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Analogy in Semantics

Abstract. The principle of compositionality seems too trivial and too restrictive at the same time. I propose that this principle should be seen as (part of) a definition of what "meaning" is in a theory that posits a very abstract concept of "meaning", one very far from empirically testable reality. The principle of compositionality presupposes an analytic/atomistic approach to meaning, where the properties of a whole must be explained in terms of those of its constituent parts. In my paper, I will propose a *holistic* approach instead: I will emphasise the global features of signs. I will introduce the principle of *generalized compositionality*, which is based on the concept of similarities between forms and meanings. My generalized compositionality principle states that we interpret and produce complex signs by analogy, relying on our earlier experience on similar complex signs and their interpretation. This move, I believe, is necessary for moving towards a cognitively more realistic model, with a view to predicting frequency effects and other psychological factors of interpretation. As a side-effect, the dubious distinction between "literal" and "non-literal" interpretations disappears.

INTRODUCTION

In this paper I will argue for a model of natural-language semantics that diverges in important ways from the main-stream approach, but it fits well within a more general cognitive framework in which language is viewed as a system of habits, in much the same sense as it was viewed in the late 1800s and in European structuralism.

I will start from two different families of problems, namely, the distinction between "literal" meanings and actual interpretations, e.g., in the case of metonymical language use (section *1.1*), and an ambiguity related to disjunctions used in negative contexts (section *1.2*). I will show that both of these types of

problems pose serious challenges for the traditional machinery of semantics that posits a compositional "translation" process that produces logical formulae.

I then turn to the formulation of and the inherent problems with the principle of compositionality (section *2.1*), and I will propose a different principle, which I call *generalized compositionality*, which avoids the pitfalls of traditional compositionality (section *2.2*). I will argue that this alternative formulation can serve as the fundamental principle of *analogy-based semantics*, a view of semantics that does not require "underlying", abstract syntactic representations or a distinction between "literal" and "non-literal" interpretation. I will briefly return to the linguistic problems that constitute the starting-point of the discussion, and outline ways of approaching them in analogy-based semantics. I conclude, in section *2.6*, by sketching a model of associative memory that can serve as an implementation of the machinery of analogy-based linguistic theory.

1 TWO PROBLEMS IN LINGUISTIC SEMANTICS

1.1 Non-literal meaning and abduction

As pointed out in (Hobbs *& al.* 1993), even the simples sentences, like his *The Boston office called*, contain *implicit information*, i.e., propositions that are *plausible* for the audience to assume, and without which we cannot speak of making sense of, interpreting, or understanding what the sentence "literally" says. In this sentence, for example, the audience has to figure out (among other things) that *the Boston office* is an office located in Boston, and that someone working at that office (rather than the office itself) placed the call. (Hobbs *& al.* 1993) propose to consider this mechanism a case of abduction, i.e., to consider the "literal" interpretation of the sentence as a conclusion, and the plausible assumptions the audience has to take on as missing premises, which would then make the conclusion true.

Unfortunately, the two key terms that I have just employed, *plausibility* and *literalness* are very hard to grasp, and there is hardly a consensus surrounding them. For example, it is not clear why 'someone working at the Boston office called' is more plausible than, say, 'someone who happened to be at the Boston office called'; or, to take another example, it is not clear what the "literal meaning" of a compound like *Boston office* is: 'an office somehow related to Boston' (as (Hobbs *& al.* 1993) assumes, in which case we have to rely on abduction again to get the metonymical interpretation) or 'an office located in Boston', and it is also not clear whether this expression is ambiguous, i.e., whether it has more than one "literal meaning".

From the linguistic point of view, the approach taken in (Hobbs *& al.* 1993) illustrates nicely the paradigm going back at least to (Grice 1967), according to which utterances can be assigned context-independent, purely linguistic,

"literal" *meanings*, which leave much uncertainty as to the appropriate interpretation in a given context. In Grice's (1967) view, it is the anomalies and contradictions arising from this basic "meaning" that give rise to all sorts of implicit information that the audience tends to assume, in order to resolve the anomalies, and thereby arrive at a contextually determined "non-literal" interpretation. The process often involves ontological (real-world) knowledge and pragmatic considerations. In (Hobbs *& al.* 1993), no anomaly is needed to trigger this process: implicit information is always retrieved until a *maximal consistent* stock of background knowledge is incorporated into the interpretation through abduction (by assuming only *maximally plausible* pieces of information).

