Workshop *Part-Whole Structure and its Reflection in Natural Language*

Université Côte d’Azur

January 23, 2025

**Notions of a Whole in Semantics**

Friederike Moltmann

The aim of the talk

Give a very general, informal overview of notion of a whole that have been used or are important for the semantics of natural language.

1. Notions of a whole in extensional mereology, in particular the notion of an atom

2. Notions of whole based on structural relations among parts: the notions of an integrated whole and of boundedness

3. Notions of wholes prior to parts

----------------------------------------------------------------------------------------------------------------

**1. Notions of a whole in extensional mereology**

**1.1. Assumptions of extensional mereology (Link 1983, Champollion/Krifka 2017)**

Unstructured parts and wholes

Transitive part relation

Entities that share the same parts are identical

Sum formation or fusion *sum*

(1) For a nonempty set P, sum(x, P) =def ∀y(y Ο x 🡨🡪 ∃z(y Ο z & P(z)))

A sum of a set P is a thing such that everything which overlaps with it also overlaps with something in P, and vice versa.

The axiom of the Uniqueness of Sums (extensionality)

Two things composed of the same parts are identical.

(2) Uniqueness of sums: ∀P(P ≠ ∅ 🡪 ∃!z sum(z, P))

**1.2. Sum as notion of a whole in extensional mereology**

Uses of sum formation in semantics

1) Definite NPs:

(3) a. The children: ιx[sum(x, children)]

 b. The water: ιx[sum(x, [*water*])]

2) Non-Boolean conjunction: conjunction interpreted by sum formation (⊕, sum)

(4) a. John and Mary embraced.

 b. The men and the women gathered.

 c. The oil and the vinegar were mixed.

(5) a. E(j ⊕ m)

 b. G(ιxsum(x, M ∪ W))

 c. M(ιxsum(x, O ∪ V))

Issues with the notion of a sum as a notion of a whole

Does not apply to parts of individuals to yield individuals:

(6) a. the hot dog = the sausage and the bun?

 b. The sausage and bun taste similar / ?? costs 4 dollar.

 c. The hot dog tastes similar.

However, non-Boolean conjunctions of adjective conjunctions are applicable to single individuals:

(7) The Italian flag is red, green and white.

Non-Boolean adjective conjunction is domain-neutral:

(8) a. the blue and while pillow

 b. the blue and white pillows

 c. the blue and white laundry

States:

(9) a. John’s being calm and nervous ≠ John’s being calm and John’s being nervous

 b. John’s being calm and John’s being nervous do not go together.

 c. ??? John’s being calm and nervous does not go together

(10) a. John’s hope to win and to become rich makes sense.

 b. John’s hope to win and his hope to become rich make sense.

Conclusion

Sum formation strictly yield entities in the domains of pluralities and quantities, not individuals (denotable by singular count NPs)

Special case: semantics of non-boolean adjective conjunction

**2.3. Atom as a notion of a whole in extensional mereology**

The formal semantics of plurals and mass nouns generally istinguishes three domains each with its own part relation:

The domain of individuals I

The domain of pluralities P

The domain of quantities (or portions or stuff) M

(P, ⊕i) is a join semilattice i.e., (P, <i) is an extensional mereology

(M, ⊕m) is a join semilattice, i.e., (M, <m) is an extensional mereology

(11) For a plural noun extension Npl, Npl = ⊕N

Necessity to distinguish two part relations <i and <m, in addition to the part relation < applying to parts of individuals.

Example: a part of something described as a ‘sum’ is neither a part in the sense of <i nor in the sense of <m, but only in the sense of <.

A part of a plurality is never a part in the sense of < or <m.

Individuals are atoms with respect to <i, but not with respect to <m, and

<m does not apply to pluralities or individuals (except in Link 1983).

The role of the notion of an atom in semantics of singular count, plural, mass nouns

Two notion of an atom:

(12) a. For a singular count noun extension N:

 for all x, if N(x), then x is an atom with respect to <i.

(13) a. atom(x) =def  ¬∃y(y < x & x ≠ y)

 b. For a set N, atom(x, N) =def  ¬∃y(y ∈ N & y < x & x ≠ y)

Potential problems

Sequence-type nouns:

continuous parts of sequences are again sequences; similarly for sums, entities, quantities, fences, walls, Russian dolls

These do not actually pose a problem for (12a):

A part of a sequence is not a part in the sense of <i, but only in the sense of <, since a sequence is not a proper plurality.

A sequence and its parts thus are atoms – with respect to <i!

(Potential) motivations for a single part relation (Moltmann 1997)

1. Domain-neutral special quantifiers:

(14) a. What is in the bag? An apple, some bread, some coins

 b. John ate something, bread, an apple, or some peas.

