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THE STRUCTURE OF MEANING: SEMASIOLOGICAL AND ONOMASIOLOGICAL ASPECTS OF DEVELOPMENT

Abstract

The present work is a plea for a cognitive-based view of lexical meaning. Traditional, usually taxonomically based descriptions such as trees or feature bundles are rather reductive and abstract and often cannot thoroughly represent reality. They lack a psychological foundation. This has been criticized repeatedly as a serious flaw in recent years.
This article investigates how the meaning of words might be represented in a neurobiologically plausible way. To this end, the development of early word acquisition is described with several recurring phenomena, such as early underextensions, later overextensions, the interplay of linguistic and non-linguistic aspects and variable word-referent-mappings. The data are then explained in the light of network processing. In such an approach, the development of a category is seen to be influenced by intrinsic and extrinsic factors. Lexical acquisition means building a pattern of nodes and connections that represents a cognitive concept, building a pattern that represents a linguistic form and connecting these patterns. This might happen in parallel. The framework offers the possibility of integrating structuralistic feature analysis with psychologically based prototype theory and cognitive grammar. It enables us to understand the gradedness of the relevance of examples and exceptions, the possibility of change, context-dependent categorization, shifts of the decisive features, family resemblances and the relevance of the lexical field. It shows that these are crucial aspects of linguistic organization. Finally, some consequences for our conception of universals are sketched. A universal conceptual foundation is the consequence of many factors and no given precondition.

1. Introduction

The idea of extending the static description of semantic systems by a procedural account which depends on context (Eco 1985: 437), or, more specifically, of combining traditional field theory with cognitive semantics (e.g., Grandy 1987, Lutzeier 1992, Lehrer 1993) or fields with frames (e.g., Lehrer 1993) or both, not only for single lexemes but also for idioms (e.g., Dobrovol'skij 1995) and diachronic data (Kazzazi in press), is not exactly new.
Cognitive grammar has long been criticizing a strict criterial attribute model (e.g., Langacker 1987). But in this article, the emphasis is not on the possibilities of description or modes of operation and application, but on development and on actual child language data. However, growth, structure and process are dynamically interrelated, with the growth of structure starting prior to birth and leading to certain functions of the structure well after birth. It is even claimed that from the fine-grained functional organization finally conscious experience arises (Chalmers 1996: 248). The early acquisition of words in young children will be described[1] in order to motivate the necessity of a dynamic model which integrates the concepts of features, events/frames and prototypes[2]. Accordingly, this investigation deals with language acquisition data, neurocognitive correlates of language as well as some aspects of semantic theory.

1 For evidence in adults and aphasics cf. the overviews in Aitchison (1987), Obler/Gjerlow (1999).
2 Modern naming policies call for a label like *FEP approach*. But I cannot make myself like this term.

2. Strategies of acquisition

There seem to be several strategies which help children to build concepts and to map words on them, which must finally be congruent with the adult word-meaning pairs. In the beginning, the child slowly discovers some stable moments in his/her life. There are the same daily routines for meals, for being changed and cleaned, for being put to bed. There are always the same one or two care-givers, primarily the mother, who participate in these complex social rituals together with the child. The child experiences recurring objects, persons and actions. These are the basis of concepts–cognitively organized information about objects, persons etc.

Language is an integral part of the routines. While the child singles out parts of an event, such as a cup, a bed, a ball, s/he hears the relevant names. At the age of around nine months, a child has developed some basic event representations (Nelson 1996: 96) and at least some concepts of objects (Clark 1983: 793). At around one year many children produce their first words. These words are used for the most familiar persons and objects (*mummy*, *daddy*, *car*, *ball*). Others are situationally bound interjections with communicative-expressive rather than semantic function (*hi!*, *there!*, *no!*). Routines and interactions with the care-givers are thus the ultimate source for the first concepts and–related to that–for words (Bruner 1983, Gipper 1985, Nelson 1996, Elsen 1999c).

The child's task is not only to map a linguistic form to a mental concept, but to map his/her form and his/her concept to the adults' form and concept. In the beginning, concept and word formation are closely related. One cannot be investigated without the other. So usually, both developments are treated together.

Markman (1989) discusses some principles which help the child to learn concepts and words. Early conceptual and lexical development is characterized by the problem of inducing concepts. Certain principles help to narrow down the hypothesis space and guide the child towards categorization and language. For example, the *taxonomic assumption* enables children to organize objects taxonomically instead of thematically (Markman 1989: 26). That is, children group dogs together with cats and not with bones. The *whole object assumption* leads them to name whole objects instead of properties like colour or size (Markman 1989: 27). *Mutual exclusivity* refers to the finding that children at an early age assume category terms to be mutually exclusive (Markman 1989: 186), so that they refuse to call a dog both *dog* and *animal*. Similarly, Clark (1983, 1993) points to the *contrastive principle*, meaning that every form contrasts with every other form in meaning (Markman 1989: 190f., Clark 1993: 69). Even more far-reaching is the *principle of conventionality*, which states that speakers use conventional forms in their language community (Clark 1993: 67).

