Sitting, Standing, and Lying in Frames: A Frame-Based Approach to Posture Verbs

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Abstract. Posture verbs which allow for an extended locative use, such as *sit*, *stand* and *lie*, make reference to specific parts of the localized object, to the orientation of prominent object axes and to positional information, which are perceived by means of cognitive modules such as gestalt recognition and spatial perception. These properties render posture verbs an excellent object for the investigation of cognition and language. This paper analyzes the three basic posture verbs of German (*sitzen* 'sit', *stehen* 'stand' and *liegen* 'lie') in terms of frame representations. It turns out that frames can serve as a highly flexible device for decompositional analyses that is at the same time a cognitively plausible knowledge representation format.

Keywords: posture verbs, extended locative use, frame analysis, object schemata, German, Korean, French

1 Introduction

Posture verbs such as *sit*, *stand*, and *lie* basically denote particular postures of individuals. According to [1] virtually all languages have posture verbs and, in addition, often exhibit extended locative uses. For example, the English verb *sit* in (1) refers to the posture of an individual resting on the buttocks and also allows for specifying the location of this individual by means of a locative PP.

(1) *John is sitting on the swing.*

Posture verbs (henceforth PVs) with a locative extension cannot be analyzed in isolation, but need to be treated in the context of other locative expressions such as the locative PPs that figure as their complements. By consequence, any analysis of PVs has to be considered as part of an overall approach to the relation between space and language which aims at an understanding of how human language expressions make reference to space and location.

The last few decades have seen a considerable increase in the amount of studies devoted to this topic. Given the restrictions of this paper, we cannot summarize, let alone review, all the qualitative work that has been done in this area. From a cognitive perspective, the general approaches by [17] and [34] have been particularly influential. In addition, there are numerous comprehensive anthologies such as [7, 10, 13, 23], to name just a few. There are also numerous works on

the spatial meaning of particular parts of speech, such as spatial prepositions ([2, 27, 36–39]), dimensional adjectives referring to the spatial properties of objects such as *wide* and *long* ([18–20]), and locative verbs ([1, 14, 26]), which comprise verbs such as *hang (at)* and *stick (to)* in addition to posture verbs.

The typological branch of the research area, one important exponent of which is the Language and Cognition Group at the Max Planck Institute for Psycholinguistics, has revealed that languages differ significantly with respect to their spatial reference systems ([22, 23]). According to Ameka and Levinson ([1]), this diversity is in conflict with Landau and Jackendoff's assumption ([17]) that spatial language is of a rather schematic nature which abstracts away from properties such as object shape and is mainly carried by prepositions as in English. Ameka and Levinson argue that languages with a large inventory of locative verbs, in particular, are problematic in this respect since they have a full set of contrastive locative verbs which often make specific reference to properties of the figure and the ground, such as the number of axes, the presence of a canonical orientation, and distinctions such as natural vs. cultural kind, flexible vs. rigid, tall vs. stout, and container vs. flat surface.

Any formal representation must be able to cope with the cross-linguistic diversity of spatial language. In this paper, we will show that frame representations in the sense of [3, 28] are ideal for this purpose as they provide us with a highly flexible device while at the same time being a cognitively plausible, variable-free representation format.

After a short introduction to our framework in the next section, we will apply the frame model to the three basic German PVs *sitzen* 'sit', *stehen* 'stand', and *liegen* 'lie' in section 3. Given the wide range of languages which have been investigated for their posture verb repertories by the Nijmegen Language and Cognition Group and others, this may seem rather unspectacular. However, there are two reasons for our choice of German as an object language. First, German is an instance of a language which uses a comparatively large set of about ten verbs in basic locative constructions ([16]). This makes German a good starting point for exploring the potential of a frame analysis that can then be extended to languages with larger inventories of locative verbs. Second, there are already a number of investigations of German locative verbs and the subclass of PVs on which we can build the frame approach ([4, 14, 16, 32] among others). In particular, we will take the decompositional approach by [14] as a basis for the frame representation of PVs and spatial prepositions. After the exemplary frame analysis of the three basic German PVs, we will outline some possible extensions of the frame approach in section 4.

2 The framework

In our analysis of PVs, we will apply frame representations made up of recursive attribute-value structures. The introduction of frames as a cognitively plausible format of knowledge representation has led to a paradigm shift in cognitive science, artificial intelligence and other disciplines ([11, 25]), such that concepts

are no longer represented as atomic units but as complex structures built up recursively of attributes with structured values. Feature lists and binary features represent a preliminary stage in this process (cf. [8]).

Our frame approach mainly follows [3] in that we claim that the values of an attribute in a frame may be arbitrarily complex frames themselves and that the attributes in a frame can exhibit a cyclic structure. Furthermore, we add two assumptions which are not explicitly found in [3]: first, we assume that attributes in frames are functional in the sense that they assign unique values. Second, we do not claim that the central frame node is necessarily a root of the frame graph (i.e., a node from which all other nodes can be reached via directed arcs). Frames can be represented by directed, labeled graphs with arcs corresponding to the attributes and nodes corresponding to the values (for details see [28]). Figure 1 shows the graphs of simplified frames for the concepts *rented apartment* and *sibling*.