2. Modifiers with domain-independent part structure-related content

Part structure-sensitive adjectives

(15) a. the frequent rain

 b. the frequent rainfalls

Lexical condition of temporal separation of parts, in the generalized sense of ‘part’

Worries about the notion of an atom:

1. Does the notion of atom really account for countability, for being a single object?

What is wrong with counting parts of Russian dolls etc…

2. Extensional mereology with its distinction into plural-specific and mass-specific domains involves strictly language-dependent part structure, dependent on the use of plural or mass categories.

------------------------------------------------------------------------------------------------------------

**2. Structured Wholes**

**2.1. Problems for extensionality**

Different structural or functional wholes with the same parts:

Collection of lines – triangle

Wood – chair

Wood – pile of wood

Water – puddle of water

Plurality of people – committee

Committee 1 – committee 2

Rain – rain fall

Structural wholes / integrated wholes

Wholes as built from parts and structural relations among them.

**2.2. Notions of structure**

Spatial relations among parts (for material objects)

Temporal relations among parts (for events)

Function of parts with respect to the function of the whole (e.g., committee)

A simple notion of an integrated whole:

A maximally self-connectedness entity (R-integrated whole) (Simons 1987, Moltmann 1997)

(17) R-integrated whole

 For a symmetric, reflexive non-formal relation R, for the transitive closure Rtrans of R:

 X is an R-integrated whole if for any y, z, y <x, y < x, y Rtrans z and for no y, z, y < x,

 ¬z < x, y Rtrans z.

(18) Transitive closure of a relation R

 For a relation R, x Rtrans y iff for entities x1, … xn, x R x1 & x1 R x2 … & xn R y

Examples of relations R

Spatial contiguity, temporal contiguity, kinship relation

Being part of the same class, family, committee

Special case of an F-integrated whole:

(19) FF-integrated whole: based on a relation FF based on a property F

 x FF y iff F(x) and F(y).

Examples

(20) a. the blue things

 F = being blue.

 b. The children in the garden

 F = child in the garden

Some linguistic applications

The readings of part-related predicates *compare* and *distinguish* (Moltmann 1997)

FF-integrated wholes:

(21) a. John cannot distinguish the boys and (the) girls.

 b. Mary compared the blue and green balls.

R-integrated wholes

(22) a. Mary compared the furniture.

 b. Mary compared the furniture in the two rooms.

R: be in the same room as

The meaning of *times* (Moltmann 1997)

(23) a. John came several times today.

 b. John slept several times today.

General questions

Are integrated wholes always objects?

Perhaps not:

Pluralities that are integrated wholes

Quantities that are integrated wholes

Application to the mass-count distinction

(24) a. For a singular count noun N, if N holds of an entity x, then x is an (essential)

 integrated whole.

 b. For a singular count noun N and a reference situation, if N holds of an entity x, then x

 is an integrated whole in s (Moltmann 1997)

 c. For a singular count noun N, N conveys a property of integrated wholes.

Langacker (1987):

(25) If a singular count noun holds of an entity x, then x is a bounded region in some

 dimension.

The mass-count distinction for parts:

*Part of* vs. *a part of* (e.g., Moltmann 1998)

(26) a. John and Mary are part of the class.

 b. ?? John and Mary are a part of the class.

(27) a. Sugar is part of lemonade

 b. ??? Sugar is a part of the lemonade.

(28) a. Joe ate part of the apple.

 b. ?? Joe ate a part of the apple.

Notions of integrated wholes play also roles in choices of nominalizations for verbs or adjectives, conversions of mass nouns to count nouns and conversely

General worries:

1. Is integrity necessary for something to count as a single thing, be ‘one’

(29) a. the quantities of water in this glass,

 b. the amount of water the body consists in

 c. the portions of rice on this late

Singular count nouns may convey merely conceived integrity? (Langacker 1987, Moltmann 1997)

2. Even pluralities and quantities may be structured or integrated wholes, without counting as ‘one’

(30) a. John cannot distinguish / ??? count the rice and the beans. (counting two)

 b. ??? The students are one of the people I presented my work to.

 c. The students are among the people I presented to.

**----------------------------------------------------------------------------------------------------------------**

**3. Wholes prior to the parts**

Sometimes wholes seem to be prior to parts.

**3.1. Functional parts**

Door knobs, doors, handles: cannot be understood without a conceived whole

**3.2. Cases of failure of transitivity of the part relation**

Invalid:

(31) John is part of the class
 John’s leg is part of John.

 John’s leg is part of the class.

Valid:

(32) The arm is part of the body.

 The hand is part of the arm.

 The hand is part of the body.

Invalid:

(33) The page is part of the book.

 The book is part of the library.

 The page part of the library.

Valid:

(34) The page is part of Goethe’s written work.

 The book is part of Goethe’s written work

 The page part of Goethe’s written work.

It is not just the integrity of the intermediary entity that s transitivity; rather the whole determines what its parts are.

*Written work* as mass nominal allows for transitivity, to some extent, but not for inferences with ‘the empty pages of the book’, ‘the margins of the page’, etc.

Potential ways of dismissing problems for transitivity

1) dismiss functional parts as the only parts

Issue: what is the intuitive basis for the part relation, if not the applicability of *part of*?