Bloom (2000) rejects special constraints. Children have abilities at their disposal which they happen also to use for lexical acquisition. There are no separate constraints for word learning, such as the whole object assumption (Bloom 2000: 10f.). Instead, children have cognitive capacities, capacities of induction, to understand the way others think (Bloom 2000: 55) and communicate (Bloom 2000: 70), to assume that a word is a sign in Saussurian terms (Bloom 2000: 75). And all these are consequences of children's intuitive expectations about others. All constraints on word learning as proposed by Clark, Markman and others are seen as a product of the theory of mind (Bloom 2000: 67), the idea that a child has or develops the necessary intuition about how much the others know and understand (Obler/Gjerlow 1999: 86).

Yet another approach important for the acquisition of words, unfortunately neglected by Bloom (2000), is Nelson's (1996) treatment of the role of context information, the relevance of the acting within events for the development of both cognition and language. According to Nelson, children do not need special constraints or principles to decode the meaning of words (Nelson 1996: 133), but use the situational and cognitive context information to interpret language and to infer relevant information (Nelson 1996: 140). Of course, the aforementioned principles may be of help here and they might as well arise from or might be general probabilistic assumptions for information processing in general. But what exactly do children do when they learn words? One way to explore how this might be achieved is to look at objects and ask "how do children learn the meaning of object names?"

3. The building of structure

In an early paper, Clark (1973) assumed that a child acquires the meaning of a word gradually by adding features to the lexical entry (Clark 1973: 109). In the beginning, children do not know the complete meaning of a word when they use it, but only a few semantic cues. They use the word for all the objects which show these features. The more general attributes are learned first, e.g., FOUR-LEGGED for animals. They are acquired on the basis of perceptual properties of objects, e.g., dog: FOUR-LEGGED, bell: RINGS. By and by, the child discriminates more features which serve to distinguish a referent from others and can narrow down the meaning (Clark 1973: 84). Gradually, the target range of objects can be assigned when the child adds all semantic features to his/her lexical entry of his/her word.

This approach can easily deal with a mis-mapping found in all young children: overextension. An overextension is an extension of a word which is too wide compared to the adult language. Calling a cat, a dog and a sheep *dog* is an example of the overextension of *dog*. Clark can explain this by assuming that not all necessary features have been acquired to single out cats and sheep from dogs. However, she developed her ideas from the viewpoint of language, equating semantic features of words with perceptual properties of things, and neglected an intermediate cognitive level.

An alternative hypothesis, but from a cognitive perspective, was offered by Nelson (1974), who suggested an initially flexible organisation of information about objects and relations. She distinguished lexical-semantic from encyclopaedic-conceptual knowledge, which need not be adapted to language. In Nelson's view, the child starts with an abstract conceptual whole which is analyzed into its relevant parts in relation to other concepts (Nelson 1974: 278). That is, Nelson focused on intensional aspects of meaning in contrast to Clark, who concentrated on extensional aspects. A concept is formed through the child's interaction with his/her surroundings, not necessarily with the help of words (Nelson 1974: 272). Then, an object is assigned to the mental concept on the basis of functional, dynamic properties or on the basis of the relationship between the object and the child, e.g., ball: ROLLS. All of the objects which belong to the concept and which show the same relevant properties are analyzed functionally. The child creates a hierarchy of attributes. This simplifies the task of identifying further objects belonging to the concept, as all objects must show the same relation to the concept. The top of the hierarchy consists of the functional core. It defines the functionally motivated features of an object, e.g., ball: ROLLS, BOUNCES. Further down the hierarchy there are perceptual features, e.g., ball: ROUND, RED. Afterwards, a word form is mapped to the concept.

Nelson's approach can explain why early words tend to be things from the child's immediate surroundings, as these are handled by the child him-/herself. Nelson criticized

Clark because of her linguistic focus and the neglect of a conceptual level. She stressed that children distinguish whole objects. These are not seen as sets of features. Thus, a concept can be built on the basis of one single referent. Further, Nelson does not agree with the predominance of perceptual cues. However, some perceptually motivated overextensions, like *ball* for balls and round lamps, do in fact exist, but do not go well with Nelson's proposal, because, according to her, functional reasons should be favoured when calling several objects by the same name.

The idea that a concept can emerge from a single referent is yet central for another aproach, offered by Bowerman (1978), who criticized the reduction to either a functional or perceptual basis for classifying.[3] This was said to lead to a too restrictive range of application. Bowerman noticed that, initially, children hear words in relation to one single object or a few highly similar ones. For example, *duck* is always the same yellow toy duck in the bath tub. The very first words are only produced in connection with these prototypical objects (no living ducks or pictures are called *duck*). Later, the child uses the words also for new, regularly similar objects which have at least one feature in common with their prototype[4]. Bowerman even allowed several prototypes.

This approach can explain another common mis-mapping in children: underextension. This is an extension which is too narrow in comparison to the adult language, such as calling your dog *dog*, but not the neighbours‘ dog, nor the dogs in the street. This is Bowerman's initial stage. Furthermore, the formation of associative and chain complexes (Bowerman 1978: 271) becomes plausible–sometimes an early and a late referent of a word do not show common properties, although they have at least one feature in common with one other referent, having been named in between. Now, the reader will be reminded of Wittgenstein's family resemblances (Wittgenstein 1984), where some family members share the shape of the mouth, others the shape of the nose, but no element need be common to all family members. This may result from an internal structure of a concept, a typical central instance with varying peripheral instances (Bowerman 1978: 278): a prototype, a typical example and other examples assimilated to the category because of their resemblance with the prototype. This results in degrees of membership. That means that not all of the features have to be criterial/central. Of course, there are categories based on several shared features. The representation of a word as a best example does not exclude feature lists (Bowerman 1978: 279).

