# Making sense of adjectives: association vs. ascription in a family-resemblance model of semantic inheritance

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*Associative adjectives such as in electrical engineer differ from ascriptive adjectives like in red house: They are syntactically similar, yet they do not denote an intersective sense like ascriptive adjectives do. However, associative adjectives may (irregularly) denote ascriptive traits connected to the associated entity: The more semantically-similar two entities are, the more regular the traits are which are ascribed to them through association by a given adjective. This model of entities associated through family membership is analogous to a semantic network based on relative word similarities, in which families appear as clusters of relatively-similar entities.*

**Keywords**: lexical semantics, adjectives, modification, predication, similarity, family resemblance, ontology

## 1. Introduction

It has been observed that some adjectives behave differently from other adjectives in attribution as opposed to predication:

(1) a. 1. a red house → $\exists x(\text{house}(x) \wedge \text{red}(x))$
2. a house is red → $\exists x(\text{house}(x) \wedge \text{red}(x))$

b. 1. a criminal lawyer → $\exists x((\text{lawyer}(x) \wedge \text{criminal}(x)) \vee (\text{criminal\_lawyer}(x)))$
2. a lawyer is criminal → $\exists x(\text{lawyer}(x) \wedge \text{criminal}(x))$

Adjectives which tend to denote similar semantic content in both attribution and predication, such as in example 1a above, tend to be called 'ascriptive' adjectives (cf. Giegerich 2005a; Huddleston & Pullum 2002; Leitzke 1989). These adjectives can be described as denoting an entity which is a member of an intersective set of entities which are a subset of both the set of entities denoted by the modifier (e.g. all things which are red) and the set of entities denoted by the head (e.g. all things which are houses). Adjectives which may denote semantic content different in attribution from that in predication are often called 'associative' (cf. Giegerich 2005a; Huddleston & Pullum 2002) or 'relational' adjectives (cf. Bally 1944; McNally & Boleda 2004), such as in example (1)b. above (which are referred to as associative adjectives in this paper). These adjectives can be described as denoting a property of a part of the entity they modify or an entity associated with the item they modify (e.g. *mechanical engineer* ('engineer associated with mechanics')) (Ferris 1993: 24, Huddleston & Pullum 2002: 556).

Some claim that associative adjectives are syntactically adjectives while semantically behaving more like nouns (cf. Bally 1944, Giegerich 2005a), for example when Giegerich (2005a), cites the synonymy of *dental decay* and *tooth decay* as a prototypical example – both *dental* and *tooth* indicate *what* is decaying, rather than *how* it is decaying (as in *slow decay*) (Giegerich 2005a: 574-575). However, there is no productive, systematic synonymous relationship between a modifying adjective and a 'semantically-similar' modifying noun (e.g.

*dental* and *tooth*) and they are not always interchangeable: For instance, note the unacceptability of *tooth fairy* ≈ #*dental fairy*.

Moreover, even two nouns which by themselves are usually interchangeable are not always interchangeable when modifying the same head (e.g. *freedom fighter* ≈ #*liberty fighter*). The many examples of this phenomenon could be explained as being lexicalised and thus having semantic content which is not entirely compositional, but this explanation ignores the semi-regular relationship between many pairs like *dental decay* and *tooth decay*. This analysis of associative adjectives as 'noun-like adjectives' is problematic, as the semantic structure and behaviour of even modifying nouns is unclear.

Still others claim that associative adjectives form a lexical (sub-)category separate from ascriptive adjectives (cf. Baker 2003: 3-10) – consider a Dutch example:

(2) a. Een goede danser$_{ASCR}$ ('a good/moral dancer')
b. Een goed danser$_{ASSOC}$ ('a dancer who dances well')[1]

This is also problematic: While there may be specific morphosyntactic phenomena distinctive of associative adjectives, in some languages (specifically in English), there are numerous examples of adjectives which may be either ascriptive or associative. Furthermore, such associative-ascriptive pairs are productive: new formations productively feature both ascriptive and associative readings.

Instead, it is argued in this article that such morphosyntactic differences are semantically motivated; the sense denoted by a particular usage of an adjective motivates morphosyntactic behaviour and not vice versa.

It is argued that there is no clear distinction between association and ascription in themselves, similarly to as argued by McNally & Boleda (2004): There are many adjectives such as *tropical* or *bovine* which do not behave like classical cases of either association or ascription.

In conclusion, the motivation of such traits is not dictated by a classical ontological hierarchy, but rather by family resemblance as described by Wittgenstein (1953): The similarity of any number of entities may be measured by the percentage of traits they have in common. Similarly, the more traits a given entity has in common with a family in question, the more prototypical the entity is to the family in question. While no entity may have all the traits of all the members of the family in question, those with a greater proportion of traits common to the family are more prototypically tropical than those with a smaller proportion. When modifying a semantic head, the specific traits denoted in that instance are determined by the semantic collocational restrictions set by the modifier and the head.

Due to the fact that even ascriptive adjectives can denote different specific traits to each head (cf. *this elephant is big* vs. *this problem is big*), it seems that all modification behaves as the fuzzy intersection of multiple families, rather than denoting a simple subset relationship. By considering e.g. *big elephant* as denoting a set of entities which have traits common to both big things and traits common to elephants rather than simply considering *big elephant* to denote the intersection of all big things and all elephants, it may be possible to more-accurately model the seemingly idiosyncratic and irregular nature of modifiers.

