Systematicity and the Lexicon in Creative Metaphor

Abstract

Aptness is an umbrella term that covers a multitude of issues in the interpretation and generation of creative metaphor. In this paper we concentrate on one of these issues – the notion of lexical systematicity – and explore its role in ascertaining the coherence of creative metaphor relative to the structure of the target concept being described. We argue that all else being equal, the most apt metaphors are those that most resonate with the way the target concept is literally and metaphorically organized in the lexicon. As such, the lexicon plays a key role in enforcing and recognizing aptness. We perform our exploration in the context of WordNet [2,3], and describe how relational structures can be automatically extracted from this broad-coverage lexical taxonomy to facilitate the interpretation of creative metaphors.

1 Introduction

When one considers the aptness of creative metaphor and how one might measure it, one finds a whole range of issues lurking between the apparent unity of this umbrella term (e.g., see [11]). This complexity is compounded by the fact that metaphors operate at several different levels of representation simultaneously: the conceptual level, or the level of ideas; the lexical level, or the level of words; and the pragmatic level, or the level of intentions. A metaphor may fall at any of these hurdles, either through a poor choice of a source concept, or a poor choice of words in communicating this concept, or in a failure to observe the expectations of the context in which the metaphor is expressed.

Some degree of aptness is afforded by metaphors that compare semantic neighbors, inasmuch as the existence of a common taxonomic parent suggests that the source and target are in the same, or at least similar, domains (e.g., see [4]). For instance, metaphors that compare politicians to architects, or even geneticists to cartographers, derive some measure of aptness from the fact that in each case the source and target are sub-categories of the *Profession* category. However, since the most creative of metaphors are those that make the greatest semantic leaps between the source and target concepts, such category-hopping metaphors do not have the luxury of comparing concepts that are already deemed similar in taxonomic terms, as evidenced by a common superordinate concept, but must instead establish a new basis for conveying similarity that is not itself taxonomic. Consider for instance a corollary of the above metaphor in which "genomes are maps". The aptness of these similarity-creating metaphors is instead a measure of the isomorphism between the relational structures of the source and target, so that the concepts with the greatest structural overlap will often produce the most apt metaphors.

In this respect, metaphoric aptness is a function of what Gentner terms the *systematicity* of a structure-mapping. According to Gentner [6] and the structure-mapping school of thought (e.g., see also [7]), the best interpretations of a metaphor or analogy are those that systematically pair-off the greatest amount of connected relational structure in each concept. We refer to this kind of structural aptness as *internal systematicity*, since any sense of aptness arises out of a coherence between the internal structures of the concepts being mapped.

Lakoff and Johnson [1] also place a strong emphasis on metaphoric systematicity, but in their hands the notion is construed in more *external* terms. To L&J, systematicity is a measure of the generativity of a metaphoric schema, so that the same schema (such as *Life is a Journey*) can serve as the deep structure for a wide variety of different, but mutually systematic, surface metaphors (such as "my job has hit a rocky patch" and "my career has stalled"). In this view, systematicity is a measure of how much a metaphor resonates and

coheres with existing metaphors for thinking about the target concept, so that when viewed collectively, they together suggest the operation of a common underlying schema. This view of systematicity is external to the concepts involved since it predicates their aptness to each other on the existence of other structures (metaphor schemas) into which they can be coherently connected.

In this paper we argue that the lexicon is central to the determination of both kinds of systematicity, internal and external, especially if one is an adherent of the *generative lexicon* view of word meaning as championed by Pustejovsky [5]. In such a lexicon we can expect to find precisely the kind of relational structure needed to perform structure mapping and thereby measure the internal systematicity of a metaphor like "a passport is a travel diary". In addition, we can expect to find the lexicalized metaphor structures that represent the surface manifestations of existing modes of thought, and it is against these structures that the external systematicity of an interpretation can be measured.

This research is conducted in the context of WordNet [2,3], a comprehensive lexical knowledge-base of English. The structure of WordNet makes explicit some of the relationships needed to construct a generative lexicon, most obviously the formal (taxonomic) and constitutive (meronymic) aspects of word meaning. But to truly test a model of metaphoric interpretation on a large-scale, it is necessary to augment these relationships with the telic and agentive components that are not encoded directly but merely alluded to in the textual glosses associated with each sense entry. In the sections to follow we describe a mechanism for automating the extraction of these relationships from WordNet glosses (in the same vein as [7]), and demonstrate how these extracted structures can be mapped and projected to generate appropriate interpretations for metaphors involving lexical concepts.