Taken together, the three presented views lead to the idea that concepts may be created on functional grounds, but objects may well be named for of other reasons, probably because they are important and/or salient to the child in shape, colour etc.

4. Restructuring

Barrett (1982) attempted to link the view that semantic features must contrast (cf. Barrett 1978) with the prototype model. He combined previous insights with his observation of

3 However, both Clark and Nelson soon modified their original views in allowing functional as well as perceptual features as being decisive, c.f. Barrett (1982) for a review.

4 For *prototype theory* cf. Rosch (1973ff.), Lakoff (1987a, b) or cf. *stereotypes*, Lutzeier (1981ff.).

systematic shifts in word-fields.[5, 6] According to Barrett, semantic fields are systematically divided by the extensions of related words, without overlap, in the early phase of acquisition (Barrett 1982: 317). The child first acquires the meaning of an object word from a prototypical object, and the word meaning is represented by this prototypical referent. Then s/he realizes some important cues. Now, the word meaning is stored in form of a prototype and some basic features. Next, the child compares the word with other, already acquired words which have prototypes with similar attributes. Those attributes common to all referents serve as the defining features of the semantic field to which the word now belongs. The child compares the prototypes and identifies the contrasting features. Now, the word meaning is represented in the lexicon as a prototype, a set of features that define the semantic field and another set of features which serves to distinguish the referent from other items in the field. Overextensions may be found when some words still have to be learned and the referents are labelled with the already acquired words. This process is repeated each time a new word enters the field. One result is a constant shift of the range of the meanings. As Trier already wrote "die [inhaltliche] Bestimmtheit entsteht durch Abgrenzung gegen Nachbarn" (Trier 1931a: 42), and later "Außerhalb eines Feldganzen kann es ein Bedeuten überhaupt nicht geben" (Trier 1931a: 44). Meaning cannot exist in isolation. The meaning of a word depends on neighbouring words in the field. Trier also found shifts in the structure of a field when he investigated diachronic change. As a psychological result, this meant "Soll der Hörer verstehn, so muß Zahl und Lagerung der sprachlichen Zeichen dieses Begriffsfeldes ihm unausgesprochen gegenwärtig sein." (Trier 1931a: 46). Another result of Barrett's view is that an overextension can be repaired when new words are acquired. You can call a sheep *dog* only as long as you do not know the word *sheep*. Then you diminish your primary, overextended meaning of *dog* by exactly the range of meaning which is covered by *sheep*.

To demonstrate how Barrett sees the acquisition of early words, some examples from the literature on language acquisition will be presented in the following. The first is from Clark (1973), who worked with Pavlovitch' diary data (cf. Pavlovitch 1920 in Clark 1973).

The child Pavlovitch observed used *bébé* 'baby' initially for a) the reflection of self in the mirror, for b) photos of self, for c) all photos, for d) all pictures, for e) books with pictures and for f) all books. Then the child produced *deda* 'granddad', which was used for all photos. Now, *bébé* referred to a) the reflection of self in the mirror, to b) photos of self, to d) all pictures, to e) books with pictures. The next step was the acquisition of *ka´ta* 'card' for all pictures of landscapes and views. *Deda* still meant all photos. But *bébé* was now used for a) the reflection of self in the mirror, for b) photos of self, for e) books with pictures and for f) all books. The fourth stage began with the new word *kiga* 'book' for all books. *Ka´ta* still referred to pictures (not of people). *Deda* still referred to all photos, but *bébé* now referred to a) the reflection of self in the mirror and b) the photo of self. That is, the first word was used for quite a range of objects. With each new word, this range of reference was narrowed down, with the new word taking over part of the original range and diminishing the overextension (cf. Clark 1973: 87).

5 Barrett (1982) used the term *semantic field*. *Bedeutungsfeld* was initiated by Ipsen (1924), later, *Wortfeld* by Trier (1931ff.). Dobrovol'skij (1995) suggests abandoning the difference between conceptual, semantic and lexical differentiation, as linguistic and conceptual structures are closely related. Instead, he speaks of *relations* between lexical and conceptual structures (Dobrovol'skij 1995: 103).

6 The idea of systematic restructuring of word meanings when new related words are acquired was already discussed in Clark (1973), who referred to the work of Pavlovitch (1920). Clark used the term *semantic domain*. An example from Clark (1973) will be given below.