This model of understanding heavily relies on a dichotomy between "linguistic knowledge" (driving the translation mechanism that produces a "meaning" from a linguistic expression), on the one hand, and "background knowledge", from which plausible assumptions are retrieved by the abduction process. But this dichotomy is disputable. For example, in the case of *Boston office*, the abduction process must use an axiom in the knowledge base according to which "$\texttt{located\_at}(y, x) \rightarrow \texttt{rel}(x, y)$", where the translation of *Boston office* contains "$\texttt{office}(x) \wedge \texttt{boston}(y) \wedge \texttt{rel}(x, y)$", so "$x$ is located at y" is a plausible premise for x standing in the relation "$\texttt{rel}$" with y, and the conclusion is part of the "literal meaning" of *Boston office*. But it is not at all clear why just the use of the mysterious relation"$\texttt{rel}$" is part of the "linguistic" module, whereas possible interpretations of such compounds are located in the "background knowledge", although they are clearly of a linguistic character, too (as shown by the fact that the same type of compounds cannot be interpreted in this way in Hungarian: there, a suffix must be added to *Boston* in order for it to refer to the location of the office).

In general, there is no universal recipe for deciding whether a certain ingredient of understanding (in our example, 'the office is located in Boston') should stem from "linguistic knowledge" (in our example, this would amount to a particular "compounding rule" to this effect), or from "background knowledge" (in our example, this corresponds to the approach in Hobbs *& al.* 1993). There is no accepted philosophical, linguistic or psychological evidence for deciding either way for any particular case.

The shakiness of the distinction between "linguistic" and "background" knowledge is not a purely theoretical problem. In particular, it is challenging for any potential *mental model* of the mechanism of understanding, in particular a model of *acquisition*, on the one hand, and a model capable of predicting *performance data*, on the other. It is not obvious, to say the least, how the distinction between "linguistic" and "background" knowledge could be learned, and I do not believe there is any psycholinguistic evidence to the effect that the "translation" of an expression such as *the Boston office* (i.e., retrieving its

"literal meaning") should be separable from the process of interpreting it using background knowledge.

1.2 Disjunction of NP's

Let me now turn to a completely different problem, or rather a family of problems, unrelated at first sight to those explained in *1.1*. These problems, which have puzzled semanticists for a long time (e.g., Szabolcsi 2002; Szabolcsi & *al.* 2004), are connected to the interpretation of *disjunction* in various embedded positions. For example, consider the following ambiguity:

(1) *He didn't close the door or the window.*
   a. 'He left both the door and the window open'
   b. 'He left either the door or the window (or both) open'

Szabolcsi (2002) explains the ambiguity in an essentially syntactic way (although she relies on features that can be viewed as having semantic content). She claims that, under one interpretation, negation "has a wider scope than" disjunction, whereas the opposite holds when the other reading is to be obtained:

(1′) a. ¬('closed the door' ∨ 'closed the window')
   b. (¬'closed the door' ∨ ¬'closed the window')

Note that in order to obtain these readings, highly unnatural (abstract, covert) syntactic structures have to be assumed: both of these formulae are very distant from the surface structure of the sentence in (1). Thus, this mechanism requires a non-deterministic "translation" step from any theory that respects compositionality.

The situation is even worse when negation is not explicit, but inherent in the predicate, as in the following example:

(2) *You forgot to close the door or the window.*
   a. ¬('remembered to close the door' ∨
      'remembered to close the window')
   b. (¬'remembered to close the door' ∨
      ¬'remembered to close the window')

In order to get the interaction of negation and disjunction here, one has to assume a representation in which the negation inherent in *forget* is made explicit by converting it into *not remember*.

