

On the Ontological Basis for Logical Metonymy

Telic Roles and WORDNET

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Abstract

The analysis of examples of Logical Metonymy, where an event-taking verb is combined a non-eventive object, intuitively involves the recovery or insertion of a missing verb generally known as a Telic Role. For example, for *Mary enjoyed the meal*, an appropriate might be *eat*, i.e. *Mary enjoyed eating the meal*. The question for lexical semantics is where do telic roles reside and how are they accessed? In this paper, we investigate the use of WORDNET, a widely used semantic network, both as an appropriate repository and also as an organization suitable for the recovery or assignment of telic roles.

1. Introduction

The interaction of aspectual verbs such as *begin* or *finish* with simple, non-eventive noun phrases (NPs) has been used to motivate an account of *logical metonymy* in which telic (purpose/function) and agentive (creation) roles are distinguished components of the lexicon, see (Pustejovsky, 1995). Others, e.g. (Lascarides and Copestake, 1995) and (Verspoor, 1997), have highlighted the role of context and convention. Consider (1).

- (1) a. John began the novel (*reading/writing*)
- b. The author began the unfinished novel back in 1962 (*writing*)

(1a) can mean *John began reading the novel*, accessing the functional sense or telic role of *novel*, or *John began writing the novel*, accessing the specific means of creation or agentive role of *novel*. The telic/agentive role ambiguity seen in (1a) can be made less apparent in context, either within the same sentence, as in (1b) above, or through discourse or semantic inference, as in (11) and (12), to be discussed below. Note that there are important constraints, e.g. with respect to boundedness and aspect, on the possible NPs that can appear with *begin*. See (Verspoor, 1997) and the references cited therein for discussion of the relevant factors.

Other verbs such as the subject-experiencer psych verb *enjoy*, or verbs such as *refuse*, exclude the agentive role.¹ For example, contrast (2a) with (1a).

- (2) a. Mary enjoyed the novel (*reading*)
- b. Timmy refused the meal (*to eat*)

In (2b), *refuse* can access the telic role for *meal*, namely *to eat*. However, there is room for ambiguity here; (2b) is also compatible with the interpretation *Timmy refused to accept the meal*, cf. (3) below.

- (3) Timmy refused the present (*accept*)

¹*Enjoy* can take *write* explicitly, as in *Mary enjoyed writing the novel*. But this is not an instance of what Pustejovsky terms "coercion".

In (3), arguably the telic role of *present*, meaning *gift*, is *accept*. However, the same account cannot be posited for *meal*; its basic function (if one exists) is to be consumed or eaten; thus creating a problem for enumeration in lexical representation. In other cases, such as (4), there is no (felicitous) telic role at all.

- (4) a. !John enjoyed the rock
- b. !!John enjoyed the door

A physical object like *rock* has no obvious function. Yet (4a) can be marginally interpreted in the context that some (physical) aspect of the object gave *John* pleasure, e.g. its appearance as in *John enjoyed looking at the rock*. Or we can appeal to other perceptual properties, e.g. the tactile sense as in *the blind man enjoyed touching the rock*. To take one more example, consider (5):

- (5) Mary enjoyed the garden

The prototypical definition of a garden as a pleasing arrangement of plants and other natural (or non-natural) objects admits not only the (putative) telic role *to see* but also a range of other possibilities, illustrated in (6).

- (6) a. Mary enjoyed *seeing* the garden
- b. Mary enjoyed *inspecting* the garden
- c. Mary enjoyed *visiting* the garden
- d. Mary enjoyed *strolling* through the garden
- e. Mary enjoyed *rollerblading* in the garden
- f. Mary enjoyed *sitting* in the garden
- g. Mary enjoyed *dozing* in the garden

The ease of defeasibility of telic roles and the productivity of plausible alternatives is striking. In general, the recovery of appropriate contextual function falls outside the domain of local or specific lexical knowledge. It belongs more appropriately to systems that carry out reasoning and inference about the real world.