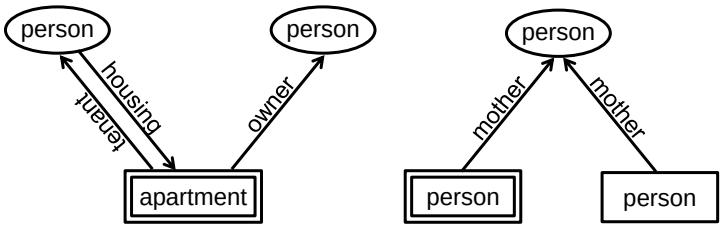

Fig. 1. Frame graphs of *rented apartment* (left) and *sibling* (right)

In the graphs, the labeled arcs represent the frame attributes while the node labels indicate the type of the attribute values. For example, in the frame graph of the concept *rented apartment*, the concept is modeled as an apartment which is further specified by two attributes, namely OWNER and TENANT. Both attributes have values of the type person. By typing frames and assuming a type signature, the class of admissible frames can be restricted (cf. [28]). In a type signature, the types are ordered in a hierarchy which is enriched by appropriateness conditions which constrain the domain and range of attributes. Thus the type signature determines which type of entities can have a certain attribute and of which type the values of each attribute are. In the frame graphs, the assumption that frame attributes are functional is modeled by the graph condition that a node may not have two outgoing arcs labeled with the same attribute. The central node of a frame, here the node labeled 'apartment', is marked by a double border. It indicates that this frame is a frame about an apartment rented to somebody and not about somebody renting or renting out an apartment. Note that the special notational treatment of the central node is necessary as it may not be a root or the only root of the frame graph ([30]). The frame graph on the left in Figure

1 has two roots while the one on the right has no root. Nodes corresponding to concept arguments are given a rectangular shape. As we treat nominal sortal concepts like *apartment* as one-place predicates, the central nodes of their frame graphs are argument nodes. The frame graph on the right in Figure 1 represents the concept *sibling* as a person for which a second person exists with which the first shares its mother. As *sibling* is a relational concept, its frame graph exhibits two argument nodes.

In our decompositional approach to PVs, we have decided to apply frames and not a formalism based on predicate logic as is commonly done since we consider frames to be cognitively more adequate. Frame theories have always been motivated cognitively: [3] argues that frames are used as a general format in accounting for the content of mental concepts and gives empirical evidence for attribute-value sets in cognition. [24] provides evidence for frames from a linguistic perspective. In [31] a biologically motivated model for the cortical implementation of frames is developed by applying the paradigm of object-related neural synchronization. Recently, [35] have shown that the attribute-value structure of frames provides an adequate formalization of the theory of grounded cognition. Moreover, the frame approach has already been successfully applied in the analysis of the inferential use of perception verbs such as *sound* and *feel (like)* ([12, 29]).

It is evident that the information represented in a frame graph can also be expressed in predicate logic. However, if one compares both approaches, there are advantages of frames which result from their variable-freeness: in contrast to predicates in predicate logic, which fix the number of arguments they take and their order, frames are more flexible. Additional attributes can be added and substructures can be addressed via labeled symbols instead of ordered argument positions. The main advantage is that in a decompositional frame analysis the unity of a concept is always preserved while in an analysis in predicate logic the elements constituting a concept can be scattered around only being connected by shared variables. We argue that the confinement to recursive attribute-value structures with attributes as basic elements will lead not only to more explicitness but also to a cognitively more plausible, variable-free analysis of PVs.

3 A frame analysis of German posture verbs

The properties that are relevant to the choice of a specific PV in German were established, among others, by [4, 14, 16, 32]. These properties include (i) the way the localized object is kept in its position (e.g., support from below in the case of *sitzen* 'sit' and support from above in the case of *hängen* 'hang'), (ii) the state of matter of the supporting medium (e.g., *schwimmen auf* 'be afloat on' versus *liegen auf* 'lie on') and (iii) the orientation of the most prominent object axis (e.g., *die Leiter steht* 'the ladder is standing' versus *die Leiter liegt* 'the ladder is lying'). [14] proposes an analysis in which these properties are explicitly implemented as conjuncts in predicate logic representations. Following [18], she

assumes that part of the spatial requirements that are imposed by the PV on the localized object is captured in object schemata.

Our account of PVs builds heavily upon the analyses proposed in [14, 18–20]. In particular, we adopt two important ingredients of their approaches: the support relation and object schemata. The support relation captures the fact that PVs require the located object to be supported somehow in order to remain in its position. As will be shown below, PVs differ with respect to which part of the located object is supported. Object schemata are representations of the spatial knowledge of objects. They consist of a hierarchy of object axes which is determined by their saliency. Additionally, object schemata allow for further characterization of object axes, such as identifying the so-called 'canonical vertical', which is the axis that is aligned with the vertical if the object is in its prototypical spatial configuration. In the following, we present an analysis of the three German PVs *sitzen* 'sit', *stehen* 'stand', and *liegen* 'lie' in which the support relation and object schemata are directly translated into frame representations.

3.1 *Sitzen* 'sit'

The German PV *sitzen* 'sit' basically refers to the posture of an individual resting on the buttocks. Like English *sit*, *sitzen* allows for specifying the location of the sitting individual by means of a locative PP as in (2).

(2) *Hans sitzt auf der Schaukel.*
Hans sits on the swing
'Hans is sitting on the swing.'

Kaufmann ([14, p. 103]) proposes the representation of *sitzen* in (3), which is formulated within the framework of Two-Level Semantics ([5, 6] among others).

(3) a. *sitzen* 'sit': $\lambda P \lambda x$ [SIT(x) & P(x)]
b. Int(SIT(x))= $\exists$y[support$_S$(d-us(y), buttocks(x))]

In (3a) the representation of *sitzen* at the level of semantic form is given. Semantic form is intended to be a minimal decomposition which is restricted to aspects of meaning relevant to grammar, in particular to argument realization. The representation in (3a) simply states that *sitzen* is translated into a conjunction of a one-place predicate SIT(x) and an additional predicate P(x) which is to be instantiated by the predicate contributed by the locative PP. The interpretation of SIT(x) at the level of conceptual structure is provided in (3b). In contrast to semantic form, conceptual structure is an elaborate semantic level, which can be made more fine-grained in any direction that matters. The representation in (3b) says that the predicate SIT is interpreted ('Int') as a relation between the figure x and some supporting entity y such that the deictic upper side ('d-us') of y supports the buttocks of x. In addition, the physical state of the supporter must be solid, which is indicated by the subscript 's' for 'solid'.

