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Intensional Relative Clauses and the Notion of a Variable Object

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1. The puzzle

Apparent trope-referring terms with intensional relative clauses

- (1) a. The number of people that fit into the bus exceeds the number of people that fit into the car.
- b. The impact of the book John needs to write must be greater than the impact of the book he has already written.

Trope-referring terms (Aristotle, Woltersdorff, Strawson, Lowe, Williams, Campbell, Bacon)

Qualitative tropes:

- (2) a. the wisdom of Socrates
- b. the originality of the book
- c. the elegance of the dress

Quantitative tropes (Campbell 1990, Moltmann 2009):

- (3) a. the number of planets (Moltmann, to appear a)
- b. the weight of the book
- c. the height of the building
- d. the temperature in the room

The range of apparent trope-referring terms with intensional relative clauses

- (4) a. the number of books John wants to write (attitude verb)
- b. the height of the desk John needs (transitive intensional verb)
- c. the number of screws that are missing (intransitive intensional verb)
- d. the length of the time John might be away (modal verb)

- e. the number of bottles of wine John bought (on the internet) (transitive intensional verb)
- (5) a. the originality of the book John wants to write
 b. the simplicity of the dress Mary needs for the occasion
 c. the wisdom of the director the institutes should hire

Several issues

What do the NPs stand for, can they stand for tropes?

Which predicates do they accept?

When is a modal in the main clause required?

What is the compositional semantics of the relative clause construction?

2. Common assumptions about tropes and linguistically manifest properties of tropes

2.1. The relation of a trope to its bearer

A trope is a particular feature of a real object; it is a concrete as its bearer.

Dependence of a trope on a bearer (ontological dependence)

A trope exists in a world w at a time t only if its bearer exists in w at t .

Two tropes are identical only if their bearers are identical.

2.2. Similarity relations

Tropes instantiating the same property are similar.

Tropes instantiating the same natural property are exactly similar.

The same as expressing similarity:

- (6) a. The quality of this fabric is the same as the quality of that fabric.
 b. The impact of John's book was the same as the impact of Bill's book
 c. The number of women is the same as the number of men
 d. The height of the desk is the same as the height of the lamp.

The *is* of numerical identity:

- (7) a. ?? The quality of this fabric is the quality of that fabric.
 b. ? The impact of John's book was the impact of Bill's book.
 c. ?? The number of women is the number of men.

d. ?? The height of the desk is the height of the lamp.

2.3. Standard properties of concreteness

Tropes act as objects of perception (in fact as the immediate objects of perception (Williams, Campbell, Lowe)):

- (8) a. John noticed the simplicity of the dress.
 b. John observed Mary's politeness.
 c. John noticed the small number of women that were present.

Tropes as relata of causal relations:

- (9) a. The heaviness of the bag she was carrying made Mary exhausted.
 b. The number of passengers caused the boat to sink..
 c. The weight of the lamp caused the table to break.

More problematic: the spatio-temporal location / extension of tropes:

- (10) John's happiness lasted only a year.
 (11) a. ?? John's happiness was in Munich
 b. ?? John's heaviness on the table

2.4. Other properties of concreteness

Description-independence

Tropes generally have an internal structure 'below' the description used to refer to them:

- (12) a. John described Mary's beauty.

Contrast: states, facts:

- b. ?? John described (the state of) Mary's being beautiful.
 (13) a. John compared Mary's beauty to Sue's beauty.
 b. ?? John compared (the state of) Mary's being beautiful to (the state of) Sue's being beautiful.

Measurable extent

Tropes may have a measurable extent; facts / states / states of affairs cannot have a measurable extent.

- (14) a. Mary's happiness exceeds Bill's.
 b. * The fact that Mary likes Bill exceeds the fact that Mary is tall.
 c. * The state of Mary's liking Bill exceeds the state of Mary's being tall.

Tropes referred to with the help of predicates, however determinable, unspecific, quantificational, are always maximally specific, but not so states, fact, or states of affairs. There are no determinable tropes.