The second example is from Barrett (1982), using diary data from Lewis (1951). In the beginning, the child K. said *tee* to cats, cows, horses, large dogs, small dogs, and toy dogs, that is, to four-legged animals. This was probably the feature shared by the referents and thus counted as the defining characteristic of the semantic field. When the word *goggy* was learned in relation to a toy dog, the child probably compared the prototypes of the two animal terms and found contrasting cues, so that *tee* was no longer used for small dogs. Then *hosh* was introduced and used for horses and large dogs, presumably due to a featural analysis which contrasted +HOOVES with –HOOVES and LARGE with SMALL. *Goggy* still referred to small dogs and toy dogs. But *tee* was now used for cats and cows. With the form *pushy*, the child labeled cats. *Hosh* remained for horses and large dogs, *goggy* for small dogs and toy dogs. But *tee* referred to cows only. Barrett hypothesized that the child acquired a prototypical referent for *pushy*, realized decisive attributes and added the word to the semantic field because of the feature FOUR-LEGGED. Then the child compared the prototypes of the words, identified the contrastive features of cats and stored the meaning of this new word in form of the prototype, the features defining the field and the features distinguishing it from the other words in the field. Accordingly, the word *tee* could no longer be used for cats (cf. Barrett 1982: 329)[7].

Barrett's model explains why the child initially only names objects from his/her immediate surroundings. These catch the child's attention early and are good candidates for prototypical referents. The fact that children often need only one prototypical object was already mentioned by Bowerman (1978). This may result in underextensions, when a child fails to generalize from the prototype to related objects. Thus, underextensions are equally well explained by Barrett. Overextensions are found when not all contrasting features are recognized, when incorrect ones are used, and when not all words in a field are acquired. That is, not all early words should show overextended use. It should be mentioned here that, indeed, overextension is not found for all words. That was a problem for the previous hypotheses of Clark and Nelson, which predicted quite a large number of overextended words. In this respect, Barrett's model is an improvement. Still another important fact can be explained, namely, that at first underextensions appear, then overextensions, both towards the beginning of the acquisition process. The mis-matches disappear with time, with the acquisition of more words and with the recognition of more contrasting features. Finally, an important idea is that word meanings can only exist in relation to other, related ones within a field and that this helps children on their way to acquire object names. Trier's 'omnipresence' (*Allgegenwärtigkeit*) is obviously something which develops in children over time as an automatic consequence of the way they process information.

However, Barrett sometimes ignores that children might have different views on concepts and features from adults when he concludes that not all features that the child uses have to be criterial (Barrett 1982: 318). If the child uses ROUND to label both ball and round lamps then this feature is criterial for the child. He misses the possibility that mis-mappings might result from other than cognitive re-shifts. Furthermore, there are meanings which overlap with others. And finally, his hypothesis predicts that overextensions only occur when the target name for an object has not been acquired. Names for objects are overextended to referents for which the child lacks the proper name (Barrett 1982: 320f.). But this is not always the case. Even Barrett discussed three exceptions. But he interpreted the first two names as an adjective and a request resp., concluding that they are not true counterexamples. The third case was left open.[8] Thus Barrett's approach is in need of

7 Barrett used the transcribed forms [ti:] *tee*, [gɔgi] *goggy*, [hɔʃ] *hosh*, [pʊʃi] *pushy*.

8 He mentions one word, *ball*, which was overextended to a referent for which the target term had been acquired before, namely the word *beads*, from Leopold's diary of his daughter Hildegard. Barrett

refinement, too.

5. Influences of phonology, lexicon and cognition on the naming of concepts/referents

The analysis of continuous diary data on a German-speaking girl, A., (Elsen 1991) yielded several phenomena which were not congruent with Barrett's model. In Elsen (1994, 1995) several kinds of overextension are described. Semantic overextensions were distinguished from lexical overextensions and phonological overextensions.

Semantic overextensions emerge because of an immature conceptual system as described by Clark, Nelson, Bowerman, Barrett and others. When words are used deliberately for objects whose names are not yet established in the lexicon, this is called *lexical overextension* (Elsen 1994: 306). That is, the child tries to fill a lexical gap. Finally, when an articulatorily difficult word is avoided and a more easily pronouncable substitute is chosen which happens to refer to another, related word, this kind of ‚mis'-use is called *phonological overextension*. In Elsen (1994), the overextended use of [vava] for dogs and ducks for articulatory reasons was described.

A.'s concept of ducks was well developed by the middle of 0;11[9], as the child correctly applied her private form [bagba] correctly and daily in different situations. The target word *Ente* 'duck' seemed to be too difficult. The structure $V_1C_1C_2V_2$ needed for the correct pronunciation of the word was not present in the child's productive phonological system. She tried to pronounce it several times towards the end of 0;11. But she did not produce these forms spontaneously, nor did she use them afterwards. Her self-constructed substitute does not exist in the target language and the child was not encouraged in its use. As neither forms for ducks satisfied the girl's needs–[bagba] was not used in the target language, and *Ente* was too difficult to produce–she applied a semantically related and well-established form which was consistent with her phonetic ability: [vava]. This happened to be the word for dogs. The result was a phonologically motivated overextension.