## 2. Morphosyntactic and lexical issues

### 2.1 *Introduction*

As stated above, there is a subset of adjectives that denote traits which identify a subsection rather than an intersection of the set of entities able to be denoted by their head. It is considered by many that such subsective, or associative, senses are typically barred from the predicative position, e.g. *main idea* ~ **this idea is main* (Giegerich 2005a; Huddleston & Pullum 2002). In other words, some claim that such subsective (rather than intersective) senses grammatically occur only in attribution: e.g. through analogy, associative *criminal lawyer*$_{\text{ASSOC}}$ ('lawyer associated with criminal law') ~ $^{\#}$*this lawyer is criminal* ('this lawyer is associated with criminal law') (Giegerich 2005a: 581ff).

Due to this morphosyntactic asymmetry between attribution and predication in regards to adjectival sense, it is tempting to consider associative adjectives as lexicalised in some way. However, it will be shown that there is a productive relationship between associative and ascriptive adjectival senses and that association is not lexicalised in any way. At the same time, it will be shown that the semantic distinction between the senses motivates distinctive morphosyntactic behaviour, and that association is noticeably less compositional than ascription on both a semantic and morphosyntactic level.

### 2.2 *Associative and ascriptive senses exist as sense pairs*

Despite that there appears to be restrictions in the type of sense that predication can denote, adjectives which are able to denote an associative sense are not barred from predication: Giegerich (2005a: 581ff) claims that "some such adjectives (*bovine*, *feline*, *equine*) have a second, metaphorical or figurative sense under which they are ascriptive and intersective, and not subject to such syntactic restrictions, e.g. *John's behaviour was rather bovine*", and that if an associative adjective cannot motivate such a reading, it is unacceptable in predication (such as when Giegerich (2005b: 53-54) finds $^{?}$*this decay is dental* to be unacceptable). However, associative senses are not universally barred from predication, such as in "*Look at Olga dance – she's beautiful!*" (McNally & Boleda 2004: 180). McNally and Boleda (2004) consider classically-associative adjectives to retain their associative sense in predication while still being intersective (here referred to as ascriptive).

Likewise, many new associative formations are precluded from predication such as $^{!}$*dental magician* ~ $^{\#}$*this magician is dental*. Nevertheless, there seems to a productive pair-like relationship between ascriptive and associative senses, as they are present in new formations – compare:

(3) a. 1. a Chomskian critic → $\exists x((\text{critic}(x) \wedge \text{chomskian}(x)) \vee (\text{chomskian\_critic}(x)))$
2. this critic is Chomskian → $\exists x(\text{critic}(x) \wedge \text{chomskian}(x))$

b. 1. a $^{!}$Pullumite critic → $\exists x((\text{critic}(x) \wedge \text{pullumite}(x)) \vee (\text{pullumite\_critic}(x)))$
2. this critic is $^{!}$Pullumite → $\exists x(\text{critic}(x) \wedge \text{pullumite}(x))$

In attribution, $^{!}$*Pullumite*, like *Chomskian*, may subsectively associate its semantic head with a published syntactician or, in addition, intersectively ascribe the traits of the respective

syntactician to the semantic head in question (Napoli 1989). [!]*Pullumite* is unattested but is nevertheless acceptable in ascriptive predication, ascribing traits associated in the fashion that attested associative adjectives do: For example, (3a1) denotes a critic either supporting or opposing transformational grammar, while (3ab) can only denote a critic supporting transformational grammar.

In conclusion, predication entails ascription as e.g. Huddleston & Pullum (2002) and Giegerich (2005a) claim. Nevertheless, the denotation of an ascriptive sense by a classically-associative adjective is clearly productive; it seems that in such associative-ascriptive pairs, each sense is not denoted by a lexical item separate from that denoting the other sense. The two senses are closely related to one another in a systematic way, and the relationship is not lexicalised in any way.

### 2.3 *Association is not lexical*

While there is little evidence of a lexical distinction between associative-ascriptive pairs, some may explain this by claiming that ascription is a grammatical phenomenon while (attested) adjectives denoting an associative sense (such as *dental* in *dental decay*) are lexicalised: Many distinguishing features of lexicalisation can be seen in classically-associative constructions, such as the presence of restrictions on their productivity (cf. Kiparsky, 1982; Lipka et al. 2004, Giegerich 2009). Likewise, there are morphosyntactic distinctions between associative and ascriptive constructions – in addition to Dutch (see example (2)), consider the distinction between pre- and post-nominal modification in French:

(4) a. 1. l'homme grand$_{\text{ASCR}}$ ('the tall man')
2. le grande homme$_{\text{ASSOC}}$ ('the great man')
b. 1. l'homme brave$_{\text{ASCR}}$ ('the brave man')
2. le brave homme$_{\text{ASSOC}}$ ('the good/moral man')
c. 1. l'ecole ancienne$_{\text{ASCR}}$ ('the old school')
2. l'ancienne ecole$_{\text{ASSOC}}$ ('the former school')

Many adjectives in French are able to denote a sense distinct in pre-nominal position from the sense denoted in post-nominal position, the pre-nominal sense being relatively more abstract and not intersective (Bouchard 2002: 64-66). Nevertheless, there are associative adjectives which appear in post-nominal position and are unable to occur in pre-nominal position, e.g. *le génie mécanique* ~ **le mécanique génie* ('the mechanical engineer') (McNally & Boleda 2004: 181). The lack of a regular, isomorphic relationship between adjectival sense and pre-/post-nominal position may seem like evidence supporting a lexical analysis of associative adjectives.

