Activating Attributes in Frames

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1 Introduction

The general topic addressed in this paper is the activation of scalar attributes in the context of degree gradation of non-scalar verbs. Non-scalar verbs such as German *stinken* 'stink' do not lexically encode a scale, meaning there is no scalar attribute in their lexical representation. Nevertheless such verbs can be used in a degree context as in (1). In the sentence, the intensifier *sehr* 'very' specifies the intensity of the dog's smell.

(1) *Der Hund stinkt sehr.*
the dog stinks very
The dog stinks very much.

If the verb does not lexicalize a scale, a scalar attribute has to be activated in the degree context; otherwise the degree construction could not be interpreted. Therefore, I will argue (i) that the scalar attribute is retrieved from the conceptual knowledge associated with a meaning component specified in the verb, and (ii) that frames provide a suitable means of representing the process of (scalar) attribute activation. The aim of the paper is to illustrate how this process is constrained.

2 Verb gradation

Following Bierwisch (1989), gradation is a linguistic process of comparing two degrees on a scale. Gradation is usually associated with adjectives, and languages like English and German have special adjectival degree morphology such as comparative *-er* and superlative *-est* in English. However, gradation is not restricted to adjectives (Sapir , 1944; Bolinger , 1972); verbs and nouns can also be graded (see e.g. Morzycki (2009) on the gradation of nouns). Verbs and nouns differ from adjectives in not having special degree morphemes (at least in English and German). A further difference between the gradation of adjectives and verbs is that verb gradation is more complex than its adjectival equivalent. It is either possible to specify the temporal extent (duration or frequency) of an eventuality or to specify the degree of a gradable property associated with the verb. The first type is called 'extent gradation', the second is called 'degree gradation' (Bolinger , 1972; Löbner , 2012; Fleischhauer , 2014). Two German examples of verbal degree gradation are shown in (2).

(2) a. *Peter ist sehr gewachsen.*
Peter is very grown
'Peter has grown a lot.'
b. *Peter hat sehr geblutet.*
Peter has very bled
'Peter bled a lot.'

In (2-a), the intensifier *sehr* specifies the degree to which Peter increased in size; it is a vague, context-dependent high degree (see Fleischhauer (2013) for a deepter discussion of degree gradation of change of state verbs). In (2-b) the intensifier indicates the quantity of emitted blood.

There is a crucial difference between the verbs *wachsen* 'grow' and *bluten* 'bleed' in (2); the former is lexically scalar, whereas the latter is not. A verb is lexically scalar iff it expresses a scalar predication in every context of use (see, among others, Levin and Rappaport Hovav (2010) and Fleischhauer and Gamerschlag (2014) on scalar verbs). In (3-a) *wachsen* expresses a comparison between the size of the child at the beginning of the event and its size at the end of the event. Hence, it expresses a scalar predication although it is not modified by an intensifier.

(3) a. *Peter ist gewachsen.*
Peter is grown
'Peter has grown.'
b. *Peter hat geblutet.*
Peter has bled
'Peter bled.'

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The sentence in (3-b) does not compare the quantity of blood emitted by the boy to some other quantity; hence, the verb is lexically non-scalar. This means that only *wachsen* but not *bluten* lexically encodes a scale.

Although the verb *bluten* is gradable (2-b), it does not lexicalize a scale. The gradation scale varies for different verbs: it is an intensity scale in (1) and a quantity scale in (2-b). Since the scale varies for different verbs, it is not contributed by the intensifier. Rather, a suitable gradation scale is rather from conceptual knowledge.

3 Frames

Frames, in the sense of Barsalou (1992a; 1992b), are recursive attribute-value structures. A frame is a representation of a concept and represents the referent of the concept in terms of its attributes, the values of the attributes, the attributes of the values and so on. One way of representing frames is by using attribute-value matrixes (AVMs) like in figure 1. The AVM in figure 1 shows a partial frame for the concept 'tree' (based on Petersen and Osswald (2012)). A tree consists of a crown and a trunk, hence CROWN[1] and TRUNK are attributes in the frame of 'tree'. The value of the attribute CROWN is the underspecified value or, in different terms, the uninstantiated type 'crown'. The value of trunk is the uninstantiated type 'trunk' which can be further characterized as having an attribute BARK. The bark of the tree is characterized as having a certain color.

$$\begin{bmatrix} \textit{tree} & \\ \text{CROWN} & \text{crown} \\ \text{TRUNK} & \text{trunk} \begin{bmatrix} \text{BARK} & \text{bark} & \begin{bmatrix} \text{COLOR} & \text{color} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Figure 1: Partial frame for the concept 'tree'.