2.5. Quantitative comparison and evaluation of tropes

Tropes share properties of quantitative comparison with their bearers.

Predicates of 'quantitative', 'neutral' comparison: *exceed* and *equal*

- (15) a. John exceeds Mary in eagerness.
 b. John equals Mary in sloppiness.
- (16) a. The eagerness of John exceeds the eagerness of Mary.
 b. The sloppiness of John equals the sloppiness of Mary.
- (17) a. ?? The property of being very eager exceeds the property of being not so eager.
 b. ?? The property of being extremely sloppy exceeds the property of being somewhat sloppy.
- (18) a. The height of John exceeds / equals the height of Mary.
 b. John exceeds / equals Mary in height.
- (19) a. The number of men exceeds the number of women.
 b. The men exceed the women in number.
 c. The number 13 ?? exceeds / ok is greater than the number 8.

Predicates of quantitative evaluation:

- (20) a. The eagerness of John is great.
 b. ?? The property of being very eager is great.
 c. ?? John is great in eagerness.
- (21) a. The number of participants is high.
 b. ?? 100 is high.

3. Trope-reference with intensional relative clauses

Evidence for a trope-reference

Predicates of perception and causation:

- (22) a. John noticed the number of screws that are missing.
 b. The number of screws that are missing caused the table to fall apart.

- c. Mary was astonished by the length of the paper John needs to write
- b. Mary noticed the amount of repair that is required to make the machine work again.

Predicates of similarity and identity:

- (23) a. The number of women in the room is the same as the number of men in the room.
- a'. ?? The number of women in the room is the number of men in the room.
 - b. The number of books Mary wants to write is the same as the number of books Sue wants to write.
 - b'. ?? The number of books Mary wants to write is the number of books Sue wants to write.

Predicates of quantitative comparison and evaluation:

- (24) a. The originality of the book John wants to write exceeds by far the originality of any book John has so far written.
- b. The elegance of the dress that the bridesmaid needs should not exceed the elegance of the dress that the bride will wear.
 - c. The height of the desk John needs exceeds the height of the desk John is using right now.
 - d. John compared the number of books Mary wants to write to the number of books Sue wants to write.
- (25) a. The number of people that fit into the bus is high.
- b. The amount of work John has to do is enormous.

4. Functional uses of NPs and the individual-concepts approach

4.1. Reference to individual concepts

Standard examples

- (26) a. John changed his trainer.
- b. The temperature is rising.
 - c. The number of students has increased.

Functional uses of trope terms

- (27) a. The beauty of the landscape has changed.
- b. The amount of corruption in this administration has become more noticeable.
 - c. The impact of this book has diminished.

- (28) a. The number of students has increased.
 b. the increasing number of students
- (29) a. The number of teachers sometimes exceeds the number of students.
 b. The increasing number of students causes problems for the current availability of class rooms.

Standard approach (Montague etc):

Functional NPs stand for individual concepts: functions from world-time pairs to objects

Predicates like *change*, *rise*, *increase* apply to individual concepts directly.

Other predicates apply to individual concepts via type-shifting+meaning postulate:

- (30) For any predicate of individuals P and individual concept f,

$$P^{w,t}(f) = 1 \text{ iff } P^{w,t}(f(w, t)) = 1.$$

Other candidates for NPs referring to individual concepts:

Definite NPs with intensional relative clauses:

- (31) a. the assistant John needs to hire (Moltmann 2008)
 b. the gifted mathematician John claims to be (Grosu/Krifka 2007)

4.2. Some problems for the individual-concepts approach

1. Substitution problems

- (32) John changed his trainer.

John changed a function.

Appeal to type of predicate $\langle\langle e \rangle, t \rangle$ vs $\langle\langle e, t \rangle, t \rangle$?