While the problem explained in *1.1* allegedly concerns how we arrive at the desired interpretation from the "literal", "linguistic" meaning, the problem of interpreting disjunctions seems related to the "translation" itself, i.e., to how we get from a surface utterance to the "literal", "linguistic" meaning.

Under the standard approach, in order to account for ambiguities like the one presented here, we must assign two different logical formulae to one and the same utterance, depending on factors that are not entirely clear.

In both cases, there is a gap between a surface expression and its interpretation, i.e., both problems challenge the traditional, *compositional* approach to semantics, which consists in assigning a logical representation to utterances in a systematic way, then interpreting that representation with respect to a model of the world. It looks like we have to revise the concept of compositionality in the sense it is normally used while, for obvious reasons, we do not want to deny the systematic character of interpreting natural-language utterances.

2 GENERALIZING COMPOSITIONALITY

2.1 Problems with compositionality

The principle of compositionality is usually stated as follows:

(3) *The principle of compositionality*
The meaning of a complex expression is a function of the meanings of the constituents which syntactically constitute it.

This principle, attributed to Frege, is considered the starting-point of modern semantics, aiming at establishing and examining the systematic relationship between form and meaning in natural language. It is commonly thought of as saying something fundamental (in fact, almost trivial) about meanings and the science of meanings. On the other hand, it has puzzled most modern semanticists in various ways because of the multitude of phenomena that it does not naturally apply to. To mention a couple of those, there is the context dependence of the use of many, if not all, linguistic expressions (so the context of utterance can be seen as an additional factor, not mentioned in the principle of compositionality, potentially influencing the possible use of a complex expression), and there are legions of obviously complex expressions in all natural languages the meaning of which is "non-compositional" or idiomatic to a smaller or greater extent (which means that their meanings are more or less unrelated to the meanings of their constituent parts).

As for context dependence, the received view seems to be that the principle of compositionality is a methodological axiom that demarcates what is covered by part of the definition of meaning exactly by eliminating those properties of linguistic use that depend on contextual information. That is, context dependence does not contradict compositionality; to the contrary, compositionality carves out just those aspects of the use of linguistic signs that are independent

of context,[1] and constrains the term *meaning* by excluding all other aspects (and tacitly relegating them to some other field of study, say, "pragmatics").

The problem of those expressions that are idiomatic to some extent is a much tougher one. We could approach this problem in the same vein as context dependence, by saying that the principle of compositionality limits semantic study to the so-called "compositional" (non-idiomatic) constructions, but it is not at all clear where the boundaries would lie, and what such a semantics could do with mixed cases when a complex expression has both idiomatic and non-idiomatic aspects. For example, an idiom like *spill the beans* has the same aspectual and thematic features as its main verb *spill* does (it is agentive and expresses an accomplishment or an achievement), so it is "transparent" in this respect. (As a matter of fact, the view that there is a concept of "meaning" that abstracts away all context dependence, can be challenged in a similar vein, but I will not go into that discussion here.)

So buying into the principle of compositionality seems to represent an important sacrifice for a truly scientific approach to meanings. On the other hand, it can be shown that it is ridiculously easy to still satisfy the principle, given the fact that the concepts of *meaning*, *syntactic constitution* and *function* figure in it without any further specification or constraint. The principle imposes no constraint on ambiguities (of the expressions constituting a complex one) and on the process on their resolution. For example, take the understanding of *The Boston office called:* the principle of compositionality does not constrain how *office* and/or *call* are to be disambiguated. For example, it is not a violation of compositionality if one uses "global" information on what the whole utterance (or even the text that it occurs in) is about, or what the speaker's intentions are. This means that, effectively, there can be wildly non-compositional steps in a strictly speaking compositional interpretation process.

So both "non-compositional" constructions and context dependence can be "explained away" by appealing to the presence of multiple (possibly infinite) ambiguities and obscure mechanisms for their resolution. Meanings can be of any nature whatsoever, so it is possible to encode not only semantic, but also formal properties in them. As an extreme case, we can posit that the "meanings" of constituent expressions specify their interpretation for each (type of) complex expression they occur in, which is compatible with the definition, yet it would make compositionality entirely empty. As for the concept of "function", a function can do just about anything and, by taking this to the extreme, one can arrive at wildly unnatural, yet compositional mechanisms of interpretation—like ignoring the meaning of a constituent; for other examples, see, e.g., (Zadrozny

[1]Sometimes context still plays a role, when reference to context is said to be built into "meanings". For example, the fact that the personal pronoun *I* refers to the speaker is said to be part of its "meaning", while the context determines who the speaker actually is. Cf. (Gendler Szabó 2000) for a summary.