2 Qualia Extraction from WN Glosses

In a generative lexicon, the core elements of word meaning are represented by a nexus of relations called a *qualia structure*, which ties together the formal (i.e., hierarchical relations), constitutive (i.e., meronymic), telic (i.e., functional) and agentive (i.e., construction/creation) aspects of a word. For instance, a diary is *formally* a kind of book that *constitutes* a collection of personal writings whose *telic* purpose is to record the observations of the *agent* that compiles it. When a word like "diary" is used metaphorically, this relational nexus provides the structure for determining the internal systematicity of any interpretation. For instance, it is apt to describe a passport as a kind of travel diary since both are kinds of book *(formal)* that record *(telic)* travel experiences.

We describe here an approach to qualia extraction from WordNet glosses that balances coverage with quality: by attempting to extract a relatively narrow slice of the relational structure inherent in WordNet glosses, we can be confident of quite high levels of competence. Nevertheless, even this narrow slice yields a significant amount of qualia structure, since WordNet already encodes formal and constitutive relations in its taxonomic and meronymic links between synsets. We thus concentrate our efforts on the extraction of telic (i.e., goal-oriented) and agentive (activity-oriented) lexical relations.

We exploit the fact that the agentive and telic aspects of lexico-conceptual structure are often expressed using nominalized verbs that implicitly encode relational structure. A small number of highly productive morphology rules can thus be used to connect "observe" to "observer" and "observation" (and vice versa), "specialize", to "specializer" and "specialization", and so on. For example, the WordNet concepts *{botanist}* and *{philologist}* are both defined with glosses that explicitly employ the term "specializing", thus evoking the concept *{specializer}* (a hyponym of *{expert}*) Now, because *{specializer}* is compatible with the concepts *{botanist}* and *{philologist}* by virtue of being a hyponym of *{person}*, this in turn suggests that *{botanist}* and *{philologist}* should be seen as hyponyms of *{specializer}*, making *specializer_of* an appropriate telic relation for each. Thus, using a combination of derivational morphology and simple taxonomic reasoning, the relational structure *specializer_of:specialization* can be associated with each concept. Since this structure is not already encoded in WordNet, it provides an additional dimension of similarity for any future metaphoric mapping.

Broad clues as to the syntactic form of the gloss (such as the use of the passive voice) are also a

valuable source of extraction information, especially when they can be robustly inferred from a simple combination of keyword analysis and inflectional morphology. For example, the passive voice should cause an extracted relation to be inverted, as in the case of *{dupe}*, whose WordNet gloss is *"a person who is swindled or tricked"*. The resulting relational structure is thus:

$$\{dupe\} \rightarrow of\_swindler{:}swindler \wedge of\_trickster{:}trickster$$

This approach requires the WordNet taxonomy to act as a vital sanity-check for any extracted relationship. In general, it is sensible to associate a relation *r* with a concept *c* if the nominalization of *r* denotes a concept that belongs to the same taxonomic category as *c*; thus, it is sensible to ascribe a *specializer_of* relation to *{botanist}* only because *{specializer}* and *{botanist}* are each a hyponym of *{person}*. However, this broad injunction finds an important exception in metonymic contexts. Consider the WordNet gloss for *{diary, journal}*, *"a daily record of (usually private) experiences and observations"*, which initially yields the relationships *of_diarist:diarist*, *of_experience:experience*, *recorder_of:recording* and *observer_of:observation*. A taxonomic sanity-check reveals that *{diary, journal}*, as a sub-category of *{communication}*, is not compatible with either *{recorder}* or *{observer}*, both sub-categories of *{person}*. However, it *is* taxonomically compatible with the objects of these relations, *{recording}* and *{observation}*, which suggests that a diary is both the object of, and a metonym for, the diarist as observer and recorder. This metonymy is most evident in the familiar address "dear diary", in which the diary is conceived as a personified counterpart of the observer. The concept *{diary, journal}* therefore yields the modified relational structure:

$$\{diary, journal\} \rightarrow {*}observer\_of{:}observation \wedge {*}recorder\_of{:}recording \wedge of\_experience{:}experience$$

The (*) here signals that the *observer_of* and *recorder_of* relations hold metonymically rather than literally. The presence of these relationships facilitate creative uses of the concept *{diary}* that follow the general pattern whereby artifacts are viewed from an intentional stance. For example, consider that the WordNet gloss for the concept *{witness, spectator}* is "a close observer", so that the following relational structure is extracted:

$$\{witness, spectator\} \rightarrow observer\_of{:}observation$$

It now becomes apt to metaphorically consider a diary to be a witness to one's life experiences. In structure-mapping terms, this aptness is reflected in the internal systematicity of finding a key relationship, *observer_of:observation*, common to each of *{diary}* and *{witness, spectator}*.