In fact, the recovery of contextual function is more ideally suited to ontological networks, which encode general semantic relations between abstract and concrete concepts

in the real world. This paper explores the application of such a network, WORDNET, to this problem. In particular, we will make use of the *isa*, or hypernymy, relation on, assuming (as required) the existence of certain common-sense, or real-world, properties of higher-level concepts, to account for a range of data.²

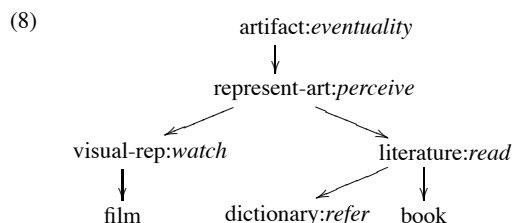
2. Hypernymy

The idea that hypernymy may inform interpretation in logical metonymy has already been hinted at, or tacitly assumed, in several places in the literature. For example, this is apparent from the summary of logical metonymy in the BNC corpus, (Verspoor, 1997), excerpted in (7):

- (7) eat FOOD/MEAL
 drink LIQUID
 tell STORY
 play MUSIC
 read/write WRITTEN_OBJECT
 take MEDICINE/TREATMENT

(The capitalized terms in (7) denote semantically relevant concepts.)

(Lascarides and Copestake, 1995) assume the following telic roles for artifacts:



Finally, (Asher and Pustejovsky, forthcoming) assert the following complex types (\otimes a type constructor):

- (9) a. $p \otimes see$ and $p \otimes hear$ to encode the fact that objects with extension are typically visible, and objects involving sound are typically audible, respectively.
 b. all artifacts inherit a general dependent type that gives their cause.
 c. *wine*: liquid \otimes_T drink (\otimes_T introduces the telic role)
 d. *class*: people \otimes_T teach

In this paper, we explicitly test the hypothesis using the somewhat coarse-grained *isa*-relation available in WORDNET.³ In conjunction with two principles, specificity and locality, defined with respect to hypernymy, we explain

²The idea of using WORDNET on object NPs to pick out contexts in which those NPs represent events on a class-based model is not new. (Siegal, 1998) performed a (medical) corpus study in conjunction with WORDNET to distinguish eventive and stative *have*, e.g. *the patient had a fever* (stative)/*blood loss* (eventive).

³As (Gangemi et al., 2001), have noted, WORDNET's hypernymy relation is a heterogeneous one, merging functional and non-functional *isa*-relations alike, e.g. *isa(tobacco,plant.product)* and *isa(tobacco,street.drug)*.

why telic/agentive roles are available for some cases but not for others. If this is the case, the locus of variation should be in ontological not lexical structure (as suggested by lexical entries such as the following):

- (10) *novel*(y): telic: $\lambda x.read(x,y)$ agentive: $\lambda x.write(x,y)$

In fact, in generative grammar, the lexicon is generally taken to be a repository of exceptions, see (Chomsky, 1965) citing Bloomfield. In this framework, non-idiosyncratic properties are factored out into grammar or further afield. Obviously, the evaluation of properties implicating mechanisms peculiar to language must stay within the domain of the language faculty. Non-language particular properties are perhaps best assimilated to general systems of reasoning and cognition.

Ontological relationships play a large role in lexical semantics and, more generally, semantic inference. Any account of language phenomenon involving the interaction of lexical entries with inheritance and (semantic) class-based behavior falls into this category. Computation involving defensible reasoning and knowledge about the physical properties of objects in the real world should therefore fall outside the scope of the lexicon.

Furthermore, as (11), from (Lascarides and Copestake, 1995), illustrates, telic roles are easily overridden through discourse priming:

- (11) a. He really enjoyed your book (*reading*)
 b. My goat eats anything. He really enjoyed your book (*eating*)

Even in cases where arguably no felicitous telic role exists to be overridden, as in (12a), discourse may play a part in supplying the missing event, as in (12b):

- (12) a. !He enjoyed your shoe⁴
 b. My dog eats everything. He really enjoyed your shoe (*eating*)

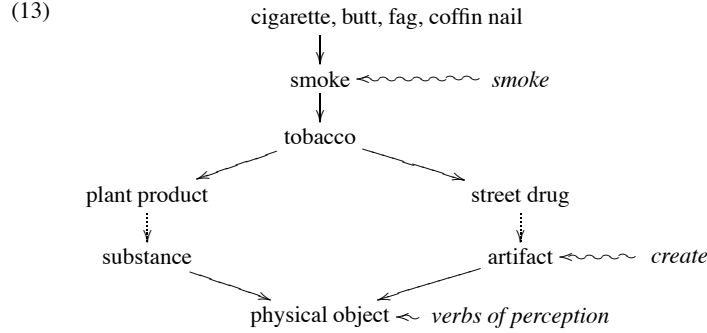
3. The WORDNET Framework

3.1. The Hypernym Hierarchy

In WORDNET, nouns are grouped into synonym sets, known as "synsets", representing single concepts. For example, *cigarette*, *coffin nail*, *butt* and *fag* are generally substitutable, and thus belong to the same synset. Concepts are related through (possibly iterated) application of the hypernymy (" \rightarrow ") or *isa*-relation, illustrated in (13).⁵ Inheritance is strictly unidirectional in this model. For example, *tobacco* may be termed a *street drug*, but the reverse need not be true. Furthermore, multiple inheritance may obtain for some concepts. For example, *tobacco* is a *plant product* as well as a *street drug*.