1994)). Finally, the principle of compositionality contains no proviso to the effect that syntactic structure be determined independently of semantics. As a matter of fact, most syntactic constituency tests (such as substitutability or mutual information) are implicitly based on the greater semantic cohesion between certain structural elements than that between others within a construction. So there is ample space for "playing around" with syntactic structure in order to satisfy compositionality.

2.2 Generalized compositionality

As I have pointed out in the previous section, the principle of compositionality is both too strong and too weak, too restrictive and too liberal at the same time. I have also mentioned that, still, it is essential to adopt it in some form or another, inasmuch as it captures one of the leading ideas of the linguistics of the late 19th century, namely, that the productive aspect of natural languages is due to the *systematicity* of our ability to understand utterances. That is, we can only understand an utterance if it is built up in a similar way to utterances we have seen earlier, and we interpret it by *analogy* to how those earlier utterances were used. By the same token, we are able to communicate through utterances if we utter ones that are sufficiently similar to those the audience is familiar with, and we have to take into account that they will be interpreted in the same way as the audience's earlier experiences dictate.

The key concepts here are *recurrence* and *similarity* rather than "meaning", "function" and "constituency", but the basic idea, I believe, is the same as in the case of the principle of compositionality. Not only elementary signs, but also their combinations must show a sufficient amount of similarity to combinations seen earlier in order for them to be understandable, which means that the way they are combined must also be recurrent, and their interpretation is to be calculated *mutatis mutandis*, by a possible recombination of signs and associated uses seen earlier. This corresponds to the emphasis put by the compositionality principle on the role of syntactic combination.

However, the reformulation I am about to propose also differs from the compositionality principle in important respects. Both similarity and recurrence are *gradual* concepts, because one expression or meaning can be similar to another not only in various aspects, but also to varying degrees, and the recurrence of a pattern (the frequency of its previous occurrences or the strength of the memories we have of them) also comes in degrees. The linguistics of the mid-20th century was reluctant to use models involving gradualness, but since many human systems, especially mental ones, clearly show gradualness effects, it will be hard to avoid appropriate stochastic models in the long run. So my generalized principle can be formulated along the following lines:

(4) *The principle of generalized compositionality*
To achieve maximal understanding, if we want to express an idea I, then we had better use an expression E that is maximally similar to the most frequent expressions E' which, to our knowledge, express ideas I' maximally similar to I. Also, this is the strategy that a hearer assumes other speakers to use.

The reason why I dare call this principle a generalization of compositionality is that it also expresses that different forms that show some parallelism are interpreted in parallel ways. Under traditional compositionality, formal parallelism is restricted to constituent structure, and semantic parallelism is restricted to the identity of the functions that combine the constituents' meanings. Thus my reformulation of the compositionality principle, in addition to the gradualness inherent in it, also crucially lacks a reference to syntactic constituency. For example, in the example I have examined earlier, it is crucial that *Boston office* is similar to expressions frequently heard earlier, in the sense that, in those expressions, the first word was similar to *Boston* (not in the phonological sense, but in terms of being names of places) and the second was similar to *office* (again, not in terms of their form, but their function), and those expressions were interpreted analogously to *Boston office*. These similarities involve "constituents" (it does matter that *Boston office* is built up of two sub-expressions in a particular linear order), but the similarity between "constituent structures" is just one particular case of many types of similarity. For example, similarities between word forms (i.e., the morphological built-up of words) is often not restricted to linear, concatenative similarity. As a matter of fact, as we have shown elsewhere (Kálmán *& al.* 2005), it would be wrong to consider linear and concatenative morphology as "normal" and qualify all other cases as deviant.