2) distinguish different part relations, for different ontological levels:

Part relation for individuals, part relation for pluralities, part relation for stuff

Issue: transitivity problems arise within the level of individuals, of pluralities, and of quantities as well.

**3.3. Expressions of completion**

Expressions of completion may make reference to particular kinds of wholes

Two words for ‘complete’ in German: *voellig* and *vollstaendig*

(35) a. die vollstaendige Uebersetzung

 ‘the complete translation‘

 b. ??? die voellige Ubersetzung

(36) a. die voellige Dunkelheit

 ‘the complete darkness‘

 b. ??? die vollstaendige Dunkelheit

*Vollstaendig* involves a reference object with discrete parts, but not so *voellig*, wich relates to a homogenous part structure.

**3.5. Completion-related absence**

Absence of something that should be there in order for something else to be complete.

Completion-related predicates of absence:

English: *lack, be missing*, German: *mangeln, fehlen*, French: *manquer*, Italian: *mancare*

Completion-related verbs of absence are intensional transitive verbs:

Existential quantification does not go through:

(11) a. The door lacks a key.

 b. There is a key x, the door lacks x.

*Lack* does not just mean absence, but is a modal notion

lack ≠ not have:

(15) a. Mary has a ponytail.

 b. ?? Mary lacks a ponytail.

(16) a. The house has a balcony.

 b. ?? The house lacks a balcony.

(17) a. John has a daughter.

 b. ??? John lacks a daughter.

(19) a. John has a painting by Picasso

 b. ??? John lacks a painting by Picasso.

Unlike have, *lack* is a modal notion, involving a weak form of necessity:

When acceptable, (15b) entails:

(20) Mary should have a ponytail.

When acceptable (17b) entails:

(21) John should have a daughter.

Application condition for *lack*

*Lack* relates to a conceptual whole and presupposes that that conceptual is not fully manifested or realized.

The whole *lack* relates to need not have objects as its realizations:

The whole may be constituted instead by relations of possession, kinship, friendship:

(22) a. John lacks a car.

 b. John lacks a father.

 c. Mary lacks a close friend.

The conceptual whole lack relates to may also be a plurality:

(23) a. The students were in the hallway, but John was missing.

 b. Bill saw the students, but John was missing.

More related issues

*Have* and *lack* can also relate an individual to a quality:

(24) a. Joe has wisdom.

 b. Joe lacks wisdom.

(25) a. Mary has talent.

 b. Mary lacks talent.

(26) a. Mary’s lack of understanding was astonishing.

 b. Mary’s lack of attention to details ruined the project.

Particularized qualities (tropes) are not really parts of objects

Parts of material objects: spatial parts

Parts of events: temporal parts

Tropes are not spatial or temporal parts!

Location-related *lack*:

(27) a. There is a lack of water

 b. There is water.

Generalization

*Lack* involves the notion of an integrated wholes that is itself not tied to single objecthood.

More general conclusion

The notion of an integrated whole is independent of the notion of a single object.

**3.4. Predicates of replacement**

Replacement can apply only to well-delimited, often functional parts:

(28) Mary replaced the wheel / the table top / the screw.

*Replace* cannot apply to qualities, surfaces, appearances of objects:

(29) ??? Mary replaced the color / the texture / the weight / the surface / the appearance of

 the object.

Replacement means taking away a structural or functional part and putting a similar or equivalent object in its place.

------------------------------------------------------------------------------------------------------------

**Conclusions**

1. The notion of a whole available in extensional mereology is clearly insufficient for the semantics of natural language, if not problematic in the first place.

2. The notion of an integrated or structural whole as a whole built from parts and relations among parts plays an important in natural language.

3. In addition, a notion of a whole that is prior to the parts plays an important role in phenomena that so far have received much less attention.

-------------------------------------------------------------------------------------------------------------

**References**

Champollion, L. and M. Krifka (2017): *Mereology*. In P. Dekker and M. Aloni (eds):

 *Cambridge Handbook of Semantics*. Cambridge UP, Cambridge.

Langacker, R. (1987):‘Nouns and Verbs‘. *Language* 63.1., 53-94.

Link, G. (1983): ‘The Logical Analysis of Plurals and Mass Terms: A Lattice-theoretical

 Approach’. In R. Bäuerle et al. (eds): *Meaning, Use and Interpretation of Language*. De

 Gruyter, Berlin, 303–323.

Moltmann, F. (1997): *Parts and Wholes in Semantics*. Oxford UP, Oxford.

---------------- (1998): ‘Part Structures, Integrity, and the Mass-Count Distinction’. *Synthese*

116(1), 75–111.

Simons, P. (1987): *Parts. A* *Study in Ontology.* Oxford UP, Oxford.

Zimmermann, E. (2014): ‘What it Takes to be Missing’. In D. Gutzman et al. (eds.):

 *Approaches to Meaning*. Bill, Ebook Central.