More difficult for trope-referring terms:

Trope-referring terms with standard functional NPs:

- (33) a. The decrease of the number of students caused concern.
 b. The increase in the amount of corruption triggered a revolt.
 c. The impact of the increasing number of students is noticeable.
 d. The rise of the temperature caused the drought.
 e. the responsibility of the president of the US

Substitution problems

- (34) a. ? the change of the function

- b. ? the impact of the function
- c. ? the rise of the function
- d. ? the responsibility of the function

2. Applicability of object-related predicates

- (35) a. John counted the screws that were missing.
 b. John counted the personnel that the company needed to hire.
 c. John counted the things that he needed to buy.

3. The philosophical notion of a trope

Tropes are actual features of real objects.

Functions can be bearers of tropes, but they are generally bearers of very different sorts of tropes.

4.3. The individual concepts approach to NPs with intensional relative clauses: formal issues

‘The book John needs to write’ as an individual concept:

Version 1

Using Grosu/Krifka’s analysis of *the gifted mathematician that John claims to be*

- Type-lift all predicates to predicates of individual concepts and singular terms to terms for individual concepts
- Treat all intensional verbs as operators quantifying over possible worlds
- No reconstruction of ‘book’

Application to the present case (greatly simplified):

(36) $\min (\{f \mid \text{book}(f)\} \cap \{f \mid \text{John need to write } f\})$

(the latter: the set of functions mapping a world w compatible with the satisfaction of John’s needs to an object John writes in w)

Problems:

- Problem of uniqueness (of a book in a given world)
- Excessive use of individual concepts
- Forced to treat all intensional verbs as operators quantifying over words

Version 2

Reconstructing the head noun to the lower position inside the relative clause

(37) The f [for any world w compatible with the satisfaction of John's needs, write^w(John, f(w)) & book^w(f(w))]

Problems:

- Same problem of uniqueness
- Unusual relative clause operator
- Forced to treat all intensional verbs as modal operators quantifying over worlds
- Problem when extending the account to trope terms:
the impact of the books John needs to write: no reconstruction possible, application in upper position impossible (unless *impact* is lifted to predicate of individual concepts)

5. The variable-objects approach

5.1. Fine (1999)'s theory of variable embodiments

Rigid embodiment

Entity whose constituting matter is not replaceable

Example: a particular quantity of water

Variable embodiment

Entity allowing for a replacement of material parts or constituting matter or for different manifestations at different times

Examples: organisms, artifacts, 'the water in the river'

Extension to functional NPs and NPs with intensional relative clauses (p.c.)

The notion of a variable object

Entity that has manifestations as different objects in different circumstances

- 'the president of the US':

variable object that has different manifestations as different people at different times

- 'the book John needs to write':

variable object that has different manifestations as different objects in different non-actual circumstances

General conditions on variable embodiments / variable objects

Existence

A variable object f exist at a time t , in a world w iff f has a manifestation at t in w .

Location

If a variable object f exists at a time t in a world w , then its location at t in w is that of its manifestation at t in w .

Property inheritance

A variable object f has a (time-relative) property P at a time t iff f 's manifestation at t has P .

But also (time-relative) properties involving different manifestations at different times:
properties of change etc.

Trope 'inheritance'

A variable object f bears a trope t in a situation s if its manifestation in s bears a trope t' exactly similar to t in s .

(Or perhaps better (Moltmann, to appear b):

A variable object f bears a trope t in a situation s if its manifestation in s bears t in s .)

5.1. Tropes with variable objects as bearers

The two cases of (single) tropes with variable objects as bearers:

(38) a. the impact of the number of students

b. the increase of the number of students

(39) a. $\text{impact}^{w,t}(e) = \text{the trope with } e \text{ as its bearer that is exactly similar to}$

$\text{impact}^{w,t}(F(e, (w, t)))$.

b. $\text{increase}^{w,t}(e) = \text{the trope that has } e \text{ as its bearer and is the instantiation of the property}$

$\lambda e' [(F(e', w, t_1) \text{ less than } F(e', w, t_2) \text{ less than } \dots \text{ for } t_1, t_2, t_3 < t \text{ and } t_1 < t_2 < t_3 \dots]$

5.2. 'The paper John needs to write' as a variable objectOption 1

The variable object each of whose manifestations is a paper John writes in a world in which John's needs are satisfied.

