'wholeness' - however this is encoded
- Structural analysis correctly predicts pattern of availability of the two readings across the two contexts, for both singular and plural forms
- Evidence that the plural operator * appears in the syntax and can interact scopally with other operators
- Tentatively: wholeness and 'missing parts' as an alternative approach to non-maximality phenomena

Outlook

- assuming a typeshifted $[\![\text{ganz}_R]\!]$, the pattern repeats itself in relational constructions including the **-Operator (Beck 2000)
- $[\![\text{ganz}_R]\!]$
  $= \lambda C_{\langle e,t\rangle}.\lambda R_{\langle e,\langle e,t\rangle\rangle}.\lambda x_e.\lambda y_e : \text{ACC}(y)(C).R(x)(y)\&[\textit{whole}](C)(P)(y)$

(25) *die ganzen Modelle von den Flugzeugen*
the *ganz* models of the airplanes

a. 'all the models of the airplanes'

b. 'the complete(d) models of the airplanes'

c. LF for (a): [the$_C$[ganz$_C$[**$_{\text{Cov}}$ models] [of.the.airplanes]] **universal**

d. LF for (b): [the$_C$ [**$_{\text{Cov}}$ [ganz$_C$ models] [of.the.airplanes]] **integrity**

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