According to Kaufmann, the support relation is central to the interpretation of *sitzen*. As a consequence, the characteristic form or shape of a sitting person is rather epiphenomenal, resulting from the posture which has to be adopted in order for the buttocks to be supported from below. This view is corroborated by the fact that the verb *sitzen* cannot be applied directly to a person who has a sitting posture but is kept in this position by the support of a body part different from the buttocks. In German, one could refer to this by the complex construction *in einer sitzenden Haltung sein* 'be in a sitting posture', but *sitzen* as a matrix verb cannot be predicated directly of an individual in such a spatial configuration. Additionally, as the example in (2) demonstrates, a sitting person does not necessarily need to adopt a prototypical sitting posture. Imagine a child on a swing putting a lot of effort into swinging. Although it remains sitting on the swing, the shape of its body will nearly never correspond to a prototypical sitting posture.

Since our focus is on the conceptual properties of PVs, the frame representation of *sitzen* in Figure 2 below is based on the conceptual structure representation in (3b). The central node of the frame, which is marked by a double border, refers to the overall situation denoted by *sitzen*. The sitting individual is introduced as the value of the THEME attribute.

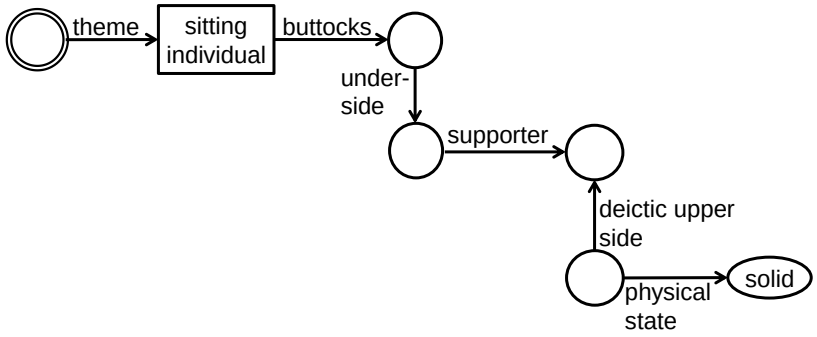

Fig. 2. Frame for *sitzen* 'sit'

In line with Kaufmann's analysis in (3b), the requirement that a specific part of the body is supported is integrated by the mereological attribute BUTTOCKS. The underside of the buttocks is the supported part of the body, i.e., it has a supporter which is the deictic upper side of the supporting entity. Moreover, the supporting entity has to be solid, which is implemented into the representation by means of the frame attribute PHYSICAL STATE and the value 'solid'.

Note that the complex frame for *sitzen* in Figure 2 is yielded by expanding the node *sitting individual* into several attribute-value pairs. However, the frame can also be collapsed down to this node without a loss of information since the type *sitting individual* is already defined as exhibiting these attribute-value pairs

in the type signature. Thus, frames allow for zooming in and out of conceptual representations by expanding nodes referring to complex concepts. This makes them more flexible than the more rigid Two-Level Semantics representations illustrated above.

The frame of *sitzen* in Figure 2 does not represent the locative extension of the PV in which the location of the theme is specified in relation to another object introduced as internal argument of a locative PP such as *auf der Schaukel* 'on the swing'. Following Kaufmann, we assume that the support relation evokes or 'activates' further locational meaning which allows for merging the above frame with a figure–ground frame. This figure–ground frame integrates the locational information specified by the local PP. In general, for local prepositions we follow [36, 37] and others who assume that prepositions of this type single out specific regions with respect to the referent of the internal argument of the preposition and, in addition, predicate of an entity to be located in this specific region. According to this view, the semantic form of the nondirectional reading of the German preposition *auf* 'on' is represented as in (4), which is taken from [14, p. 111]. The representation states that *auf* denotes a relation holding between an object x which is located in the upper region of another object y. In addition, the second conjunct requires x to have contact with y since *auf* is a preposition which always involves contact. This conjunct is necessary in order to differentiate *auf* from *über* 'above', which also denotes location in the upper region of some object but does not imply contact.

(4) *auf* 'on' [-DIR]: $\lambda y \lambda x$ [LOC(x, UPPER_REGION(y)) & CONTACT(x,y)]

The representation in (4) can be translated into the frame in Figure 3, which contributes a figure–ground schema with the located entity and the reference object being introduced as values of the attributes FIGURE and GROUND, respectively. The meaning of the preposition is integrated into this frame as identifying the LOCATION of the figure with the UPPER REGION of the ground. The bidirectional broken arrow indicates that the instantiations of figure and ground are restricted to objects which are in physical contact with each other.

If *sitzen* is combined with a subject and a local PP headed by *auf*, the frames contributed by the three elements are merged into a complex frame in which the values of the THEME of the *sitzen* frame and the FIGURE of the *auf* frame are unified. This is illustrated by the frame for the sentence *Hans sitzt auf der Schaukel* 'Hans is sitting on the swing' in Figure 4.

The *sitzen* frame in Figure 2 necessarily involves contact of the supported object with the supporter since support in general cannot be conceived without contact. At the same time, the frame contributed by the preposition *auf* requires contact of the figure with the ground. Consequently, the ground is identified as the supporting entity, which is indicated by the thick arrow between the ground and the object whose upper side serves as supporter.