Following Löbner (1998; 2014) and Petersen (2007), attributes are partial functions; they assign a unique value to their possessor argument. The requirement of functionality provides a formal constraint on possible attributes. As attributes are functions, it is possible to distinguish scalar and non-scalar attributes by looking at their domains. If the values in the domain are linearly ordered, the attribute is a scalar one (e.g. SIZE). If there is no linear order of the domain's values, it is a non-scalar attribute, such as COLOR.

[1]Attributes are written in small capitals.

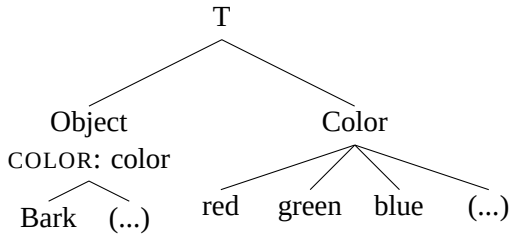

Figure 2: Partial type signature.

To restrict the admissible attributes for a frame and the admissible values for an attribute, types can be assigned to frames. Types are ordered with regard to their specificity in a type signature (Carpenter , 1992), as shown in figure 2. The type signature defines 'bark' as a subtype of the type 'object'; 'red', 'green' and 'blue' are defined as subtypes of 'color'. The type signature is enriched with appropriateness conditions (ACs) which serve two tasks: first, they restrict the set of appropriate attributes for frames to a certain type. Second, ACs specify the appropriate values for an attribute; it is required that all values of an attribute are of a certain type (see Petersen (2007), Petersen et al. (2008), Petersen and Gamerschlag (2014)). COLOR restricts its values to be of the type 'color' or one of its subtypes. Furthermore, the attribute COLOR is an appropriate attribute for 'object'. Since 'bark' is a subtype of 'object', it inherits this AC. Thus, objects of the type 'bark' have a color but do not have, for example, a price, since the type signature does not define PRICE as an appropriate attribute for 'bark'.

4 Frame analysis of degree gradation

In section 2, I suggested that the degree context activates the relevant gradation scale in the case of lexically non-scalar verbs. This process is not arbitrary but restricted by the lexical semantics of the verb. There are two reasons for this assumption: First, each semantic class of gradable verbs is only related to a single gradation scale. Second, different semantic classes of verbs are related to different gradation scales. As discussed above, verbs of substance emission such as *bluten* 'bleed' are related to a quantity scale (2-b), but verbs of smell emission, like *stinken* 'stink' in (1), are related to an intensity scale.

In the following, the analysis concentrates on the verb *bluten*. The verb denotes a process of substance emission. Its single argument is the emit-

ter, the one who is emitting blood. The emittee, which is the emitted substance, is an implicit semantic argument of the verb (Goldberg (2005) speaks of an incorporated theme argument). A frame representation for *bluten*, capturing the mentioned aspects, is given in figure 3. The boxed numeral in the frame indicates structure sharing (Pollard and Sag , 1994) and indicates that the value of EMITTER is coextensive with a some other structure, the externally specified subject.

substance emission	
EMITTER	1
EMITTEE	blood

Figure 3: Frame for the verbal concept *bluten* 'bleed'.

Degree gradation affects the quantity of the emitted blood; hence QUANTITY is an attribute of the emittee. The frame representation for *sehr bluten* 'bleed a lot' is shown in fig 4. The intensifier *sehr* activates the scalar attribute QUANTITY in the frame of *bluten* and specifies the value of QUANTITY as 'high'.

substance emission	
EMITTER	1
EMITTEE	blood [QUANTITY high]

Figure 4: Frame for *sehr bluten* 'bleed a lot'.

As QUANTITY is an attribute of 'blood', it is the object knowledge associated with 'blood' that licenses its activation. A partial frame for 'blood' is given in figure 5.

blood	
CONSISTENCY	liquid
COLOR	red
QUANTITY	quantity

Figure 5: Partial frame for the concept *Blut* 'blood'.

It is part of our knowledge of 'blood' that it has a certain consistency ('liquid'), has a certain color ('red') and is of a certain quantity. While the attributes CONSISTENCY and COLOR have fixed values for blood, the value of QUANTITY is dependent on the possessor of the blood. In figure 5 the only scalar attribute is QUANTITY, hence it is the only attribute that can be activated in a degree context to provide a suitable gradation scale.

I propose the constraint in (4) as a restriction for the activation of scalar attributes in the frames of lexically non-scalar verbs:

(4) Only meaning components that are lexically specified in the verb license the activation of scalar attributes.

In the frame for *bluten* (figure 3) only the emittee is lexically specified as being blood. The emitter is not specified in the verb, rather it is introduced by the subject argument and therefore does not give access to specific conceptual knowledge.

5 Restricting the scalar attribute

An apparent problem is the claim that the frame for *bluten* only contains one scalar attribute, namely QUANTITY. It is clearly the case that we cannot only speak of the quantity of blood but also of its temperature or pressure. TEMPERATURE as well as PRESSURE are scalar attributes too, so the question emerges why it is only QUANTITY but not TEMPERATURE or PRESSURE that is activated in a degree context?