However, as explained in section 2.2, the productivity of associative adjectives is well-attested: Not only is there e.g. *dental decay/professional/specialist/student* but, additionally, [!]*dental magician* is a possible word, plausibly denoting a magician who applies magic (whether in a literal or metaphorical sense) to teeth, analogous to *medical magician*. Due to their productivity, asserting that all of these constructions (including unattested ones) are lexical would entail that the lexicon is infinitely large.

Nevertheless, not all associative constructions are acceptable: For instance, note that associative *mechanical expert* and *mechanical problem* are acceptable but *mechanical llama* is (typically) interpretable only in an ascriptive sense ('a llama which is mechanical'): Certain

associative senses are not as readily denoted in attribution when paired with certain heads as when paired with others (e.g. $^{!}$*dental magician*$_{\text{ASSOC}}$ vs. $^{?}$*dental llama*$_{\text{ASSOC}}$). However, even classically-ascriptive adjectives show ambiguous acceptability, e.g. $^{?}$*square circle*$_{\text{ASCR}}$. The (un)acceptability is largely dependent on the context of discourse in which it appears.

New associative formations could be regarded as lexical creativity (cf. Bauer 1983) instead of being products of classical productivity. However, even creative analogy motivates a semantic structure relatively more regular than that often seen among the constructions sharing a given associative adjective: For instance, the creative re-analysis of *burger* in *hamburger* as a morpheme denoting a semantic head meaning roughly 'hot sandwich', leading to e.g. *cheeseburger*, *tofuburger* and *veggieburger*; *dental* in does not impart such a strongly-analogous semantic structure in e.g. *dental decay/building/*$^{!}$*magician*.

In conclusion, it seems that associative constructions are not lexicalised and that new formations are not products of lexical creativity. Thus, association is a grammatically productive phenomenon which is reflected in morphosyntax. However, the exact morphosyntactic behaviour of each sense may differ from language to language and the morphosyntactic behaviour of one sense may not be exclusive to that sense.

### 2.4 *Association is less compositional than ascription*

As explained above, association is a productive grammatical phenomenon although the exact meaning denoted in association seems to be much less regular than that denoted in ascription. Similarly to the observations made by Giegerich (2005a, 2005b), it is possible that the distinction between association and ascription is neither exclusively lexical nor exclusively syntactic: According to Giegerich (2005a, 2005b), there is considerable "overlap" between phenomena attributed to the lexicon and those attributed to morphosyntax and that they are not mutually-exclusive modules of language.

It is plausible that associative constructions behave more like lexical items than ascriptive adjectives without being classical lexical items, while ascriptive constructions behave more like pure morphosyntactic constructions. This may also motivate the relatively regular relationship of modifier to head in ascription compared to the relatively irregular relationship in association. Furthermore, the relative semantic non-compositionality of associative constructions may be reflected in morphosyntactic behaviour: Just as compound nouns are generally not amenable to many morphological processes (cf. Giegerich 2006, 2009; Lipka et al. 2004), it seems that adjectives denoting associative senses are not amenable to many processes which are observable in ascriptive constructions, such as gradation and modification:

(Giegerich 2005a)

(5) a. *very beautiful dancer* ('dancer who is very beautiful')
b. **very beautiful dancer* ('dancer who dances very beautifully')

It seems that ascription is semantically relatively compositional while association is not. Likewise, ascriptive senses may be denoted in either attribution or predication, while classically-associative senses typically cannot be denoted in predication. Additionally, ascription is amenable to morphological processes which often are barred from association. Therefore, it is possible that ascriptive constructions are not only more semantically compositional than associative constructions, but that they are also more syntactically

compositional: It may be that ascriptive adjectives (in either attribution or predication) heading an adjectival phrase, e.g. [*very*$_{ADV}$ [*beautiful*$_{ADJ}$]$_{AP}$ [*dancer*]$_{N}$]$_{NP}$ (‘dancer who is very beautiful’) or [*homme*$_{N}$ [*grande*$_{ADJ}$]$_{AP}$]$_{NP}$ (‘tall man’), while associative constructions are more like lexical items and associative adjectives do not head an adjectival phrase but is a non-head item within a noun phrase, e.g. [(**very*$_{ADV}$) [*beautiful*$_{ADJ}$ [*dancer*]$_{N}$]$_{NP}$ (‘dancer who dances [*very] beautifully’) or [*grande*$_{ADJ}$ *homme*$_{N}$]$_{NP}$ (‘great man’) (Bouchard 2002: 64-66). This corresponds to the observation that many morphological processes cannot occur within a lexical item (i.e. a non-compound NP) (cf. Giegerich 2006).

In conclusion, adjectives seem to show direct parallels in semantic (non-) compositionality and regularity and semantic (non-)compositionality. Association tends to be less compositional than ascription both semantically and morphosyntactically.

### 2.5 *Conclusion: Association does not constitute a lexical (sub-)category*

There is a non-lexical, grammatical relationship between association and ascription (section 2.2). Neither associative nor ascriptive constructions are lexical items (section 2.3). Lastly, association is less compositional than ascription both semantically and morphosyntactically and association behaves more like a lexical item than ascription does without in fact being classically lexicalised (section 2.4).