The region indicated by *auf* leaves some room for interpretation as to which part of the swing serves as the actual supporter: if Hans is located in the upper

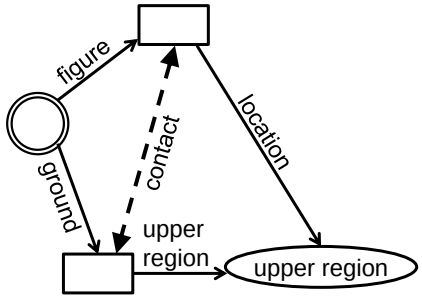

Fig. 3. Frame for *auf* 'on'

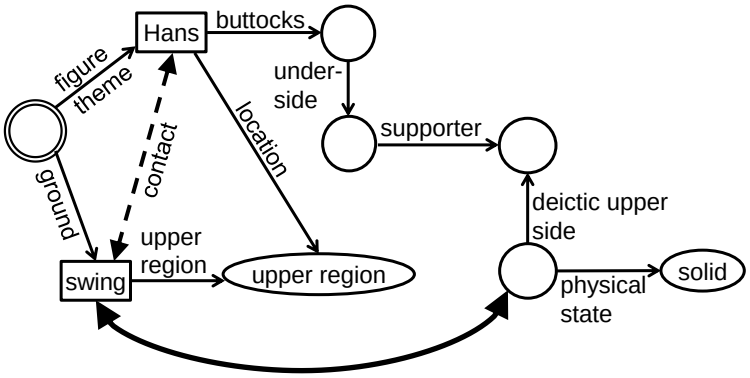

Fig. 4. Frame for *Hans sitzt auf der Schaukel* 'Hans is sitting on the swing.'

region immediately above the seat, he is supported by this part of the swing. If, however, the design of the swing also consists of beams, its upper region additionally comprises the region above the top beam so that the frame in Figure 4 could also represent a situation in which Hans is located on the top beam. This second constellation is less expected since the design of a swing does not necessarily involve a beam construction and moreover its purpose requires being located on the seat. Nevertheless, the frame in Figure 4 allows for such a flexibility, which is in accordance with the interpretation of the natural language example in (2). Interestingly, the same ambiguity arises with other kinds of supporting entities such as armchairs and sofas which allow for (noncanonical) sitting on the back or armrests.[1]

Also note that the supporting entity and the ground are not necessarily identified. This becomes evident if *auf* is substituted by another preposition

[1] We owe the observation concerning the interpretative flexibility of the frame in Figure 4 to an anonymous reviewer.

which does not imply contact, such as *unter* 'under' in *Hans sitzt unter dem Baum* 'Hans is sitting under the tree'. In this sentence the supporting entity remains unrealized since it cannot be identified with the ground *tree* 'Baum'.

The frame analysis of *sitzen* can easily be extended to the PV *knien* 'kneel', as in *Hans kniet auf dem Boden* 'Hans is kneeling on the ground'. Like *sitzen*, *knien* requires solid support from below and only differs from *sitzen* in that the knees rather than the buttocks are supported.

3.2 *Liegen* 'lie'

In contrast to *sitzen* 'sit', *liegen* 'lie' cannot be sufficiently analyzed without making reference to object axes since *liegen* does not involve a specific part of an object, such as its back, as might be assumed. This is shown by the different positions of a brick illustrated in Figure 5 below.

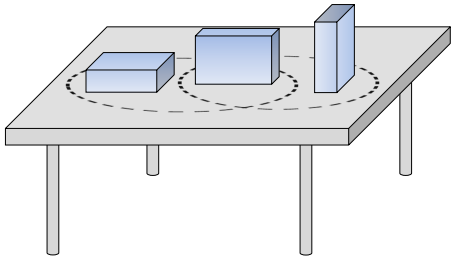

Fig. 5. Different orientations of bricks referred to by *liegen* 'lie' and *stehen* 'stand'

The two bricks inside the left circle can both be referred to by the verb *liegen* whereas this is not possible for the remaining brick on the right, whose orientation can only be characterized by the PV *stehen* 'stand.' However, the brick in the middle can alternatively be referred to by *stehen* 'stand' so that it can be grouped together with the right brick as standing bricks (marked by the right circle). The fact that a brick usually does not have a clearly distinguishable part such as a back or a unique side shows that the choice of *liegen* and *stehen* does not depend on properties of this type. Instead, both PVs are sensitive to the orientation of object axes. *Liegen* requires alignment of the most prominent (longest) axis with the horizontal whereas *stehen* can be applied if either the longest or the second longest axis is oriented vertically. The conditions for *stehen* are, however, more intricate and will be discussed in the next section.

For *liegen*, [14, p. 108] proposes the semantic form in (5a) and the conceptual structure in (5b). The interpretation in (5b) states that *liegen* holds for an object if a side 's' which is orthogonal to a nonprominent ('nprom') axis is supported from below by a solid object.

(5) a. *liegen* 'lie': $\lambda P \lambda x$ [LIE(x) & P(x)]
b. Int(LIE(x)) = $\exists$y [support$_S$(d-us(y)), s(nprom(x)))]

Given the conceptual structure in (5b), support from below entails that a non-prominent axis is aligned vertically. Since this also entails that the most prominent, i.e. maximal, axis is oriented horizontally, we will assume the simpler condition that *liegen* requires the maximal axis to be horizontal.