In Elsen (1995) the acquisition of A.'s first animal terms was described. The development showed some phenomena which the presented models cannot account for. An early term was used *after* some time of understanding it–the word for dogs. In Elsen (1994) it was argued that the child deliberately refused to pronounce *Hund* 'dog' for articulatory reasons. Only when the simpler form /vauvau/ was offered, did she start to talk about all kinds of dogs. That means, even when a concept is built, some difficulties with the form of the target expressions may prevent an early use. As in *Ente*, phonology interfered with word learning (cf. also Elsen 1999a, b). In other cases, A. did not wait for the target terms, but invented her own expressions, e.g., for ducks, hares and crows ([bagba], a sniff, [bɔa], resp.). Obviously, some concepts were delevoped before the articulatory capacities allowed for the correct words. Thus, when some words in the lexicon of a child are missing, we cannot always be sure that the relevant concept has yet to be formed. A. invented words to fill lexical gaps. The concepts were there, but the words were lacking. Obviously, several linguistic and non-linguistic aspects interact. The acquisition of (object) words cannot be

interprets her use of *ball* for the beads as an attempt to point out the similarity of shape. The second example is from his own data. The child Tina used *Mummy* for two people for whom she had already learned the names. This is interpreted by Barrett not as an example of (overextended) naming, but as a request for an action. The third example is from Lewis' (1951) data on K., who produced *tee* for a horse one day after the more appropriate form *hosh* had been used (Barrett 1982: 321).

9 Numbers like 1;2,3 refer to a child's age in years; months, days.

analyzed in exclusively cognitive-semantic terms. A model for the acquisition of words must be able to integrate cognitive and various linguistic aspects in order to explain the data.

Other examples from A.'s corpus, presented in Elsen (1995), were words for objects like eggs, potatoes, apples, etc. From 0;9 on, the girl used the term *Ei* 'egg' for eggs–a boiled egg being the prototype. From 1;0, she also used it for tomatoes, *Negerküsse* 'chocolate marsh-mallows' and potatoes. Up to 1;2,25, tomatoes were called *eggs*. Then, A. used the word for tomatoes. From 1;3,1, on she used a form of *Apfel* 'apple' for apples, for tomatoes (once with 1;3,15) and when she saw apple peels (1;3,14), further for peaches, nectarines, potatoes, oranges etc. At 1;3,27, the word for potatoes entered her lexicon and was used for whole potatoes, for boiled and peeled ones and for cut potatoes.

We might argue that the child learned *Ei* 'egg' in the context of a prototypical referent and realized some important attributes (TASTES FINE, form, size). A new word diminished the range of referents of established words. When she acquired the word for tomatoes, A. no longer called them *Ei* 'egg'. However, the child not only used her words for prototypes and similar referents, apples, peaches, oranges, but also for non-prototypical referents of the category apple and for the category potato, namely boiled and peeled potatoes and cut potatoes. In the case of apple peels she perhaps wanted to say 'belongs to apple'. But her regular use of the word for potatoes in various manifestations showed that her concept of potatoes became complex within two weeks, with a prototypical centre and less prototypical examples. The early attributes served as a working definition. She either used several prototypes, or she structured her concept. No matter how this may be, we need a model that allows for a flexible, dynamic representation of concepts.

In an earlier article (Elsen 1995), I argued in favour of an integration of prototypes and features within a word-field. A name is learned in relation to a prototype–the prototypical centre of the concept which is defined by some relevant features. The concept is gradually specified in contrast to related objects and new words. This was already described in the presented literature. Additionally, neighbouring lexemes not only restrict the range of referents of established words, but the concept will become more structured when peripheral examples are integrated. This happens in interaction with the immediate surroundings. For example, the mother peels and mashes a potato and calls the result *potato*. The original definition can be refined according to situation and use. We need a dynamic model of prototypes with structured representations of more and less important features for centre and periphery. But this structure must be flexible so that it can be changed according to the situation and in case of errors. In some situations, some central features must be dropped and only some peripheral ones must be used for the decision which object is to name. On the one hand, this will result in the aforementioned associative or chain complexes. On the other hand, some extremely peripheral examples can be named, e.g., a potato cut into the figure of a dog. Furthermore, the representation must work even when information is missing. Here, the integration within a word-field is an important support, because it provides additional information and helps to consider overlapping and borderline areas. Finally, it is possible that a child tries to label an object such as a peach, knowing that it is *not* an egg (when eggs are already called *egg*) and it is *not* a tomato (when tomatoes are already called *tomato*). The child chooses the most probable third term, perhaps *apple*, because s/he knows that all referents belong together (and because s/he wants to communicate). Either eggs, apples and tomatoes are sufficiently specified and the peach has more in common with apples than with eggs and tomatoes. Or apples are defined by not being eggs nor tomatoes, but belonging to the same semantic field and thus are grouped together with peaches. This leads us to the next aspect which must be accounted for by a good model–the relevance of script and frame information.

In several studies children were observed to produce certain words only in certain situations (Elsen 1999c: 92, cf. literature in Clark 1993: 33). In most cases these words were used adequately. For example, A. said *Berge* 'mountains' only when looking out of the window. However, once she was discovered to produce it when no mountains were visible due to of bad weather. The child had probably stored the one and only prototypical situation in which the adults uttered the word: Under certain weather conditions the Alps can be seen from the living-room window. The parents then usually go to the window and say admiringly "the mountains!". The child learned the word in a stable situational context, without knowing the semantic content (cf. Elsen 1999c: 92). She had probably not understood the meaning of *Berge*, but wanted to act correctly in a given situation (*situationsadäquat*), which meant for her: go to the window and say *Berge*. This means, first, that for children the context is important for the acquisition of words and meanings, as it provides decisive cues, even when they are misinterpreted. Perhaps children turn to this context information when they have no access to object information. For Nelson (1996) the most important process of the acquisition of words is to derive meaning from discourse context (Nelson 1996: 143). Second, the context can be of use when the exact meaning of a word is not known, but the child nevertheless wants to communicate. That is a matter of temperament, of course. Some children will only talk when they are very sure of themselves. Others don't really care whether what they say is right or wrong as long as the grown-ups listen.