⁴In the framework described in this paper, *shoe* is a "foot covering". The telic role is *cover(NP,FOOT)*, which is incompatible with prototype *V(PRO,NP)* defined in section 3. The next higher concept is "footwear" with telic role *wear*, perhaps accessed in contexts like *He enjoyed the comfortable shoes you lent him*.

⁵For brevity, a dotted arrow (" \rightarrow ") will sometimes be used to represent a hypernym sequence.

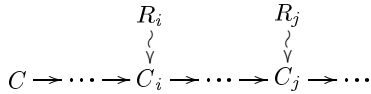


In this paper, we will assume annotation of concepts with characteristic verbs where relevant (to be indicated by “ \leftarrow ”). For example, in (13) *artifact*, defined in the gloss as a “man-made object”, is associated with the verb *create*. Similarly, the noun *smoke* is associated with the related verb *to smoke*.⁶ Finally, the concept *physical object*, defined as “a tangible and visible entity”, is characterized by verbs of perception such as *seelook at* and *touch*.

3.2. Contextual Function Search Rules

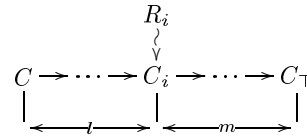
In this paper, we employ two simple principles of contextual function search over the hierarchy outlined above. In the following section, concepts will be denoted by (subscripted) C . R_i will denote a characteristic verb for a concept C_i . Given a noun $N \in C$, we have the rule of preference (14):

- (14) **Principle of Specificity:** Prefer R_i to R_j in the sequence



In other words, prefer a closer role R_i over a more general one R_j in the concept chain. The (one-way) hypernymy relation relates a specific concept to a more general concept, so the closer a matching concept is in terms of the number of links, the more specific it will be. Next, given a noun $N \in C$ and C_\top representing the top or most general concept relative to N , we have the rule of evaluation of the “goodness” of a characteristic verb R_i (15):⁷

- (15) **Principle of Locality:** Plausibility of R_i scales with m and inversely with l in



Scalars l and m represent the length of sequences $\langle C, \dots, C_i \rangle$ and $\langle C_i, \dots, C_\top \rangle$, respectively. The closer C_i is to C (l small), the more plausible R_i will be. On the other hand, if C_i is close to C_\top , m will be small, encoding the intuition that R_i (then) is a general characteristic that is not strongly associated with specific concept C . Rules (14) and (15) operate in tandem. Although the closest concept is always preferred, *ceteris paribus*, it will be deemed implausible or requiring of strong contextual support if it is many links from C or close to C_\top .

3.3. Grammatical Constraints

In what follows, we will consider the problem of determining the value of the verb V in the configuration (16b) given (16a), a restricted version of the telic role determination problem.

- (16) a. EXP enjoy NP
b. EXP_{*i*} enjoy [PRO_{*i*} [V(ing) NP]]

In (16), EXP is the experiencer subject of *enjoy*, NP the object, PRO the controlled subject of V , and V a transitive verb $V(\text{PRO}, \text{NP})$. The twin requirements that the NP as small be the embedded object and that the subject be controlled limits the possibilities for telic roles to appear as V , as will be seen in the next section.

4. Worked Examples

Cigarette: Consider (17).

- (17) Mary enjoyed the cigarette (*smoking*)

Given the hypernym hierarchy in (13), *smoke*(PRO, *cigarette*) is the strongly preferred interpretation since the concept *smoke* is highly specific (l small) and distant from general concepts *artifact* and *physical object* (m large).

Sonata: Consider the possibilities in (18).

- (18) a. Mary enjoyed the sonata (*listening to/playing*)

⁶Concepts in WORDNET have associated glosses. A gloss will typically contain a brief definition and examples of use. In some cases, the characteristic verbs can be inferred from the gloss or from members of the synset. Further exploration of this idea is beyond the scope of this paper.