The PV *liegen* involves direct reference to object axes, which can be captured in the object schemata by [18–20]. As illustrated in Figure 6, the object axes are given in hierarchical order with the most prominent (or salient) object axis, 1D, to the left and the least prominent axis, 3D, to the right. In the second line, further information is specified: 1D is identified as the maximal (longest) axis, and 3D as the minimal (shortest) axis while 'Across' characterizes 2D as an axis which is oriented orthogonally to 1D.

The linear object schema can be translated directly into a frame of spatial objects as shown for *Ziegelstein* 'brick' in Figure 7.

1D	2D	3D
Max	Across	Min

Fig. 6. Object schema of *Ziegelstein* 'brick', linear representation

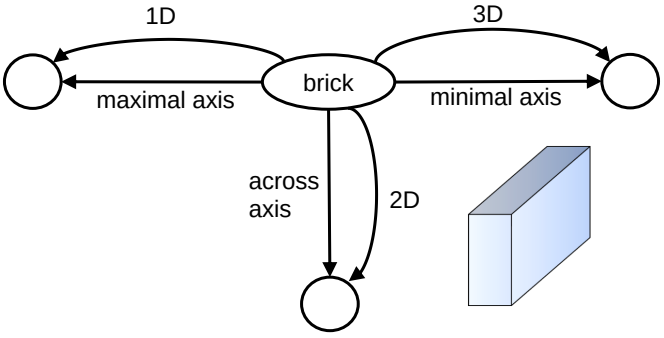

Fig. 7. Object schema of *Ziegelstein* 'brick', frame representation

1D, 2D, and 3D are captured as attributes of the brick. The values of these attributes are the axes identified by 1D, 2D, and 3D, respectively. The information which is specified for theses axes in the second line in the linear object schema above is also introduced by frame attributes, namely MAXIMAL AXIS, ACROSS

AXIS, and MINIMAL AXIS. In the case of a brick, the values of these attributes are identified with the values of the attributes 1D, 2D, and 3D, respectively.

Figure 8 shows the frame for *liegen*. As can be seen, the portion of the object schema of the located figure relevant for *liegen* is specified as part of the meaning of the PV: a lying figure requires the most prominent object axis 1D to have a horizontal orientation. The remaining part of the meaning of a lying individual is almost identical to that of a sitting individual: the figure is kept in its position by a lower, supporting object which is solid. This component of the meaning of *liegen* only differs from *sitzen* in that it is not a specific part of the figure which is supported from below.

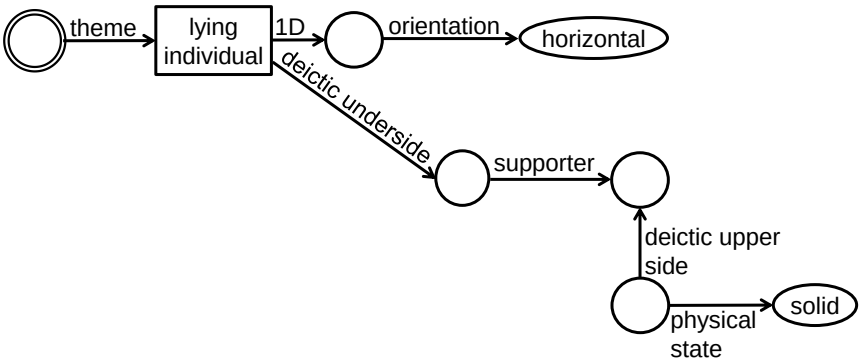

Fig. 8. Frame for *liegen* 'lie'

In the example in (6), the PV *liegen* is combined with the subject *Ziegelstein* 'brick' and the local PP *auf dem Tisch* 'on the table'. The corresponding frame in Figure 9 results from the unification of the frames contributed by the subject, the PV and the PP.

(6) *Der Ziegelstein liegt auf dem Tisch.*
the brick lies on the table
'The brick is lying on the table.'

As a further parallel to *sitzen*, the locational information contributed by the spatial preposition can be brought into the frame by a figure–ground frame, which is merged with the frame representing the meaning of the PV. Due the choice of the preposition *auf* 'on', which involves physical contact, the ground is identified as the supporting entity.

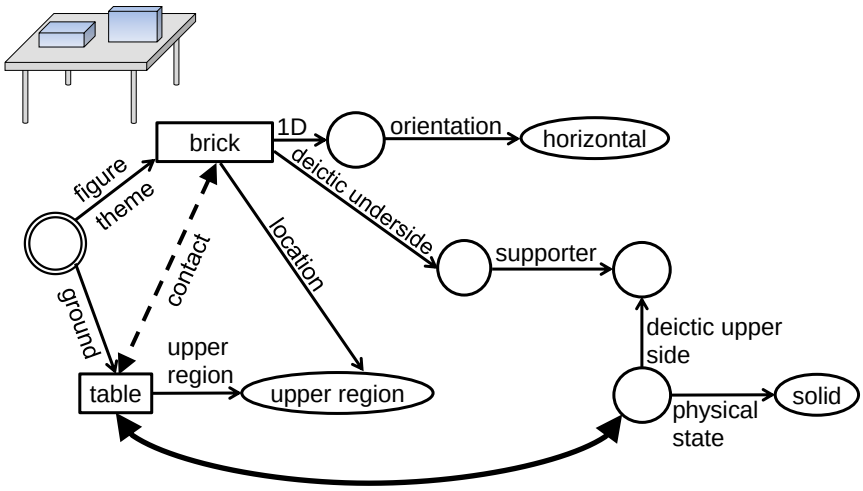

Fig. 9. Frame for *Der Ziegelstein liegt auf dem Tisch.* 'The brick is lying on the table.'