2.3 Analogy-based semantics

My claim is that the principle of generalized compositionality in (4) not only amends the weaknesses inherent in the traditional concept of compositionality, but also solves problems like those presented in *1*. That is, it offers an alternative, more appealing approach to how linguistic and background knowledge contribute to possible interpretations, and to how ambiguities arise in various contexts.

To explore this alternative, I will assume that, as long as we lack evidence to the contrary, there is a single stock of knowledge for "linguistic" and "background" knowledge, i.e., an ontology that comprises knowledge about both linguistic and extra-linguistic entities. Syntactic structures are based on surface utterances, no "underlying" or "abstract" structure is posited. No "translation" occurs at all; the structure of an utterance plays a role only inasmuch as it expresses the formal *similarity* of one utterance to the other.

Instead of translating expressions into a logical language, we just retrieve information associated with the linguistic entities perceived, be it linguistic or extra-linguistic in character. Thus, information, linguistic and non-linguistic alike, is activated through *association*. In the examples quoted in *1.1*, the relevant information comprises everything related to *Boston* and *office* and their syntactic arrangement (i.e., this particular type of compound). Those pieces of information get activated, together with all the information originating from the rest of the utterance and the utterance context. In the case of the problem in *1.2*, the relevant information that gets invoked includes the formal and functional aspects of other instances of clauses embedded in (negative) predicates, other instances of NP disjunctions, etc.

2.4 The abduction process

Independently of whether we assume two separate modules like (Hobbs *& al.* 1993) or a unique network-like knowledge base, the abduction process must be an optimization of continuous variables, since plausibility is gradual. The task is a quite complex one: as I have pointed out earlier, we have to retrieve a *maximal consistent set* of *maximally plausible* abduced premises for a set of conclusions. For (Hobbs *& al.* 1993), the conclusions are constituted by the "translation" of the input utterance; in my view, they must consist of all we might consider *empirically maximally certain*, i.e., what has been perceived, in whatever way we model that. For the example of *Boston office*, this means that we can only take it for certain that the words *Boston* and *office* have been uttered in this order (plus whatever contextual information we want to take into account).

To be sure, plausibility must rest on probability or frequency: the more probable or frequent a state of affairs is, the more plausible it is to assume it (at least with a certain probability) given that we have some evidence for the truth of something that follows from it (again, the probability that this evidence is reliable may vary). Our aim is to maximize the joint probability of the entire set of propositions, perceived and abduced, taken together. We also have to take into account the *synergy* of perceived facts and plausible assumptions, in the sense that taking the joint probability of several antecedents taken together may yield a different result from just looking at their probabilities one by one. For example, take our example *The Boston office called*. Hobbs *& al.* (1993) argue that the most plausible assumption to make is 'someone working at the Boston office placed the call', because only humans can make telephone calls, and relating a human to an office can be done most plausibly by assuming that the person works there (how exactly this is achieved by (Hobbs *& al.* 1993) is irrelevant here). However, *call* is itself polysemous (animals or even machines can call as well). On the other hand, even if calling was uniquely human, this would not ensure for the above abduction to be correct: *The Boston office is on holiday* would

not be interpreted (if it is interpretable at all) as 'someone working at the Boston office is on holiday' but rather as 'everyone working at the Boston office is on holiday'. It is only the synergy of all more or less plausible premises, i.e., their high joint probability, that makes the abduction suggested in (Hobbs *& al.* 1993) really plausible.[2]

These conditions suggest a solution in the spirit of *Bayesian networks*—e.g., (Pearl 1985) or *Markov logic networks* (Richardson *& al.* 2006). Calculations using both of these models are extremely complex, which suggests that *massively parallel* computational mechanisms are required in order to deal with them with reasonable resources. The model that I will propose shortly, in *2.6,* is intended to solve this.

2.5 Accounting for NP disjunction

In accordance with the alternative approach proposed here, when interpreting sentences like (1) in *1.2*, we do not depart from their genuine (surface) syntactic structure, and try to derive their interpretations from what the sentence actually looks like. In particular, we must take into account how sentences with a negative content and, in particular, the arguments of negative predicates are interpreted in other cases. On the other hand, we also have to look at how the disjunction and, in general, the co-ordination of NP's is interpreted in other cases. Interpretation has to proceed by analogy to all those other cases.