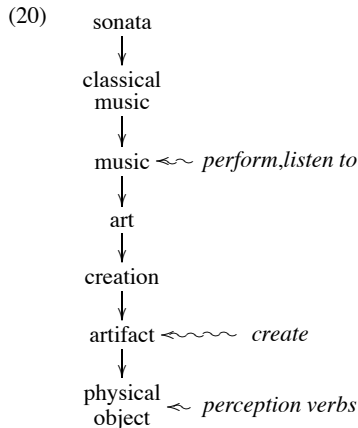
⁷In WORDNET’s hypernym hierarchy there is no unique C_\top concept. For example, *dirt* as *material* and as *gossip* have top concepts *entity* and *act*, respectively. See (34).

b. Mary began the sonata (*playing/composing*)

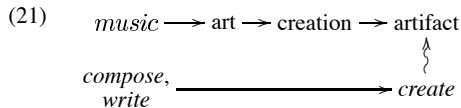
According to (Asher and Pustejovsky, forthcoming), the agentive and telic roles associated with *sonata* are *compose* and *play*, expressed in their type logic notation as (19).

(19) sonata: $(p \bullet i) \otimes_{A,T}(\text{compose}, \text{play})$

The hierarchy for *sonata* is given in (20).⁸



(20) predicts that *perform* and *listen to* are preferred in (18a). Verbs *begin* and *enjoy* differ in that *begin* allows an agentive role. This excludes subject-experiencer *listen to* but allows for *perform* and is also compatible with *create*. Note that *create* is associated with the general concept *artifact*. We can turn to WORDNET's verb hierarchy, shown superimposed in (21), to pick out the music-specific sense of *compose*.⁹



(18b) is explained since *compose* (or *write*) and *perform* are effectively equidistant from *sonata*.

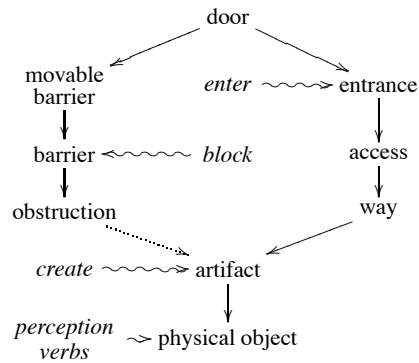
Door: Consider (4b), repeated here as (22), with WORDNET hierarchy (23).

(22) !!John enjoyed the door

⁸Note, *physical object* → *entity* in WORDNET. $C_T = \text{entity}$ has been omitted in (20) since *entity* has no possible characteristic functions.

⁹*Compose* and *write* belong to the same synset glossed as "write music". Thus the gloss locates this synset with the concept *music*.

(23)

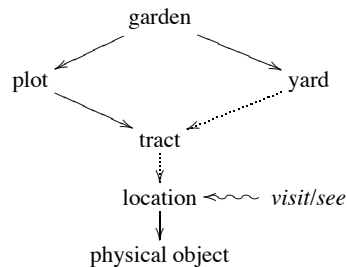


Specifically, a door can function both as an entrance (*enter*) and a barrier (*block*) to an enclosure. However, the telic verb *block* has form *block(door, ENCLOSURE)*, which is incompatible with the prototype $V(\text{PRO}, \text{door})$, thus ruling out *block*. Similar reasoning applies to *enter(PRO, ENCLOSURE)*. At the other end of the hierarchy, the canonical events associated with *physical object* are predicted to be implausible (l large, m small).

Garden: Consider (5), repeated here as (24), with WORDNET hierarchy (25).

(24) Mary enjoyed the garden (*seeing/visiting*)

(25)

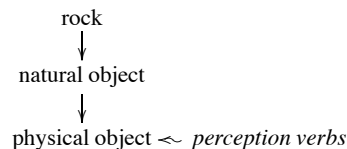


Assuming *visit* and visibility are characteristic of locations in general, (24) is accounted for. General mechanisms involved in reasoning about entailment may also play a large role in grounding *visit*. Note that the possibilities exemplified in (6) all entail *visit*.

Rock: Consider (4a), repeated here as (26).

(26) !John enjoyed the rock

(27)



Unlike *door* in (22), *rock* has no obvious function, as the simple hierarchy in (27) suggests. Hence, relatively speaking, we predict that (26), when picking out perceptual *looking at* or *touching*, is more acceptable than (22) (since l is smaller). However, the value of m is still small, indicating its acceptability can be improved significantly by contextual (discourse) support.

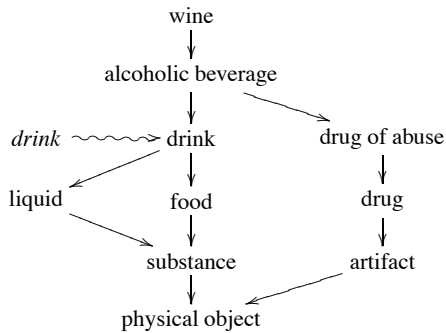
Note that WORDNET does not classify *rock* as a location, cf. *garden* in (5). Given the right context, the characteristic function *visit* may also be felicitous for *rock*, as in (28), where the rock in question is geographically significant.