3.3 *Stehen* 'stand'

As with *liegen*, the PV *stehen* 'stand' can be applied to two of the bricks in Figure 5 above. However, now the two bricks enclosed by the right circle exhibit orientations which can be referred to by *stehen* since the condition for the selection of *stehen* is that either the longest (i.e. maximal) axis or the second longest axis must be aligned vertically. Only the remaining brick on the left cannot be said to be standing since it is the shortest axis which is vertical in this case. In order to capture the two options for standing, one could assume two different frame representations which make explicit reference to the maximal axis 1D and the intermediate axis 2D and characterize them as aligned vertically. Alternatively, one can make use of the fact that both orientations of the brick which can be referred to by *stehen* exhibit a horizontal alignment of the minimal axis 3D. This alternative option is chosen in the frame for *stehen* in Figure 10.

Again, we will give an illustration of how the *stehen* frame in Figure 10 is combined with other frames when used in a full sentence: Figure 11 is a frame representation of the example in (7). The complex frame is yielded by unifying the single frames contributed by the subject, the PV *stehen* and the PP.

(7) *Der Ziegelstein steht auf dem Tisch.*
the brick stands on the table
'The brick is standing on the table.'

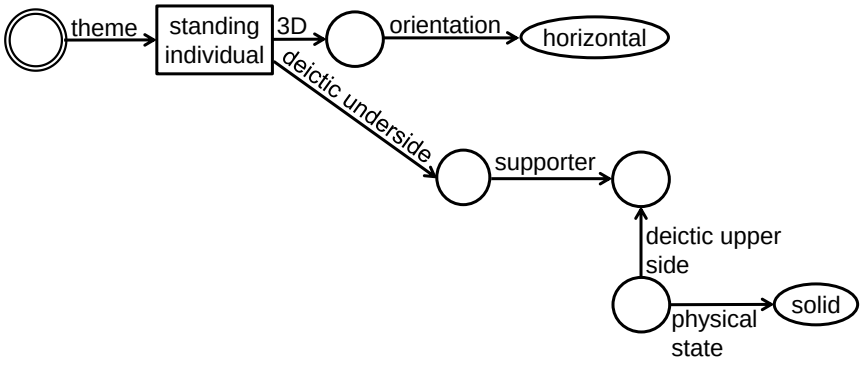

Fig. 10. Frame for *stehen* 'stand'

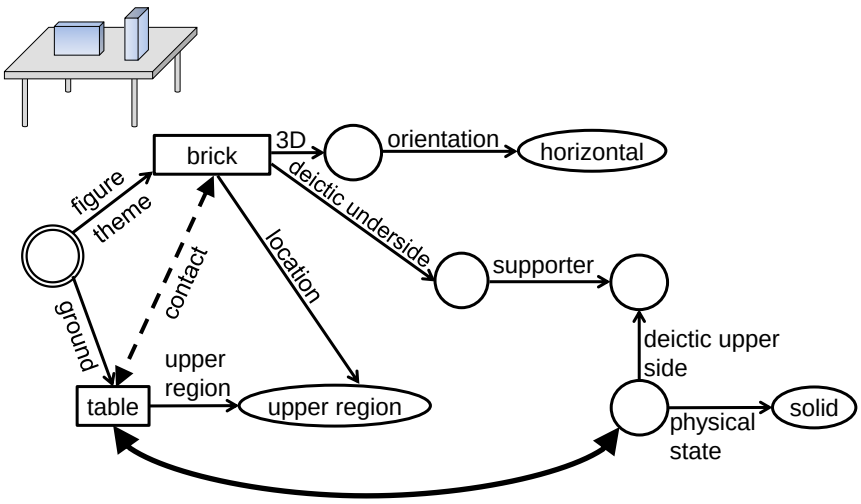

Fig. 11. Frame for *Der Ziegelstein steht auf dem Tisch.* 'The brick is standing on the table.'

As can be seen, the frame differs only minimally from the frames for *sitzen* and *liegen*. Again, as with the preceding posture verbs, the frame contributed by the PV requires support from below by a solid object. In addition, the general location scenario activated by the verb allows for the integration of the figure–ground subframe. As in the previous examples, the supporter is identified as the ground due to the choice of the preposition *auf* 'on', which implies contact between the figure and the ground.

A complication with *stehen* is that in German some objects can be said to be standing because of their canonical orientation, i.e., the way they are usually oriented. In this case, *stehen* can be applied even if the minimal axis is vertical as long as the object exhibits its canonical orientation. For example, a shoebox is oriented canonically when its lid is on top and can be opened, even though this usually involves a vertical orientation of the shortest axis. This specific use of *stehen* can be addressed by making reference to the so-called 'canonical vertical' ([18–20]), i.e., the axis which is vertical when the object exhibits its canonical orientation. By consequence, the object schema of a shoebox provided in Figure 12 below contains a specification of the minimal axis as canonical vertical. Technically, this is achieved by the frame attribute CANONICAL VERTICAL whose value is identical with the value of the frame attribute `3D`.