This suggests that there is no lexical (sub-)categorical distinction between associative and ascriptive adjectives: Such a lexically-categorical distinction between associative and ascriptive adjectives is redundant when adjectives productively show morphosyntactic behaviour distinct to either association or ascription corresponding to the sense a given adjective denotes, in the same fashion as between e.g. nouns and verbs in English (cf. Baker 2003): Baker (2003) observed that, in at least English, nouns are productively and frequently derived from verbs and vice versa, making categorical assignment a phenomenon based largely on context (e.g. *dog* is a noun if it heads an NP and a verb if it heads a VP) (Baker 2003: 264-302).

Therefore, adjectives are categorically able to denote both ascriptive and associative senses, while the sense denoted motivates semantic and morphosyntactic behaviour: The more ascriptive the sense is, the more ‘phrasally’ the construction behaves, while the more associative (and the less ascriptive) the sense is, the more ‘lexically’ the construction behaves.

## 3. Lexical semantic issues

### 3.1 *Introduction*

Although there exists a descriptive semantic distinction between associative and ascriptive senses, the distinction is not always robust in regards to the semantic phenomena associated with each of the two senses: Fundamentally, ascription denotes an entity which is an intersection of two groups of entities (e.g. in *red house*, of all things able to be denoted by *red* and of all things able to be denoted by *house*) (cf. Giegerich 2005a; Huddleston & Pullum 2002; Leitzke 1989). Association, on the other hand, is fundamentally a non-ascriptive sense which describes a part of the entity they modify or another entity associated with the modified entity (cf. Huddleston & Pullum 2002; McNally & Boleda 2004). However, while

ascription seems to be easily modelled analogously to predicate modifiers (e.g. *a young boy* ~ *the boy is young* → $\exists x(\text{boy}(x) \wedge \text{young}(x))$), associative adjectives cannot be easily described in this manner (cf. Giegerich 2005a; Larson 1998; McNally & Boleda 2004).

It will be shown that both classically-associative and -ascriptive adjectives behave similarly in regards to semantic acceptability, and that although predication has restrictions not identical to those observed in attribution, and both classically-associative and -ascriptive adjectives are subject to similar semantic collocational restrictions in predication. Furthermore, it will be shown that there is no robust, categorical distinction between associative and ascriptive senses, with many constructions displaying features of both. In conclusion, it will be argued that "associative-like" and "ascriptive-like" behaviour form ends of a spectrum of adjectival behaviour, in how "directly" they denote traits of the entity they modify according to their individual lexical semantics.

### 3.2 *Amenability to predication is motivated by semantic collocational restrictions*

According to Giegerich (2005a: 581ff), when a classically-associative adjective is forced into an ascriptive reading through predication, it denotes a figurative or metaphorical sense of the word, e.g. *feline*$_{\text{ASSOC}}$ ~ *Anne's face is rather feline*, denoting traits to the modified entity (e.g. *Anne*) which are associated with e.g. cats. However, many examples of classically-associative adjectives in predication cannot be described as figurative or metaphorical in any way, e.g. *tropical fish*$_{\text{ASSOC}}$ ~ *this fish is tropical*. Nevertheless, they can indeed be described as denoting particular traits associated with one entity to another entity (e.g. associating traits associated with the Tropics to *fish* in the example above) as described by Huddleston & Pullum (2002). Likewise, in certain circumstances, a classically-associative sense is acceptable in predication, such as e.g. "*Look at Olga dance – she's beautiful!*" (McNally & Boleda 2004: 180).

In fact, the acceptability of the predication of classically-associative adjectives depends on both context and the entity which is modified, and the exact semantic content of such ascription is also dependent on such factors – consider:

(6) a. 1. mechanical problem$_{\text{ASSOC}}$ ('problem due to a mechanical malfunction') ~ $^{?}$this problem is mechanical ('this problem is due to a mechanical malfunction')

2. cardiac problem$_{\text{ASSOC}}$ ('problem regarding the heart') ~ $^{\#}$this problem is cardiac ('this problem is regarding the heart')

b. 1. cardiac tissue$_{\text{ASSOC}}$ ('tissue making up the heart') ~ $^{?}$this tissue is cardiac ('this tissue makes up the heart')

2. cardiac surgeon$_{\text{ASSOC}}$ ('surgeon who operates on the heart') ~ $^{\#}$this surgeon is cardiac ('this surgeon operates on the heart')

In the examples in (6a), it seems that modifying *problem* with *mechanical* is relatively more acceptable than with *cardiac*. However, as seen in the examples in (6b), *cardiac* modifies *tissue* more acceptably than it does *surgeon.* Considering that a given associative adjective in predication denotes particular traits associated with a particular entity, these traits may be blocked by semantic collocational restrictions of the head.

In conclusion, it seems that the semantic collocational restrictions present in modifier-head constructions differ when the modifier denotes an associative sense from when it denotes an ascriptive sense. These differing restrictions motivate the discrepancy in

acceptability between association and ascription of a given adjective, and thus the acceptability of denoting traits associated with a particular entity to the head.