This approach has two obvious consequences which I think are desirable. First, it predicts that uncertainty may arise in the interpretation of the utterances in question if there are analogous structures with conflicting interpretations. Such uncertainties are hard to explain if one assumes a compositional semantics producing a logical form, given the fact that, informally speaking, we are dealing with the simplest syntactic structures and the simplest logical connectives. Second, it predicts that the interpretation of such utterances may show peculiar differences from one language to the other, even if independent arguments for structural differences would be hard to find.

In sum, I will assume that all the examples discussed in *1.2* and here contain disjunctions of noun phrases (i.e., we must not convert the disjunctions into sentential ones), embedded into (explicit or implicit) negation (i.e., there is no "scope ambiguity" involved). The idea is somewhat similar to Scha's (1981), who argues against reducing plural or co-ordinated arguments to quantificational structures, and for conceiving of them as marking *predication about collections*. That is, when using a disjunction of noun phrases, one talks about collections the

[2]There are also additional propositions to be abduced that (Hobbs *& al.* 1993) fails to mention. For example, the person placing the call is not just anyone working there, but one who is somehow entitled to represent the Boston office; the office must belong to a company uniquely identifiable as familiar to both the speaker and the audience; and so on.

members of which are "alternatives" of each other (in some sense of the word), while the conjunction of noun phrases refers to collections that the predicate applies to "jointly" (in some sense of the word).

It is well-known that the exact interpretation of predicating about collections is, to a large extent, underdetermined by the linguistic structure used. One consequence of this is that ample space is left for contextual influences and uncertainty. In the case of "conjunctive" collections, possible interpretations include collective, distributive and cumulative readings (cf. Scha 1981); the possible interpretations of "disjunctive" ones are different: they express "choice" in a largely underspecified sense (including free choice, uncertainty and variation).

Obviously, the preferred interpretation of such an underspecified interpretation instruction may vary depending on what the disjunctive coordination is embedded into. For example, consider:

(5) *I closed the door or the window.*
   a. 'I (always) closed some opening, I forgot/it does not matter if it was the door or the window'
   b. 'Sometimes I closed the door, sometimes the window'

(6) *Close the door or the window.*
   a. 'Close that opening, whether it is the door or the window'
   b. 'Close either the door or the window'
   c. 'Always close an opening, sometimes the door, sometimes the window'

The same effect underlies, I believe, the well-known puzzle, originally noted in (Kamp 1973), which involves disjunction embedded in a permission predicate:

(7) a. *You can have soup or cookies.*
   '(7a)' $\models$ 'you can have soup'
   '(7a)' $\models$ 'you can have cookies'
   b. *You can have soup.*
   '(7b)' $\not\models$ 'you can have soup or cookies'

Although Fox (2007) and others have argued that the entailments in (7a) are in fact conversational implicatures, they are not cancellable as conversational implicatures are supposed to be, which makes this type of analyses untenable. Instead, we must explain them by looking at similar structures, and reconstruct what sense people can make out of a disjunctive collection in a permission context. It is easy to see that, in this special type of contexts, predication about such disjunctive collections must be interpreted in nearly the same way as if they were conjunctive (although exclusiveness may be understood):

(7′) *You can have soup or cookies.*
   'You can have whichever you want (but not both)'

As a matter of course, this sentence can also be interpreted by taking the disjunction to indicate uncertainty ('You can have food, but I don't know which kind is available'), it is simply less probable or plausible for real-world reasons.