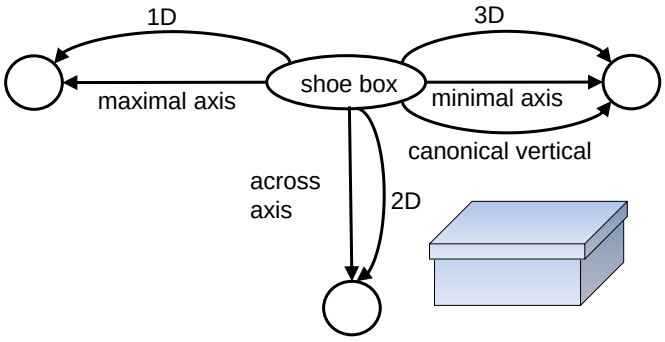

Fig. 12. Object schema for *Schuhkarton* 'shoebox'

For *stehen* to be applicable to objects with the shortest axis being the canonical vertical, the alternative frame for *stehen* in Figure 13 has to be assumed. This frame differs minimally from the frame for *stehen* in Figure 10. The only difference is that the figure is expected to exhibit an attribute CANONICAL VERTICAL which determines that the canonical vertical is vertically oriented. Only the relevant part of the alternative *stehen* frame is given in Figure 13 below. As can be seen, the alternative *stehen* frame does not make reference to the length of the axes but only requires the existence of a canonical vertical and its vertical orientation.

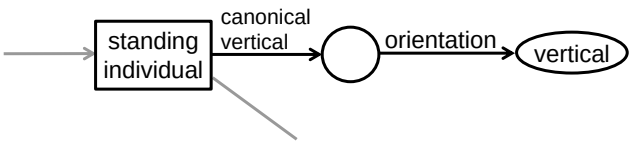

Fig. 13. Alternative *stehen* frame reduced to the relevant part

The frame in Figure 14 represents the example in (8). Since the object schema of a shoebox specifies the minimal axis 3D as canonical vertical, the frame resulting from the unification of the partial frames inherits the information that the minimal axis is the canonical vertical.

(8) *Der Schuhkarton steht im Schrank.*
the shoebox stands in.the wardrobe
literally: 'The shoebox is standing in the wardrobe.'

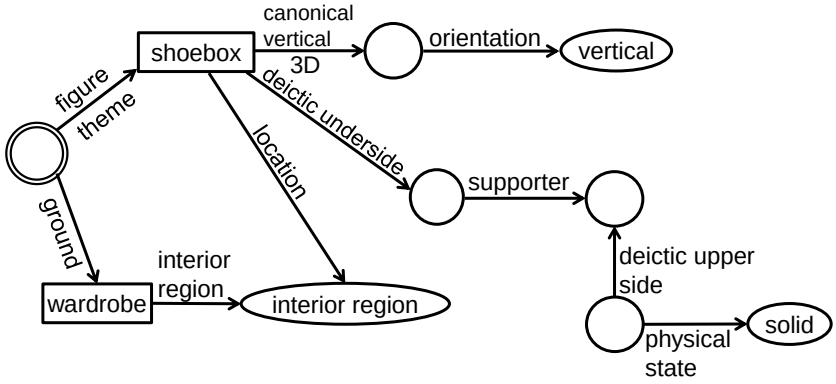

Fig. 14. Frame for *Der Schukarton steht im Schrank.* lit.: 'The shoebox is standing in the wardrobe.'

Again, the frame contributed by the local PP *im Schrank* 'in the wardrobe' is integrated into the figure–ground frame licensed by the overall locational scenario. As a contrast to the preceding examples, the preposition *in* 'in' does not imply contact but merely makes reference to the interior region of the wardrobe. By consequence, some interior part of the wardrobe, such as a shelf, can function as a supporter. Of course, this need not be the case since the box could also be located on some other object inside the wardrobe. However, our world knowledge of a wardrobe as a specific instance of a container gives us access to

the information about potential supporters for objects which are located inside the wardrobe.

For objects with a canonical vertical which is not the maximal axis, the frames for *stehen* in Figure 13 and for *liegen* in Figure 8 compete if the canonical vertical is aligned vertically while at the same time the maximal axis is aligned horizontally. In this situation, the PVs *stehen* and *liegen* should be equally applicable. Yet, for an object like a shoebox the choice of *stehen* as in the example in (8) is natural whereas *liegen* sounds awkward. This difficulty can be overcome by imposing a specificity constraint on the choice of a PV which requires that the most specific PV is chosen. This would give *stehen* preference over *liegen* since the presence of a canonical vertical in the frame of *stehen* in Figure 13 can be considered more specific than the reference to the longest object axis in the frame of *liegen* in Figure 8.

Note that the different axes which can be aligned vertically are not directly addressed in Kaufmann's representation of *stehen* ([14, p. 108]) provided in (9) below.

(9) a. *stehen* 'stand': $\lambda P \lambda x$ [STAND(x) & P(x)]
b. Int(STAND(x)) = $\exists y$ [support_S(d-us(y), s(prom(x)))]

The interpretation of *stehen* in (b) states that a side 's' which is orthogonal to a prominent axis ('prom') of the standing object x is supported by the deictic upper side of some other object y. The axis singled out by 'prom(x)' is defined as the maximal axis or the canonical vertical. However, it remains undefined how this process of axis selection works. In addition, it is not clear how objects like bricks are treated, which do not have a canonical vertical but can also be said to be standing if the second longest axis is vertical, as is the case with the brick in the middle in Figure 5 above.

4 Summary and outlook

In this paper, we have shown that frame representations in the sense of Barsalou lend themselves naturally to the representation of posture verbs. The focus of our analysis has been on the German posture verbs *sitzen* 'sit', *liegen* 'lie', and *stehen* 'stand', which are already well described in the literature. In particular, we have drawn from the decompositional account of Kaufmann ([14]), who demonstrates that the choice of one of these verbs depends on (i) the body part which is supported to keep the located object in its position and (ii) the orientation of object axes including the so-called canonical vertical for objects which exhibit a canonical orientation. These factors have turned out to be easily translatable into attributes in the frame representation of the specific posture verbs. Likewise, properties of the located object and the locational information contributed by the spatial preposition correspond directly to a confined set of simple frame attributes. As a result, all the elements of the overall make-up of a posture/location scenario could by captured in the single, uniform format of frames. This is particularly true of the axis information provided in the object

schemata by [18–20], which are extra-representational in Kaufmann's decompositional approach. Another advantage of the frame approach is that it allows for different degrees of explicitness, which is yielded by zooming in and out of conceptual representations by expanding nodes referring to complex concepts.