3.3 *Ascriptive and associative senses are not unambiguously distinctive*

Adjectival senses are subject to semantic collocational restrictions set by the head they modify, motivating the difference in predicative acceptability between e.g. *criminal* in *criminal lawyer*$_{\text{ASSOC}}$ (~ *this lawyer is criminal*$_{\text{ASCR}}$) and *mechanical* in *mechanical engineer*$_{\text{ASSOC}}$ (~ $^{\#}$*this engineer is mechanical*$_{\text{ASCR}}$). However, in many cases, the sense denoted by such adjectives in predication is not analogous to classically-ascriptive adjectives – consider:

(7) a. 1. red house ~ this house is red
2. big mouse ~ this mouse is big
b. 1. mechanical engineer ~ this engineer is mechanical
2. beautiful dancer ~ this dancer is beautiful
c. 1. dental decay ~ $^{?}$this decay is dental
2. atomic energy ~ $^{?}$this energy is atomic

The examples in (7a) have the same (ascriptive) meaning in both attribution and predication. Those in (7b) have two distinct possible readings in attribution (ascriptive or associative), but only one in predication (ascriptive). However, those in (7c) are ambiguous in the sense they denote: In attribution, they are classically considered to be associative, but do not have an ascriptive reading which is as distinct from the associative reading as the examples in (7a) have: e.g. *atomic energy* means 'energy derived from atoms' but has no distinctive, parallel ascriptive reading in the same way that *mechanical engineer* does. Similarly, they show (limited) acceptability in predication, but the sense denoted is again ambiguous.

Since predication entails an ascriptive reading of the predicated item, one might say that the examples are ambiguously acceptable because such adjectives are able to denote an ascriptive sense but only marginally. However, there are many adjectives which are unambiguously acceptable in predication but nevertheless denote an ambiguous sense (e.g. *tropical fish ~ this plant is tropical*).

In conclusion, it seems that ascription is not always unambiguously distinct from association: While some adjectives such as *mechanical* show clearly-separate associative and ascriptive senses, other adjective have a less-clear distinction between the two senses. Furthermore, sense ambiguity is not related to acceptability: The sense of a given adjective may be ambiguous while being unambiguously acceptable as a grammatical construction.

3.4 *Conclusion: Associative senses denote traits analogously to ascriptive senses*

An adjective's ability to occur in predication (and therefore ascribe traits to its head) is dependent on collocational factors determined by the head to be modified (see section 3.1). Furthermore, associative and ascriptive senses are not always distinctive and mutually-exclusive sense types (see section 3.2). Different adjectives display differing amounts of distinction between senses: While e.g. *mechanical engineer*$_{\text{ASSOC}}$ has no semantically-identical analogue in predication, e.g. *dental decay*$_{\text{ASSOC}}$ does. However, *dental* does not behave identically to classically-ascriptive adjectives such as *red* or *big*: Namely, both the

acceptability of a given construction and the exact meaning denoted by such constructions is highly irregular. For example, the meaning denoted by *dental* in *dental decay* is not identical to the meaning denoted by *dental* in *dental expert*.

The distinction in the meaning denoted between any two constructions involving the same modifying adjective is not motivated by a lexical distinction (cf. section 2.1, 2.2): Rather, it seems that the traits which are able to be denoted are determined by semantic collocational restrictions. This is not different from the fashion in which ascriptive adjectives denote traits: For example, the meaning of *big* in *big house* differs from that of *big* in *big problem*.

Not only are associative and ascriptive adjectives not always distinct from one another, but the exact meaning denoted by either association or ascription is irregular and dependent on semantic collocational restrictions. The specific traits denoted by either association or ascription is very much dependent on the head being modified. Thus, there is little semantic difference between associative and ascriptive senses apart from the "association" of one entity with another denoted by associative senses (e.g. associating *engineer* with mechanics in *mechanical engineer*).

In conclusion, the difference in sense between association and ascription seems less like a categorical distinction and more like a spectrum of 'directness' in the nature in which traits are denoted by an adjective: e.g. *mechanical* denotes traits in a less direct manner than *tropical* does (due to the mutually-exclusive associative-ascriptive sense pair of the former contrasted with the ambiguous sense of the latter), while *tropical* is less direct than *big* due to it not being associative at all. Without such a categorical distinction, associative and ascriptive adjectives can be relegated as simply two of many adjectival classes which show behaviour differing slightly from one another (cf. Pustejovsky 1995: 20ff). These observations complement those of McNally & Boleda (2004), where both association and ascription are analysed as intersective properties of kinds of entities (roughly analogous to the 'associative' reading of adjectives) which may also often denote properties of individual entities (roughly analogous to the 'ascriptive' reading of even classically-associative adjectives).

## 4. Ontological issues

### 4.1 *Introduction*

As explained in section 3.4, adjectives serve to denote traits of the entity they modify, regardless of whether they are done so in a very 'direct', predicate-like manner (i.e. in the fashion of classically-ascriptive adjectives) or in a relatively 'indirect' manner which cannot be easily described as a predicate. However, the exact meaning of such adjectives and any adjectival construction is not easily generalised. Likewise, entities which are a member of a given set of entities able to be denoted by a particular construction (e.g. all things denoted by *hibiscus*, which are also able to be denoted by *tropical plant*) may not inherit all the traits from their superclass (e.g. Hibiscus does not inherit ¬tolerate(*x*, Cold) although other subclasses of Tropical_plant may do).

It will be argued that the exact meaning of any construction (in other words, the set of individual semantic traits inherited an entity denoted by any construction) is motivated by the family resemblance of entities to one another rather than by a strict ontological hierarchy of

class-based inheritance relations. Furthermore, semantic traits in themselves ($\alpha(x)$ – e.g. *electronic lock* → $\exists x(\text{lock}(x) \wedge \text{electronic}(x))$ denote family resemblances and therefore as relationships to other entities featuring the trait in question.