To tackle this problem one has to realize that the gradable verbs of substance emission are not restricted to those that express an emission of a liquid like blood. Other verbs of this class express the emission of a solid like hair in (5).

(5) *Die Katze hat sehr gehaart.*
the cat has very shed
'The cat lost many hairs.'

The type signature in figure 6 defines 'liquid' to be a supertype of 'blood' and 'water' and to be a subtype of 'substance'. 'Solids' are also a subtype of 'substance' and form the supertype of, for example, 'hair' and 'scall'. The attributes shared by liquids and solids are inherited from their common supertype, for example CONSISTENCY and QUANTITY. But there are attributes which 'hair' and 'blood' do not share and these are inherited from the more specific supertypes 'liquids' and 'solids' respectively. For example, liquids do have a temperature and a pressure but we do not think of solids in terms of the attributes PRESSURE and TEMPERATURE. This does not result in the claim that solids do not have a temperature but I do not think that TEMPERATURE is an attribute in our object knowledge of 'hair' or 'scall'; so we do not

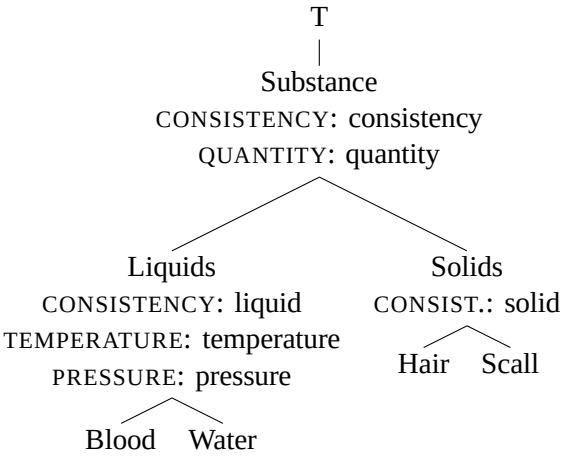

Figure 6: Partial type signature.

represents these concepts by using the attribute TEMPERATURE.

As verbs of substance emission do not only express the emission of liquids but of solids too, the admissible scalar attributes that can be activated in a degree context are restricted to those inherited from the common supertype of liquids and solids, which is 'substance'. Since QUANTITY but not TEMPERATURE or PRESSURE is inherited from 'substance', it is only QUANTITY that can be activated in the context of degree gradation. Beside the constraint in (4) a further constraint restricting the activation of scalar attributes is required:

(6) The activation of scalar attributes is restricted to those attributes which are inherited form the most specific common supertype.

The most specific common supertype for emittable substances like 'blood' and 'hair' is 'substance'. Hence, (6) restricts the activation of scalar attributes to those which are inherited from 'substance'; those attributes inherited from a more specific supertype like 'liquids' cannot activated in a degree context.

6 Conclusion

In this paper, I have shown that lexically non-scalar verbs can be graded by intensifiers like *sehr*. But this requires the activation of a suitable scalar attribute, otherwise the degree construction could not be interpreted. The process of attribute activation is not unconstrained, rather the lexical meaning of the verb as well as conceptual knowledge provide constraints on this process. The scalar attribute is activated from the conceptual knowledge associated with a meaning component lexically specified in the verb. Furthermore, the gradable attributes that can be activated are restricted to those inherited from the most specific common supertype. This ensures a homogeneous interpretation of degree gradation of verbs of substance emission, otherwise degree gradation of verbs (of substance emission) would be totally idiosyncratic.

Frames provide a suitable framework for the analysis of the sketched phenomenon as they allow representing lexical knowledge and conceptual knowledge in the same representational format. The frame analysis in this paper concentrates on a single semantic verb class but it can easily be extended to cover other classes of gradable verbs, for example verbs of smell/light/sound emission or experiencer verbs, too. I propose that the general constraints formulated in (4) and (6) hold for these classes of verbs as well, the only difference consists in the associated conceptual knowledge.

The process of attribute activation is not restricted to scalar attributs in the context of verbal degree gradation. A similar process occurs if verbs of sound emission are used for denoting motion events like in (7) (based on Kaufmann (1995, 93)). In this construction, a motion frame is activated which is licensed by the fact that the motion of a motorbike produces a yowling sound. In this case and in opposition to verbal degree gradation, knowledge of the subject referent is relevant too.

(7) *Das Motorrad jaulte über die*
the motorbike yowled over the
Kreuzung.
crossing
'The motorbike yowled over the crossing.'

It is a promising task for the future to explore the process of attribute activation in more details and to see how the activation of attributes from the conceptual knowledge is constrained by lexical semantics and other factors.

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