As opposed to the permission context, the negative context easily yields both types of readings. The reading in (1′a), with "wide-scope negation", corresponds to the free-choice reading, whereas the reading in (1) corresponds to uncertainty:

(1) *He didn't close the door or the window.*
   a. 'He didn't close them; whichever you pick, it is true that he didn't close it'
   b. 'He didn't close one of them; I don't know which (or maybe both)'

(Szabolcsi 2002) claims that the Hungarian counterpart of (1) is less ambiguous than the English sentence. In particular, while reading (a) is preferred in English (if there is a preferred reading), reading (b) seems preferred in Hungarian. My own informal survey shows that, in fact, both readings exist in Hungarian, too, and they are more or less prominent depending on the context. (Note the difficulty of capturing how contextual factors can help disambiguation if the different readings are due to different syntactic structures.) For example, consider:

(8) *Nem csuktad be az ajtót vagy az ablakot.*
not closed-you in the door-acc or the window-acc
'You didn't close the door or the window'
   a. When explaining the source of the draught:
   'you left both the door and the window open'
   b. When explaining the source of the cold temperature:
   'you left the door or the window (or both) open'

In (a), the preferred interpretation is like in (1′a), because draught is due to two things open simultaneously, whereas (b) is more likely to be interpreted as (1′b), because one opening is sufficient for explaining the cold temperature.

If the difference between English and Hungarian is not as prominent as (Szabolcsi 2002) claims, then the syntactically grounded explanation faces a serious problem, because slight biases or weak tendencies are hard to account for in a theory of syntax like transformational generative grammar. Obviously, since we all believe that natural languages are systematic, it is essential that we look for parallel phenomena that can be related to the interpretation of disjunctions in negative contexts.

One obvious candidate for such a parallel phenomenon is the behaviour of *indefinites* in negative contexts since, in the logical sense, indefinites can be considered abbreviations of potentially infinite disjunctions. Indefinites can be interpreted in pretty much the same way as disjunctive collections:

(9) a. *He closed a window.*
b. *You can have a cookie.*
c. *I bought a car.*

The interpretation of "choice" and/or "uncertainty" varies from one sentence to the other: a genuine free-choice reading is only available in (9b); in the case of the indefinite in (9a), the "choice" and the "uncertainty" interpretations are almost undistinguishable. The sentence in (9c) seems to have an "uncertainty" reading only, namely, the addressee reading, there is no "choice" whatsoever involved, only uncertainty, namely, the addressee cannot be certain what car the speaker bought.

When an indefinite occurs in a negative context, it usually has both a "choice" and an "uncertainty" interpretation:

(10) *I didn't buy a car.*
a. 'I bought no car' (choice)
b. 'There is some car (it does not matter/you may not know which) I didn't buy' (uncertainty)

But English and Hungarian sharply differ in this respect:

(11) *I didn't buy a car.*

(12) a. # *Nem vettem egy autót.*
not bought-I a car-acc
b. OK*Nem vettem autót.*
not bought-I car-acc
'I didn't by a car (= I bought no car)'
c. OK*Nem vettem meg egy autót.*
not bought-I pref a car-acc
'I didn't by one of the cars, there is a car I didn't buy'

That is, in Hungarian the "choice" interpretation of indefinites within a negative context can only be achieved by using *bare nominals* like *autót* 'car-acc' in (12b); a genuine indefinite only tolerates the negative context in an "uncertainty" reading, as in (12c), and only if a prefixed version of the verb is available (in this case, *meg* + *vettem* 'pref-bought-I' is the prefixed version of *vettem* 'bought-I', and the prefix is relegated to a post-verbal position because of the presence of negation).

Under an analysis like Szabolcsi's (2002), indefinites and disjunctions share the property that they avoid "having smaller scope than negation" (except maybe certain circumstances). But such an analysis would predict, e.g., that (8a) should be as bad as (12a), which is far from true. On the other hand, if one interprets the relevant sentences based on analogies with other structures, then

the argument goes as follows. In English, free-choice indefinites in negative contexts are highly frequent (cf. (10a)), whereas in Hungarian they are much rarer (given the unacceptability of sentences like (12a)). This predicts a stronger tendency for a similar distribution of "choice" vs. "uncertainty" readings in general in the respective languages, including the interpretation of predication about disjunctive collections. The effect on the readings of disjunctions can well be a slight one, which cannot be obtained in a theory that attributes the difference to features that trigger or block various transformations. As a matter of fact, one could even give an estimation of the degree of these tendencies if one had a sufficiently rich semantically annotated corpus.