4.2 *Denoted traits are not inherited according to a classical ontological model*

There is no lexical distinction between association or ascription (see section 2), and there is no categorical distinction between association and ascription in terms of regularity of meaning (see section 3): The exact meaning denoted in the case of either association or ascription is largely dependent on semantic collocational restrictions – Consider the irregularity in the inheritance of even a small example subset of traits:

(8) a. 1. a. tropical fish ~ this fish is tropical → {¬tolerate(*x*, Cold), colourful(*x*), $^{\#}$humid(*x*), $^{\#}$warm(*x*) ...}
b. tropical plant ~ this plant is tropical → {¬tolerate(*x*, Cold), colourful(*x*), $^{\#}$humid(*x*), $^{\#}$warm(*x*) ...}
2. a. tropical storm ~ this storm is tropical → {$^{\#}$¬tolerate(*x*, Cold), $^{\#}$colourful(*x*), humid(*x*), warm(*x*) ...}
b. tropical climate ~ this climate is tropical → {$^{\#}$¬tolerate(*x*, Cold), $^{\#}$colourful(*x*), humid(*x*), warm(*x*) …}

b. 1. a. big dog ~ this dog is big → {large(*x*), strong(*x*), $^{\#}$significant(*x*), $^{\#}$imperative(*x*) …}
b. big house ~ this house is big → {large(*x*), strong(*x*), $^{\#}$significant(*x*), $^{\#}$imperative(*x*) …}
2. a. big issue ~ this issue is big → {$^{\#}$large(*x*), $^{\#}$strong(*x*), significant(*x*), imperative(*x*) …}
b. big problem ~ this problem is big → {$^{\#}$large(*x*), $^{\#}$strong(*x*), significant(*x*), imperative(*x*) …}

Both classically-associative adjectives (cf. examples in (8a) and classically-ascriptive adjectives (cf. examples in (8b) denote traits in an irregular fashion. It is possible that there are multiple senses denoted by e.g. *tropical* and *big* and the specific sense denoted by *tropical* is ambiguous without context (the head it modifies). However, the great productivity of predicative constructions featuring *tropical* combined with the predictable nature of the sense denoted depending on the head it modifies suggests that these senses are motivated in a more systematic way than this assumption proposes.

It could be said that such traits are denoted according to IS-A ('is an instance of') relationships in a classical ontological hierarchy, e.g. the classes of entities known as Fish and as Plant are subclasses of the class Life, and thus an instance of Fish or Plant is not only an instance of the respective class but also an instance of Life (cf. Brachman 1983): It is possible that because e.g. both Fish IS-A Life and Plant IS-A Life, *tropical fish* and *tropical plant*, in denoting the intersection of things both Life and things associated with 'the_tropics, commonly inherit the trait ¬tolerate(*x*, Cold) while inheritance of the traits humid(*x*) and warm(*x*) is precluded by the semantic collocational restrictions of the class Life. Inversely, it is possible that Storm ¬IS-A Life and Climate ¬IS-A Life and therefore do not inherit ¬tolerate(*x*, Cold), while Storm IS-A Environment and Climate IS-A Environment and thus inherit the trait humid(*x*).

Nevertheless, consider e.g. *hibiscus*: Hibiscus IS-A Tropical_plant but there are many subclasses (in fact perhaps the majority) of Hibiscus which feature tolerate(x, Cold). If the denotation of semantic traits was inherited from an entity's superclass(es) according to a rigid interpretation of a classical ontology, such "non-prototypical" traits would not occur. In conclusion, it seems that the inheritance of traits cannot be modelled by a strict ontological hierarchy.

4.3 *Inheritance of a given trait may be ambiguous*

Not only are traits not inherited according to a strict IS-A relationship, but the inheritance of a particular trait given an utterance is not always unambiguous – consider e.g. *tropical disease ~ this disease is tropical* → $^{?}$¬tolerate(*x*, Cold)/$^{\#}$humid(*x*): The acceptability of the presence of the trait ¬tolerate(Disease, Cold) is ambiguous, e.g. it would seem strange to assume that a person (which can have the trait tolerate(*x*, Cold)) infected with an instance of Tropical_disease will be cured by experiencing Cold by causing the infection to die: It seems that the trait ¬tolerate(*x*, Cold) cannot be universally applied to the set of entities able to be denoted by *disease*. Nevertheless, *tropical disease* is acceptable.

It is alternatively possible that the trait is associated with Tropical_disease through e.g. the carrier of the disease: For example, members of the set of entities able to be denoted by *mosquito* readily feature the trait ¬tolerate(*x*, Cold), and thus a disease carried by such an entity is not likely to be found in a cold climate. Alternatively, *tropical* in *tropical disease* may denote a more general meaning, one not used only for instances of Life (as many instances of Disease, such as Virus, do not satisfy all the conditions of being true life forms): *tropical* may ascribe a more general trait of ¬located_in(*x*, 'the_tropics) to *disease*.

Regardless of the exact nature of trait inheritance, it seems that in many cases, the inheritance of a given trait is not always as straightforward and unambiguous as traits denoted explicitly by ascription ($\alpha(x)$), e.g. red(*x*) in *red book* (rather than being implicitly denoted implicitly through inheritance). In fact, even the exact nature of such directly-denoted traits may be ambiguous, c.f. *red hair ~ this hair is red*, which may denote hair which is e.g. either (naturally) ginger or is bright crimson (artificially dyed) (or any other shade of red, for that matter).