Problem

A world in which John's needs are satisfied may contain several papers that John writes in that world.

Moreover some of those papers may not qualify as the paper John's needs to write.

The complement of need gives only a partial characterization of the exact need.

Option 2

Make use of situations exactly satisfying John's needs:

The variable object each of whose manifestations is a paper John writes in a situation *s* exactly satisfying John's needs

- Uniqueness relative to a situation of satisfaction
- Situation may impose constraints of the paper John writes in the situation, constraints the speaker need not know.
- The same world may include several situations of satisfaction

What is a need?

Option 1

A (complex) conditions involving John R(j)

- Make such a condition an implicit argument?
No: speaker need to know what the condition consists in.
- Is there a single such condition for all sentences *John needs S*?
Certainly not: different conditions may be associated with different occurrences (relative to different contexts)

The case of nonstative intensional verbs:

promise, buy (as a transitive intensional verb)

(40) a. The paper John promised.

Situations: situations exactly satisfying a particular 'promise' John made

(40) b. The bottle of wine John bought (on the internet)

Situations: situations exactly satisfying a particular 'purchase' John made

Conclusion

The variable object 'the paper John needs to write' is an object that depends on a 'need'.

Semantic question: where does a 'need' come from?

Not a Davidsonian event argument

A recent syntactic proposal:

Need = have a need (Harves /Kayne, to appear)

6. The Modal Compatibility Requirement (MCR)

The MCR

NPs with intensional relative clauses require an appropriate modal in the main clause to ‘access’ the entities in the counterfactual circumstances (Grosu/Krifka 2007, Moltmann 2008)

- (41) a. The impact of the book John needs to write ?? exceeds / ok must exceed / ok might exceed the impact of the book he has already written.
 b. The elegance of the dress the bridesmaid should wear ?? does not exceed / ok should not exceed the elegance of the dress that the bride will wear.

Exemptions from the MCR:

- (42) a. ?? The number of people John might invite exceeds the number of people Mary might invite.
 a’. The number of people that can fit into the bus exceeds the number of people that fit into the car.
 b. The length of the vacation John is allowed to take exceeds the length of the vacation Mary is allowed to take.
 c. The number of papers a student has to write during this program is too high.
 c’. The quality of the paper John must write is ?? very high / must be very high.

Explaining the MCR

The MCR is in place just in case the NP refers to a variable trope that has manifestations only in counterfactual circumstances and the manifestations in those circumstances are not exactly similar.

Notions of a variable trope:

Variable trope with a constant bearer:

- (43) a. The impact of the book has increased.

Variable trope whose variability is driven by the variability of the bearer:

- (43) b. The impact of the book John needs to write
 c. The number of people John might invite

The notion of a variable trope whose variability is ‘driven by’ the variability of its bearer

(44) For a variable object e ,

$\text{impact}^{w,t}(e) = \text{the variable trope } o \text{ such that for any circumstance } s \text{ in which } e \text{ has a}$
 $\text{manifestation } F(e, s), \text{ impact}^{w,t}(F(e, s)) = \text{the manifestation of } o \text{ in } s.$

Explaining the exemption from the MCR

The MCR is not in place in case the NP refers to a simple trope with possibly a variable bearer.

General assumption

A variable object f bears a trope t if every manifestation of f in a situation s bears a trope exactly similar to t in s .

Why are such cases restricted to quantitative tropes?

Tropes of variable objects are subject to the same constraints as tropes of ‘ordinary objects’: they are determinate (not determinable).

Only quantitative tropes are likely to be exactly similar among the tropes of manifestations of variable objects.

Another case of exemption from the MCR: intentional verbs

(45) The originality of the paper John wants to write exceeds the originality of the papers he has so far written.

In (45) *want* acts as an intentional verb, taking an intentional object as argument.

The bearer of the trope is in fact a single intentional object, not a variable object.

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