3 Internal Systematicity

Because purely taxonomic interpretations are created on the basis of commonalities, they tend to be highly symmetric, as in the case of similes such as "credit unions are like banks" and "gamblers are like alcoholics". In contrast, the most creative metaphors are asymmetric [9], since they impose the highly-developed relational structure of the source concept onto that of the less-developed target [1, 6, 7]. Without this imposition of relational structure, metaphor can only be used to highlight existing similarities rather than to actually create new ones, and is thus robbed of its creative function.

The projection of relational structure can be performed either literally or figuratively. In a literal interpretation, the relational structure of the source is simply instantiated with the target concept, so for example, a literal "travel diary" is a diary that contains travel recordings and travel observations. In contrast, figurative interpretations first attempt to retrieve a counterpart for the source using the target as a retrieval cue, and then project the relational structure of the source onto this counterpart [6]. For instance, WordNet contains a variety of concepts that are formally similar to *{diary, journal}* and which also mention "travel" in their glosses, such as *{travel_guidebook}* and *{passport}*. These facilitate the following reading:

$$\text{"travel"} + \{diary, journal\} \rightarrow \{passport\} + {*}observer\_of{:}\underline{travel}{:}observation \wedge {*}recorder\_of{:}\underline{travel}{:}recording \wedge of\_experience{:}\underline{travel}{:}experience$$

Projecting the relational structure of *{diary, journal}* onto *{passport}* causes the latter to be seen as a journal of travel observations and experiences, and indeed, many travelers retain old passports for this very purpose.

Metaphors are most apt when projection highlights a latent relational structure that already exists in the target concept [8]. For example, the compound "pastry surgeon" can be understood taxonomically as referring to *{pastry_cook}*, since like *{surgeon}* it is a sub-category of *{person}*. But to fully appreciate why *{surgeon}* is more apt than other hyponyms of *{person}*, like *{astrologer}* say, one must look to the shared relational structure that is highlighted by the metaphor. WordNet 1.6 defines a surgeon as a *"physician who specializes in surgery"*, while a pastry cook is glossed as *"a chef who specializes in pastry"*. Both *{surgeon}* and *{pastry_cook}* thus become associated with the relationship *specializer_of:specialism*. This common relational structure facilitates the measurement of what we have termed internal systematicity (in the Gentner sense). Thus, *{surgeon}* is seen as an apt vehicle for *{pastry_cook}* as both are people that specialize in a particular field. Instantiation of the shared structure leads to the following interpretation:

"pastry" + {*surgeon*} → {*pastry_cook*}
+ *specializer_of:* *pastry*:*surgery*

The choice to delve deeper, and recursively determine an appropriate interpretation of "pastry surgery", is left to the comprehender, who may instead choose to read the metaphor as a simple request to view pastry chefs as specialists. But this raises the question of how much structure must be shared for an interpretation to appear apt rather than merely inept. For example, one can equally well say "pastry linguist" or "pastry geologist" to highlight the specialist nature of pastry chefs, since *{geologist}* and *{linguist}* are also associated with an extracted *specializer_of* relationship. What makes these alternate metaphors seem clumsy is the difficulty in assigning appropriate interpretations to the recursive metaphors that they imply: "pastry geologist" implies the metaphor "pastry geology", while "pastry linguist" implies the metaphor "pastry linguistics".

(?) *"pastry"* + {*linguist*} → {*pastry_cook*}
+*specializer_of:*pastry*:*linguistics*

There is little that can be done to put a sensible interpretation on "pastry linguistics" in WordNet, given the taxonomic and relational structure of *{pastry}* and *{linguistics}*. In contrast, "pastry surgery" has more potential for meaningful interpretation using WordNet structures. There exists a sense of surgery that denotes a discipline in the natural sciences, and from *{pastry}* a broad search will find the concept *{dietetics}*, another discipline of the natural sciences dedicated to food preparation. This analogue of *{surgery}* can be found by first considering all concepts associated with "pastry", then all concepts associated with "baked goods", then "foodstuff" and "food", until an appropriately similar candidate is found.