In conclusion, the inheritance of a given trait is not absolute given a particular instance of inheritance: A trait $\alpha(x)$ may not always be inherited by all instances of *x*, and the inheritance or non-inheritance of a given trait is not always unambiguous.

4.4 *Inheritance of traits is motivated by family resemblance*

As stated above, the traits inherited by a denoted instance of a set of entities (e.g. the entity denoted by an instance of *tropical plant*) cannot be easily modelled by a classical hierarchy of ontological IS-A relations, and the inheritance of a given trait may not be unambiguous. However, generalisations may still be made: If an entity is a member of a particular set, given no evidence supporting the contrary, it can be naïvely assumed that the given entity inherits (all of) the traits of the particular class:

(9) $$D = \underset{\alpha_i \in A}{\forall} \underset{\beta_j \in B}{\forall} \frac{\alpha_i(x) : \beta_j(x)}{\beta_j(x)}$$

In other words, there is the default assumption *D* stating that if an entity *x* is an instance of the class *α*, and *α* is a member of the set of classes *A*, it may be concluded that, without any evidence proving otherwise (i.e. without collocational restrictions), *x* features every trait *β* in the set of traits *B* associated with *A* (cf. Reiter 1980).

Conversely, the reverse is also true: given the presence of traits prototypical to a given set of entities, a default assumption may be made that the entity in question is a member of that set. For example, with world knowledge that the set of entities able to be denoted by *monkey fish* is a subset of that able to be denoted by *tropical life* (Monkey_fish IS-A Tropical_life), it inherits the trait ¬tolerate(*x*, Cold). Likewise, if *monkey fish* → ¬tolerate(Disease, Cold), it is likely that Monkey_fish IS-A Tropical_life.

With these assumptions, a naïve model may be created in which if there is no previous idiosyncratic knowledge of a given entity (e.g. tolerate(*x*, Cold) in the case of Hibiscus) then it has all the traits of the set(s) of which it is a member. However, the more traits a given entity has in common with a set of entities in question, the more likely the entity is a member of that set – although, as stated in section 4.2, not all members of a particular set of entities must feature an identical set of traits with all other members of the set. Likewise, it seems that the fewer the traits a given entity or subfamily has in common with a given family or superfamily, the less readily-acceptable the IS-A relationship is: For example, despite that, botanically, Tomato IS-A Fruit, it is not as prototypically 'Fruit-like' as e.g. Apple, Lemon or Blackcurrant in a culinary sense, as Tomato typically lacks certain core traits of Fruit such as sweet(*x*), sour(*x*) or tart(*x*), i.e. traits which are typically associated with the family. This phenomenon is also observable in new formations: For example, while *monkey fish* may entail an instance of Tropical_fish, it does not follow that *monkey fish* entails ¬tolerate(*x*, Cold) (analogously to Hibiscus ISA Tropical_plant).

Thus, rather than family membership being absolute, it is a similarity measure of a given entity to the family in question: For example, the similarity of one entity to another can be measured using e.g. Tversky similarity, where *A* is the set of traits of the entity in question and *B* is the traits of the entity to which the first is compared. α, β and γ are constants representing the variation among individuals in how similarity is measured (Tversky 1977):

$$S_{Tversky}(A,B) = \alpha f(A \cap B) - \beta f(A - B) - \gamma f(B - A) \tag{10}$$

By using such a metric to compare all entities to all other entities, a family can be modelled as a subset of entities which have a relatively-high mutual measure of similarity to each other. Thus, a naïve measurement of a given entity's resemblance to a given family would be a function of the similarity of the entity in question to all the entities in the family:

$$S(A,F) = \frac{\sum_{B_i \in F}^{N} S(A,B_i)}{N} \tag{11}$$

In other words, the naïve measurement of similarity of an entity with the set of traits *A* is the mean similarity of the entity to all the members of the set of entities *F*. Making an absolute judgement of family membership would involve comparing this similarity measurement to the theoretically minimal possible similarity measurement an entity could have while still

being a member of the family:

(12) $M(A,F) \leftrightarrow S(A,F) \geq \alpha$

In other words, the membership function *M(A,F)* returns *true* if and only if the similarity measurement *S(A,F)* is equal to or greater than a given constant $\alpha$.

In conclusion, the organisation of entities is done according to family resemblance, where family membership is motivated by a measure of similarity to the other members of the family according to the semantic traits the feature. These phenomena are well-defined, notably by Quillian (1967), who developed a conceptual network of entities related to each other by the traits related or ascribed to them. Thus, the presence of traits common among family members may identify an entity in question as a member of that family, while it may be a more- or less-prototypical member of such a family than another entity (cf. Wittgenstein 1953). In conclusion, traits inherited by constructions such as associative *tropical plant* and even ascriptive *red book* are not inherited according to a strict ontological hierarchy but rather according to a system of family resemblances, where such constructions denote a member of a family of entities which are members of both the family denoted by the head (e.g. *plant* or *book*) and also the family denoted by the modifier (e.g. *tropical* or *red*).