Context (communicational situation, event, structured event, frame, script) are thus the next important factors for the acquisition of words which have to be integrated in a model.

In sum, the relevant aspects to be included in a model are a prototype and prototypical structure of a concept/word meaning, features, lexical field information and context information, where the term context covers situational, event, frame and script context. All of it joins up in the meaning of a word. All of it has to grow together in the process of acquisition. Children make flexible use of those aspects according to cognitive, linguistic and motor maturity, situation and individual condition. We cannot assume a rigid temporal order in the acquisition sequence or a strict linear order of these sources of information as components in a model. These aspects work simultaneously, but with varying allocation of relevance.[10]

6. Networks and the brain

In the following, some basic principles of networks will be described. The aim is not to create a new model, but to see whether the processing phenomena found in simulations are consistent with the real-life data. This should lead us to assume an explanatory relationship, which should further help in reformulating linguistic models of description. In this case, the integration of feature analysis and prototype theory, which is demanded by the acquisition data (and by cognitive linguists), receives a neurological foundation.

The structure and the mode of operation of a network are adopted from the brain in imitation of the neurocognitive facts–the architecture and the mode of operation of the brain. The idea of network-like processing of information can be found in several 'schools' of network-users, which are more or less close to neurobiological facts (e.g., Smith/Thelen

10 Langacker (1987) suggests a similar framework, which is–true–not based on acquisition data, but nonetheless sketches the hypothetical evolution of lexical categories in a comparable way. Kazzazi (in press) combines these aspects in her diachronic analyses.

1993, Thelen/Smith 1994, Elman et al. 1996, Lamb 1999, Kochendörfer 2000). They may differ in their architectures, some processing aspects and the way information is represented. For example, in some models there are varying activation strengths, in others this is represented by varying degrees of the frequency with which stable action potentials are transmitted. In localist models one node may represent one linguistic unit. In distributed processing, a node complex serves this function. The difference is less serious when you consider that the local unit itself, at least in recent architectures, can only be activated when a connected pattern of further units is activated, too. Thus, the “local” representation is in fact a bundle of nodes plus a “head” node (a “mother” node), comparable to phonetic features united in a phonological “head” node. Of course, the patterns leading to various “head” nodes may overlap.

In a network, information is processed in (nodes and) connections. Like the nervous system, a computer model is built of hierarchies of functional units of increasing scope and complexity. In the brain, a cell body receives signals directly or through connections, its dendrites. The exit-connection of a cell is called axon. It ends in a synapse. This is the point of connection to the next cell or its dendrites. The nerve impulses are of stable size. Input means the induction of a postsynaptical potential which may be excitatory or inhibitory and which is graded. Although in computer models all information has to be transmitted via connections (axons) and nodes, in the brain some nerve cells communicate directly through their dendrites, probably some kind of economizing effect (Shepherd 1978: 96). There even seem to be interactions without direct contact (Shepherd 1978: 100, Pribram 1991: 11). In the brain, changes in neurodensity are variable across regions (Campell/Whitaker 1986: 61). There are different cell structures and microcircuits in different regions of the brain (Shepherd 1978: 102) with specific properties (Blakemore 1989), whereas artificial networks are more homogenous. Therefore, we should always keep in mind that network models are abstractions.
In the models, the use of internal symbols and rules is avoided. All areas in the brain, in the computer network–and let us not forget that there are many varieties–or in the hypothetical model are interconnected. Activation spreads quasi-simultaneously via parallel routes through the system, creating a pattern of activated nodes and connections. The current flows bi-directionally.

6.1 Acquisition

Learning means that the machinery is altered by individual experience. The acquisition process is characterized by constructing structure and, via connected patterns, data. Nodes and connections are supposed to be given, in imitation of the fact that by far the greatest number of neurons[11] and connections are present at birth, but the thickness of myelination[12] keeps growing for a while. Thus, nodes and connections must be brought into use. Learning means changing–changing the connection strength and threshold values[13]. The more connections are used, the stronger they get. When they are not used, they become weak: a connection or a whole pattern of nodes and connections can fade when it is not used regularly. Nodes may change in their threshold value. With more use, with more activation energy, the threshold rises (Lamb 1999: 213). Initially, nodes and connections are weak.

11 Of course, biological neurons have a complex internal structure (cf. Shepherd 1978).

12 Myelin is the insulation around the axons which enables electrical activity to be conducted at a high speed (Willis/ Widerstom 1986: 29, Lamb 1999: 346). Local (short) connections are not myelinated (Lamb 1999: 323).

13 Threshold refers to the fact that a node will only be activated when there is enough incoming activation to satisfy the threshold. It is still not clear how far the details correspond to neurological facts.