(28) Mary enjoyed Ayer's Rock (*visiting*)

Wine: Consider (29) with hierarchy (30).

(29) Mary enjoyed the wine (*drinking*)

(30)

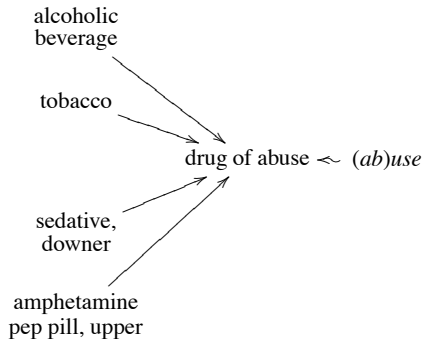


(30) strongly predicts (29) (*l* small, *m* large). However, this assumes the branch containing *drug of abuse* (with telic role (*ab*)use) is marginalized, i.e. *wine* as *drink* is preferred over *drug of abuse*. Contrast (29) with (31).

(31) Mary enjoyed the amphetamine/sedative (*using*)

(31) is also strongly predicted in our analysis as the elaborated WORDNET hierarchy fragment in (32) illustrates.

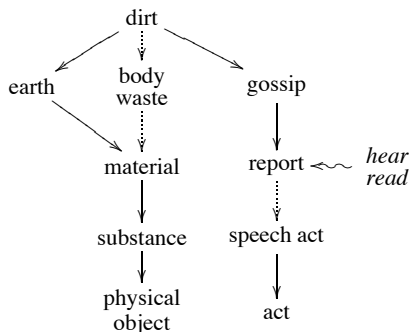
(32)



Dirt: Consider (33) with hierarchy (34).

(33) !John enjoyed the dirt

(34)



In (33), *dirt* as a natural substance has no plausible telic role. The corresponding WORDNET hierarchy is shown in (34). The relevant sense is given by the sequence $\langle \text{dirt}, \text{earth}, \text{material}, \text{substance} \rangle$; the elements of which have no obvious purpose or function. Hence the status of (33).

According to WORDNET, *dirt* is also, perhaps little used, slang for fecal matter. Other (more common) words sharing the same synset are *crap*, *shit*, *poop* and *turd*. The telic role for *body waste*, perhaps *discharge*, is generally available for the synset, as can be seen by substitution of *dirt* in (33). So an appropriately annotated WORDNET makes essentially the right prediction for the synset as a whole. Finally, the right prediction is also made for *dirt* in the sense of malicious gossip, as in (35).

(35) John enjoyed the dirt on OJ Simpson
(*hearing about/reading about*)

5. Conclusions

In this paper, we have argued for an ontological approach to the problem of logical metonymy using WORDNET's hypernymy relation for non-eventive nominals. That is, we interpret logical metonymy to be a phenomenon belonging to systems of semantic interpretation and general reasoning, governed by simple rules of specificity and locality with respect to concept hierarchy. We have shown, through worked examples, how such a mechanism accounts for data of the sort commonly cited in the literature.

Interesting questions remain for future work. For example, not all concepts in the WORDNET hierarchy have simple lexical realization satisfying the grammatical constraints, the question of what happens with lexical gaps remains. Since languages vary with respect to concept lexicalization, the question of whether the results obtained here generalize to other languages exhibiting logical metonymy remains open.

6. References

- N. Asher and J. Pustejovsky. (forthcoming). The metaphysics of words in context. *Journal of Logic, Language and Information*.
- N.A. Chomsky. 1965. *Aspects of the Theory of Syntax*. MIT Press.
- A. Gangemi, N. Guarino, and A. Oltramari. 2001. Conceptual analysis of lexical taxonomies: The case of wordnet top-level. In *Proceedings of FOIS 2001*.
- A. Lascarides and A. Copestake. 1995. Pragmatics of word meaning. In *Semantics and Linguistic Theory (SALT5)*, Austin, Texas.
- J. Pustejovsky. 1995. *The Generative Lexicon*. MIT Press.
- E. V. Siegal. 1998. Disambiguating verbs with the wordnet category of the direct object. In *Workshop on Usage of WordNet in Natural Language Processing Systems*, University of Montreal, Montreal, Canada.
- C. M. Verspoor. 1997. Conventionality-governed logical metonymy. In H. Bunt, L. Kievit, R. Muskens, and M. Verlinden, editors, *2nd International Workshop on Computational Semantics*, pages 302–312, Tilburg, Netherlands.