{*dietetics*} ≡ *the scientific study of food preparation and intake*

This is not a particularly well-known concept, so it would be difficult to argue that this forms the cornerstone of an easily understood metaphor like "pastry surgeon". However, the concept *{dietetics}* does at least concretize, in WordNet terms, the idea that one can take a precise, scientific view of food preparation, and it is the plausibility of this notion that allows us to make sense of pastry preparation as a surgical activity. There is no true substitute for situated experience of the world, but when it comes to metaphor interpretation using lexical resources like WordNet, we should be willing to use any lexical precedent we can find.

As an alternate strategy, we can seek to recruit a sub-category of surgery that can be modified in some way to accommodate the concept *{pastry}*. One such category is *{plastic_surgery}*, whose gloss reveals a concern with the reformation of body tissue.

{*plastic_surgery*} ≡ *surgery concerned with therapeutic or cosmetic reformation of tissue*

∴ *"pastry"* + {*surgery*} → {*plastic_surgery*}
+ *reformation_of:* *pastry*:*tissue*

In taxonomic terms, *{plastic_surgery}* is perhaps most appropriately adapted for this purpose, since *{tissue, tissue_paper}* and *{pastry}* are both hyponyms of *{substance}* in WordNet. Of course, the sense of "tissue" intended by the author of the above gloss is not *{tissue, tissue_paper}* but *{tissue}* as a hyponym of *{body_part}*. However, creative metaphors often involve a degree of domain incongruence, whereby a given word has a

different meaning in the source and target domains (see [9] and [11] for the origins of this term). In fact, one might say that domain incongruence is essential to creative metaphor, since interpretation will necessitate the grafting of structure from radically distant parts of the concept ontology, and such grafts may fail if the features involved maintain their strict, source-dependent definitions.

4 External Systematicity

As the recruitment of a bridging concept like *{plastic_surgery}* demonstrates, metaphors appear more apt when they systematically evoke, or connect into, established modes of metaphoric thought [1]. For instance, if WordNet were to lexicalize the metaphor *Language Of Food* in some form, this lexicalization might be recruited to support the idea of a "pastry linguistics" and thus make the metaphor "pastry surgeon" appear more apt. This is systematicity considered from an external vantage as described by Lakoff and Johnson. For example, for the metaphor "political mechanic" a number of appropriate concepts can be reached from "political" that prove to be taxonomically compatible with *{mechanic}*, among them *{political_leader}*, *{political_scientist}* and *{machine_politician}*. However, closer inspection of the projected structure suggests that the last, *{machine_politician}*, is the most systematic:

"political" + {*mechanic*} →
{*machine_politician*} + *machinist_of: political:machine*

Because the extracted qualia structure for *{mechanic}* hinges on the relationship *machinist_of:machine*, there is a suggestive lexical systematicity with the concept *{machine_politician}*. Furthermore, the instantiated structure creates a fortuitous pairing *political:machine*, which already exists in WordNet as the lexicalized metaphor *{political_machine}*. This marks "political mechanic" as a systematic outgrowth of the established metaphor schema *Political System As Machine* (whose corollary is *Political Operatives as Fixers*). The same schema comes into play when interpreting the metaphor "political draftsman", whose WordNet gloss also evokes images of machinery.

Lexicalized metaphor schemas, like *{political_machine}*, *{political_science}* and *{political_campaign}*, act as the recognizable landmarks in the search space of possible interpretations for novel metaphors. So if an interpretation can be generated that connects into an established metaphor, it has a greater provenance than one that stands alone. Here are some further examples:

{*torchbearer*} ≡ *a leader in a campaign or movement*

∴ *"political"* + {*torchbearer*} →
{*political_leader*} + *campaigner_of: political:campaign*

{*missionary*} ≡ *someone who attempts to convert others to a doctrine or program*

∴ *"political"* + {*missionary*} →
{*commissar*} + *programmer_of: political:program*

{*sociologist*} ≡ *a social scientist who studies the institutions of human society*

∴ *"political"* + {*sociologist*} →
{*political_scientist*} + *scientist_of: political:science*