They are laid out in the architecture, i.e. they are available, but not yet accessible. When information flows through the system, learning starts and the amount of energy rises. A node receives some minimal activation via few connections, but the sum is too low to activate the node, which still has a low threshold value. Next time, either more connections to a node transport activation or few connections transport more activation (activation potentials of a stable size at a higher frequency). The threshold is reached, the node is activated. Each time, the connections can carry more information and the threshold value of the node rises, allowing the node to pass on more and more activation. Thus, the existing connections and nodes are strengthened with repeated activation. Their initial state changes from neutral or latent to ‘occupied’, as they are now assigned to a node or a complex pattern. With each activation, several paths are activated simultaneously. Over time, a main path, region or pattern emerges as the winner over the more weakly activated fellow paths, regions or patterns through the processes of competition and selection, because the development is enhanced by the blocking of the losers through inhibitory connections. Connections which become useless fade. In the brain, nerve cells are not connected randomly, but in a special configuration with rather sparse connection patterns (Pribram 1991: 5), due to the loss of unnecessary material. This evolutionary process (”survival of the fittest”) also leads to specialization of large areas and modular organization.

We see that on the one hand, information from various domains is gradually integrated. Linguistic aspects grow together over time. Complex structures emerge. There is always variation in the activation of different areas. On the other hand, each item such as a feature, a sound, or a word exhibits an individual pattern of activated connections. These items do not exist as entities or objects, but must be understood to be a characteristic pattern at a characteristic position in the system. We can use names like /p/ or *dog* or *noun* to refer to items or categories. But that only facilitates communication and reasoning. It does not mean that they are sounds or categories *per se*. They are only generalizations. A member of such a group can show a more or less prototypical structure, more or less similarity to the activation pattern of the prototype. An early and repeatedly activated area or sound is stronger than a later one. Thus, frequent sounds, words, patterns of the target language are learned earlier. In young children, frequent patterns often replace infrequent ones. When too much information is processed, only a part will survive.

6.2 Simulations

How are child language data and networks related? How can the observations on the acquisition of words be explained and reconciled with neurocognitive facts?
There are several computational models of associative word learning (e.g., Gasser/Smith 1998, Richards/Goldfarb 1986). In simulations of mapping meaning to sound for verbs, several phenomena typical of small children resulted, such as problems with synonyms and overextensions (Cottrell/Plunkett 1994). In simulations of image-label-mapping, the models showed prototype effects, early underextensions and later overextensions (Plunkett et al. 1992). The representations which developed in acquisition were contextually embedded (Plunkett/Sinha 1992).

In Kochendörfer (2000: 93ff.), the simulation of concept formation was described by the example of various containers for drinking, following Labov (1973). The experiment was conducted as a means of exploring the procedure, not of imitating the acquisition process. The input to the network model consisted of several good examples which were determined by [+ CONTAINER FOR DRINKING, + HANDLE, + SAUCER, + LOW, sometimes [+ COFFEE], sometimes [- COFFEE] as a “good” cup, the same except for [+ HIGH] as a “good” tumbler/*Becher*. The results have to be interpreted as general principles of processing. They are quite revealing for our understanding of concept and word-formation.

Kochendörfer explicitly tried to keep very close to neural facts. As exact imitation is not possible, one level of abstraction is to use a node as a neural unit without giving it complex structure (Kochendörfer 2000: 19). In his simulation, some higher-level nodes emerged which represented concepts and could be activated by one or two cells that represent features. In some cases, any combination of two features was sufficient. That means, these higher level nodes show exactly the variability of feature assignment which is claimed for many concepts by prototype theory (Kochendörfer 2000: 98). Network modelers repeatedly stress that the prototypical organisation of concepts and structures is the automatic result of neural processing (Elman et al. 1996: 127ff., Lamb 1999: 226, 336ff., Kochendörfer 2000: 98). Saliency and frequency lead to higher strengths for the more important features. But a sufficient number of peripheral ones will do as well for less typical examples of a category.

Another result was the emergence of complex hierarchies of concepts. A concept was represented by a feature bundle (and a head node). A feature itself could be represented by yet another feature complex, resulting in a complex but structured organization of meaning (Kochendörfer 2000: 100).

A further simulation included “bad” examples with incomplete feature complexes. Processing yielded more activated cells for good examples. The more units were activated, the higher the chances were for further processing. This might be related to a quick and easy judgement of good examples by speakers in experiments (Kochendörfer 2000: 101). When there were insufficient features, a node (complex) representing a bad example was not activated. In the worst case, only one (weakly activated) feature may be involved, so that the sum of activation energy is too low. However, this can be compensated by including context information (Kochendörfer 2000: 102).