2.6 Machinery: An associative memory model

As I have suggested in section *2.4*, that solution to the logical problem outlined in *1.1* requires a formal model of *association* capable of embodying parallel stochastic algorithms. Such networks are well-known in the history of artificial intelligence, from the semantic nets of (Schank *&al.* 1969; Schank 1975, 1982) through Bayesian networks (e.g., Pearl 1985) to the countless versions of neural networks (for an overview see, e.g., Arbib 1995). It is not clear, however, how the type of analogical reasoning that I have outlined in the previous sections can be implemented in such systems. Purely symbolic networks such as Schank's can model associations between concepts, but they do not make it possible to decompose and create new combinations of concepts by analogy of combinations seen earlier; purely neural networks, on the other hand, which do not contain explicit representations of concepts, are ill-understood, and it is not clear whether and how they can solve a particular logical problem like the one I am concentrating on.

For this reason, I am proposing a *hybrid* conceptual/neural network, which stores *aspects* or *properties* of concepts/experiences/memories, together with their *probability* (depending on how frequently they have been activated, i.e., observed or used). Novel combinations (new "concepts", so to say) can arise in such a network, because we can interpret the simultaneous activation of properties as their recombinations. (For the problems discussed in this paper, the relevant properties include uses of place names and *office*, properties of compound nominals in English, negative predication, predicating about collections, "disjunctive" and "conjunctive" collections, and so on.) Since we intend to model association, the algorithm that operates on the network is *activation spreading*.

Obviously, the system is capable of *learning* by incorporating new properties (never observed earlier) and by updating the frequency of a property whenever it gets activated (for any reason, either by direct observation or by internal use). The main difference between this system and predecessors is that the *connections*, i.e., associations between properties, do not ever change: neither

new connections nor "connection weights" can be introduced (except when a new property gets incorporated in the network). Associations only exist between more and less *general* properties, just like in a classical *generalization network* (e.g., Hispanicus 1947; Levinson 1996), plus *inhibitory links* exist between more or less incompatible properties. The role of probability (frequency) is that the spreading of activation (and inhibition) is stronger from more frequent nodes. Crucially, activation also spreads more efficiently (with less loss) from more specific to more general nodes than the other way round. This corresponds to the idea that the decomposition of a more concrete experience (i.e., its association with its properties) is quasi-automatic, whereas the association from properties to the more concrete experiences that exhibit that property is less fluent.

The memory model outlined here is explained in detail in (Kálmán 2010). It has been successfully tested on relatively simple examples in morphology and syntax, but not yet in the much more complex realm of semantics. Therefore, for the moment, I can only speculate on how analogy can be made to work in the domain of semantics, as I have explained in sections *2.4* and *2.5*.

3 SUMMARY

We have witnessed various problems with the dominant view of understanding. This view posits a level of "literal" or "linguistic meaning", which is then supplemented by extra assumptions made by the audience using their "background knowledge". But the borderline between "linguistic" and "background" knowledge is questionable. On the other hand, the principle of compositionality, which underlies modern semantics in general, and formal semantic theory in particular, also posits a level of "linguistic", "context-independent meanings", tacitly relegating all other information used in the production and understanding of linguistic signs to other modules (namely, "pragmatics"). So I had to reformulate this principle in order to bring it into harmony with the homogeneous view of understanding that I advocate.

The reformulation of the compositionality principle (which I have dubbed *generalized compositionality*), is based on a general principle of human linguistic communication, namely, *systematicity*, which means that similar forms tend to be associated with similar functions, and vice versa. (It should be noted that, as a consequence of this general principle, linguistic systematicity also means that different forms tend to be associated with different functions, and vice versa.) Since, as a consequence, the principle of generalized compositionality relies only on similarity and recurrence, it incorporates a *holistic* approach to linguistic signs: as opposed to the traditional, *atomistic* view, which aims at deriving all properties of complex signs from the properties of their constituent parts, the holistic view emphasises global similarities which, in principle, need not always be defined

recursively, as a similarity of "constituent structure" and the similarity of the corresponding "constituents".[1]

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