These examples are fortuitous in the sense that the instantiation of qualia structure directly suggests an existing WordNet concept. In most cases, however, the external systematicity becomes visible only upon recursive consideration of the instantiated structure as a source of metaphor in itself. Consider the metaphor "genetic cartographer", for which *{geneticist}* is retrieved as a thematically similar concept:

{*cartographer*} ≡ *a person who makes maps*
{*geneticist*} ≡ *a person who specializes in genetics*

∴ *"genetic"* + {*cartographer*} →
{*geneticist*} + *mapper_of: genetic:mapping*

There is no denotation for "genetic mapping" in WordNet, so at first blush the above interpretation fails to connect into an existing lexicalized metaphor. However, when we recursively consider the combination "genetic mapping" as a metaphor in itself, we obtain the following interpretation:

"genetic" + {*mapping*} → {*chromosome_mapping*}

{*chromosome_mapping*} ≡ *the process of locating genes on a chromosome*

The word "mapping" is used here in a domain-incongruent way (see [11]). This allows us to recognize "genetic mapping" as an alternate way

of denoting the concept *{chromosome_mapping}*, while the fact that a mapping metaphor has already been lexicalized in the genetics domain allows us to recognize the external systematicity inherent in the interpretation of "geneticist as cartographer".

5 Conclusions: The Challenge of Aptness

I suspect we can all agree that aptness involves a complex interaction of different issues that arise from lexical and conceptual choice. The real question is the degree to which each of these issues influences a particular interpretation, and the weighting, if any, that is to be given to each component of aptness in an algorithmic model. Take the metaphor "political surgeon": by considering the concepts in the semantic neighborhood of *{surgeon}* reachable via the thematic cue "political", we find the following competing interpretations:

{political_scientist} ≡ *a social scientist specializing in the study of government*

{spin_doctor} ≡ *a spokesperson for a political party or candidate …*

The first of these interpretations, *{political_scientist}*, is apt for reasons of internal systematicity, as both it and *{surgeon}* have an extracted qualia structure that contains a *specializer_of:specialization* relationship. This leads to the following interpretation:

"political" + *{surgeon}* → *{political_scientist}* + *specializer_of:political:specialization*

The second interpretation, *{spin_doctor}*, does not exhibit the same internal systematicity, but it does exhibit an external systematicity of sorts: the head of this compound term, "doctor", denotes a concept *{doctor, physician}* that is a hypernym of the metaphoric vehicle, *{surgeon}*.

It would seem a matter of personal choice as to which interpretation should be privileged here, as different listeners may attach more weight to the presence of internal systematicity in *{political_scientist}* than to the suggestion of external systematicity in *{spin_doctor}*, and vice versa. This suggests that the problem of aptness determination involves a great deal of hidden parameters yet to be made explicit in any model of interpretation. As researchers interested in the computational treatment of metaphor, our goal then should be to explicate what factors we can, in algorithmic and representational terms, to provide the basic inventory of components needed to proceed with our investigation into this elusive and considerably vexing phenomenon. In this paper we have argued that the natural place to compile this inventory is the lexicon, since this bridges the divide between word and world knowledge that aptness judgments so readily exploit.

We conclude with some empirical observations regarding the efficacy of extracting qualia structures from WordNet glosses. The process as it is described here, operating completely via a combination of derivational morphology rules and taxonomic sanity-checking, is currently able to automatically extract relationships from 40% of the noun glosses in WordNet 1.6. Furthermore, 96% of all noun glosses contain at least one word with a denotation in this extraction set, which suggests that future extensions to the process may be able to obtain much higher coverage with relatively minor additions to the mechanism.

Our main concern at present is not *under*-generation, but *over*-generation, though we are encouraged by the quality of the results achieved so far. We are further encouraged by recent events in the development of WordNet, which will soon be augmented with sense-tagged glosses and explicit, hand-coded morpho-semantic connections between verbs and their nominalizations (see [10] for news of these developments). These enhancements should increase the precision of the extraction process while entirely removing its dependency on over-generating morphology rules.

Finally, it should be remembered that aptness determination is itself a powerful form of sanity-check on the well-formedness of knowledge representations. Since the goal of aptness measurement is to reject ill-formed figurative interpretations and rank those that remain in order of appropriateness, it is plausible that this pruning and ranking processes can be profitably turned on the qualia structures underlying the aptness process itself. In this way, an understanding of what makes a metaphor apt may have practical application not only to understanding the utterances of humans, but to understanding the knowledge structures automatically extracted by machines.

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