### 4.5 *Traits denote family membership*

While the inheritance of traits by an entity is motivated by a function of the family or families of which the entity in question is a member and a measure of how prototypical the entity is to each family from which it inherits traits, even the traits inherited are fuzzy and display variations in prototypicality: For instance, Apple IS-A Fruit and Banana IS-A Fruit, and *apple* and *banana* both feature contain(x, Seed). However, contain(Apple, Seed) is a much more prototypical instance of contain(*x*, Seed) than contain(Banana, Seed) is, the seeds of apples being more prototypically Seed-like than those of the bananas. It can be said that Apple and Banana are both members of the family denoted by contain(*x*, Seed), but Apple is more prototypical of the family of seed-containing things than Banana is.

In conclusion, inherited semantic traits (e.g. *apple* → contain(*x*, Seed)) behave in the same way as traits denoted directly (e.g. *apple* → apple(*x*)), and so all traits may be modelled as indicators of family membership. This entails that such traits are also non-absolute and are in fact a similarity measure to other entities as described in section 4.4.

### 4.6 *Conclusion: Entities and traits are organised according to family resemblance*

Associative and ascriptive senses both can be described as denoting a set of semantic traits to the head they modify in the same way that the head in question denotes its own set of semantic traits on its own: In this way, the adjective *red* is semantically not unlike the noun *book*, with the exception that *book* denotes a bearer of referential index (Baker 2003: 95-158). These traits inherited from neither the modifier nor the head itself are inherited according to a strict ontological hierarchy of class-based IS-A relations. Rather, traits display the behaviour of a system based on family resemblance. Traits are not absolute, and rather serve as a measure of how similar a given entity is to a family in question, e.g. the set of entities able to be denoted by *red shirt* may on average be more prototypically red(*x*) than the set of entities able to be denoted by *red wine*.

While, a classical ontology cannot easily represent an organisation of entities based on their relationships to other entities with similar traits, a semantic network could (cf. Quillian 1967): A number of semantic models have already been designed based on semantic networks, such WordNet (Fellbaum 1998), and it is possible to create a semantic network based on similarity measures (cf. Schvaneveldt et al. 1989), analogous to the formation of families based on the common similarity of their members.

It may be possible to define a network family relationships where a single family consists of a cluster of entities which share a large amount of common edges connecting the, to each other (i.e. a large number of common traits among them), and therefore which have a high mutual similarity measure. For example, many entities able to be denoted by *tropical* may feature ¬tolerate(*x*, Cold), located(*x*, 'the_tropics), humid(*x*) and/or warm(*x*): The more edges two given entities have in common, the more similar they are and vice versa. Moreover, even the traits mentioned in this paper seem to display the characteristics of families in themselves, as the presence or absence of these traits is not absolute but rather relative: If "traits" and "family resemblances" are ultimately the same phenomenon, an entity's specific semantic structure may be derived from the complex network of relationships it has with other entities (Croft 2004; Taylor 1995).

## 4. Conclusion

In this paper, it has been shown that classically-associative and -ascriptive adjectives are not separate (sub-)categories either grammatically or lexically as they may have been described by some (cf. Bally 1944; Giegerich 2005a, 2005b; Huddleston & Pullum 2002). Adjectives freely denote either associative or ascriptive senses, and the distinction between these senses is often ambiguous. Both associative and ascriptive adjectives denote a set of traits to the head they modify, just as the head itself does.

The distinction often seen between the two groups of adjectives is motivated by the semantic compositionality of the construction in which they appear: Although the distinction between the two senses varies among languages, instances which denote traits very directly and in a predicate-like way ($\alpha(x)$ – e.g. *electronic lock* → $\exists x(\text{lock}(x) \wedge \text{electronic}(x))$ are more likely to show 'ascription-like' morphosyntactic behaviour, while adjectives which denote traits in a more indirect manner are more likely to show 'association-like' behaviour ($^{\#}\alpha(x)$ – e.g. *electronic engineer* → $^{\#}\exists x(\text{engineer}(x) \wedge \text{electronic}(x))$. This analysis agrees with McNally & Boleda's (2004) analysis of adjectives as denoting properties of kinds as opposed to (always) denoting only properties of individual entities: In the case of classically-ascriptive adjectives like *red* in *red book*, traits are denoted directly to the entity denoted by the head which the adjective modifies. In the case of classically-associative adjectives like *electronic* in *electronic engineer*, traits are inherited indirectly from the family denoted by the adjective.

It has been shown that entities are organised not by class-based IS-A relationships, but rather by fuzzy family resemblances: The more prototypical a given entity is to a family in question, the more traits it has in common with other family members, and vice versa. In fact, such semantic traits ($\alpha(x)$) denote family resemblance in themselves, being non-absolute and showing degrees of prototypicality as well as denoting similarity to other entities featuring the given trait.

It may be possible to define a network-based semantic model based on the relative similarities of each entity in the model, forming 'families' by clustering entities with a high

mutual similarity measure. However, in this paper, there is no attempt to create a formalisation of an entire semantic network in this fashion and to model. Such a model may also be cognitively plausible, as explored by e.g. Schvaneveldt et al. (1989) and Tversky (1977), but these claims should be investigated empirically through methods in cognitive science and/or experimental psychology.

## Notes

[1] Acknowledgements to the reviewer for supplying the Dutch examples in the paper.

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In *SKASE Journal of Theoretical Linguistics* [online]. 2010, vol. 7, no. 3 [cit. 2010-12-15]. Available on web page <http://www.skase.sk/Volumes/JTL17/pdf_doc/01.pdf>. ISSN 1339-782X.