6.3 The acquisition process of building lexical meaning

The development of a category is influenced by intrinsic and extrinsic factors. For our words, learning means building a pattern of nodes and connections that represents a cognitive concept with connections to auditory, visual etc. areas, building a pattern that represents a linguistic form and connecting these patterns. This might happen in parallel. In several models, all information is united in, and coordinated by, a “head” node (Lamb: *central coordinating nection*, Kochendörfer and others: *grandmother node*, *Großmutterzelle*) which can only be activated when sufficient activation arrives and which represents a word (or a concept, morpheme, phoneme, etc.). We might assume that an early concept is represented by a concept-head-node and only a few feature nodes with connections to visual and/or auditory etc. areas. They are activated simultaneously as an early, quite meagre pattern. On the surface, this may be understood as a *Gestalt*[14] which was learned via one example, perhaps the child’s dog, the prototype, and which results in underextensions when other dogs are not called *dog* and the child has not yet abstracted the cultural entity (Eco 1985: 74) *dog*. In situations of acting and communicating, related

14 The recognition of gestalts preceded the analysis of features in studies that investigated the identification of objects (faces) (Brown 1996: 299). Neurologically, there seems to be a general shift from holistic to analytic perception. “This shift coincides with increasing selectivity and awareness of spatial detail, discrimination, and orientation. [...] The process corresponding to this shift has been described as an emergence of adult patterns of connectivity through refinement of an initially diffuse set of connections.” (Brown 1996: 299). But in detail, Gestalt or holistic processing is not quite clear.

concepts and words are experienced and compared. Similar concepts share features. Two not yet fully analyzed concepts, say a sheep and a dog, share all features in this state. When they are attached to one word, say *dog*, overextended use of this word results. Another reason for overextension might be that the correct connections for a new word (*sheep*) are still too weak as they are relatively new and the older ones attached to the former word (*dog*) win. This might be enhanced by articulatory problems (Cottrell/Plunkett 1994: 385). Common areas of patterns are strengthened due to higher frequency of activation. Cognitively, several similar examples might be abstracted to a unit of certain cognitive autonomy, something which Langacker (1987: 374) called a *schema* of a category, abstracted from specific properties like COLOUR (WHITE, GREY, BROWN, but not GREEN or RED for dogs). Further areas emerge which belong to one concept only (perhaps BARKING and BLEATING or +/- WOOL) and are found contrasting. New feature nodes are integrated. More relevant features develop stronger connections. Information on context (typical and temporarily typical situations, events, frames etc.) are part of the pattern as well as special features of meaning and form. The amount of digested information increases. When information of central features is missing (some animal of a certain size, but it doesn't make any noise), situational information can help and compensate (it's in the kitchen, sheep don't belong there, so it's a dog). As related representations share activated areas, other members in a field are activated together with the target word (cf. *Mitmeinen*, Trier 1934b: 446). Thus, another case of compensation is when a child has difficulties with a word *form* and chooses a related word with an easier form instead. The network of connections and the overlap of activated areas will lead the way to the substitute in situations of communicational need. Finally, connections to related concepts that leave out central aspects might lead to metaphorical use, and ultimately, change (e.g., *fox* +/- HUMAN, +/- BROWN-RED, etc.). A metaphor might develop into a new category with a clear distance to the original concept (e.g., *star*). Such developments and differences are of course gradual.

In the child language corpora, we found several recurring phenomena such as early underextensions, later overextensions, linguistic and non-linguistic influences (by, e.g., articulation, co-members in a lexical field, situation), flexibility of categories and the dynamic, context-dependent, graded structure of a concept/word meaning. We saw that the observations on the acquisition of early words could be explained by facts on neural processing. This should lead us to a cognitive-based model which tries to provide linguistic structure with psychological reality and relates growth, process and structure, and thus, function. This complex internal as well as external development cannot be simulated by models, but it requires the neural plasticity which enables continuous change.

7. Vista: universals

The idea that our neurobiological basis leads to certain developmental and processing phenomena has consequences for our understanding of universals.

The peripheral nervous system prestructures the nature of perception and production. The neural architecture and mode of operation is responsible for many system-internal, automatic "facts" about language and cognition. As the functional organization of the brain determines behavioural capacities and gives rise to conscious experience (Chalmers 1996: 248), there is a lot of common ground on the bio-genetic level that may lead to universals in cognition and language. Of course, there are further determining factors. There are the living conditions, and we definitely have constants throughout mankind. We live on land, not in water nor on trees nor under ground. We live in groups. To survive, we manipulate our surroundings and grow corn, go hunting or build supermarkets. On the psychological level, all humans need communication with other humans. They are afraid of the unknown, think beyond the *hic et nunc*, want to gain knowledge, develop religions. Thus, there is a common ground of interacting biological, environmental and psychological constants which lead to identical processing architectures, identical experiences and identical solutions. These are influenced and superposed by socio-cultural, linguistic, individual and situational conditions. A culture subdivides the continuum of experience and structures the concepts–"there is no way to predict from the [...] prototype alone precisely which array of instantiations or extensions–out of all the conceivable ones–happen to be conventionally exploited within a speech community" (Langacker 1987: 370). In the acquisition process, children are led to adapt this subdivision, these structures, guided by language. The possibility to switch to alternatives found in the neighbouring cultures always remains open. At the same time, a category is always individually structured because it reflects the experience, situation and processing activity of the individual language user. It is highly probable that no two persons share exactly the same structuring.

With the help of network models we may one day disentangle intrinsic from extrinsic factors and know more about which aspects of linguistic universals result directly from our neurocognitive equipment. We will understand that universals have probabilistic rather than absolute occurrency rates and that a universal conceptual foundation is the consequence of many factors and no given precondition.

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