The analysis of German can be extended in several ways: first, in addition to the basic posture verbs discussed above there are other locative verbs such as *hängen* 'hang' and *lehnen* 'lean' which need to be considered in a comprehensive frame analysis of locative verbs. Second, posture verbs, like locative verbs in general, exhibit more abstract uses, often involving semantic drift or bleaching as in *Die Stadt liegt in einem Tal* 'The city lies in a valley' or *Der Verdächtige steht unter Beobachtung* 'The suspect is (literally: stands) under surveillance'. Here, a frame analysis that captures these semantic processes by means of reduction and reanalysis of single frame attributes seems promising. This approach may even be extended to the grammaticalized aspectual use of posture verbs as markers of the progressive aspect, which is not attested for German but for other Germanic languages such as Norwegian, Danish, Swedish, and Dutch ([9, 15, 21]). Third, the framework outlined above builds on the view that spatial prepositions are best analyzed in terms of regions ([36, 37] among others). However, [38, 39] argue that prepositions are better translated into vectors in order to deal with PP modifications like *The tree is ten meters behind the house* which involve the specification of a distance. The challenge for a frame approach is to cope with constructions of this type by introducing attributes such as DISTANCE and DIRECTION which are licensed or "activated" by attributes already contained in the frame of the spatial preposition.

Moreover, the frame account needs to be extended to other languages which differ significantly with respect to the repertory of posture verbs and the factors that govern their use. As a first step, we have contrasted the German data with posture verbs in French and Korean. The comparison between German and French already reveals numerous differences. For example, French does not have posture verbs directly corresponding to German *sitzen*, *liegen*, and *stehen*. Instead, it makes use of a variety of different strategies to refer to stative posture/location scenarios such as using the copula *être* or the unspecific locative verb *se trouver* 'be located', applying the resultative forms of change of posture verbs (e.g. *s'asseoir* 'sit down') and change of location verbs (e.g. *poser* 'place, put'), and also employing verbs which basically denote a change in spatial extension (e.g. *allonger* 'stretch out', which is preferably interpreted as 'lie' when its resultative form is combined with animate subject referents).

Like French, Korean does not have stative posture verbs but has a more systematic inventory of change of posture verbs whose resultative forms can be utilized to refer to stative location. However, the use of these verbs is constrained with respect to admissible subject referents. For example, *seta* 'stand' can only be combined with a nonhuman subject if the subject referent is at least as tall as a human (cf. [33]). As illustrated by the pair of examples in (10), *seta* can select a subject like *Pekhingem kwungcen* 'Buckingham Palace' but not a subject like

hwapwun 'flower pot' since the height of the latter is usually far below the height of a human.

(10) a. *Pekhingem kwungcen-i nay nwun aph-ey*
Buckingham Palace-NOM my eye in.front.of-LOC
se-iss-ta.
stand-be-IND
literally: 'Buckingham Palace is standing in front of my eyes.'
b. **Ku hwapwun-i cengmwun-yeph-ey se-iss-ta.*
the flower.pot-NOM main.gate-side-LOC stand-be-IND
intended: 'The flower pot stands next to the main gate.'
(a-example from M.-H. Min p.c., b-example taken from [33, p. 361])

For the use of *seta* with nonhuman subject referents one can assume the frame in Figure 15, in which a value constraint on the attribute LENGTH requires that the vertical axis is as tall as or taller than a human. The example in (10a) shows that the vertical needs not be the longest axis since the vertical axis of Buckingham Palace is the shortest axis of the building. However, the vertical axis in (10a) is the canonical vertical. Consequently, the length attribute is built into the frame as an attribute of the canonical vertical.

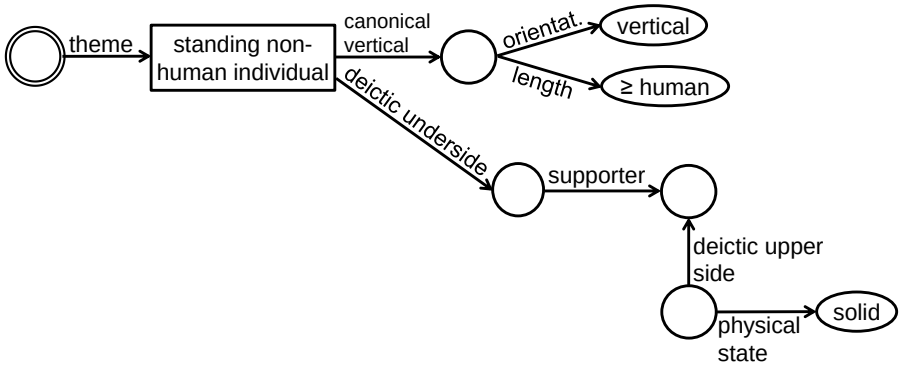

Fig. 15. Frame for Korean *seta* 'stand' combined with nonhuman subject referent

Finally, the analysis can be extended beyond linguistic matters. The frames presented above are built on linguistic analyses which investigate the necessary conditions for the use of specific verbs in a given language. The analyses are "minimal" in the sense that they focus on the factors which are relevant for the choice of a PV and refrain from representing detailed encyclopedic knowledge. Yet, given their flexibility frame representations can also be applied for purposes such as representing anatomical details and the motor activity which is required to remain in a specific posture. This may be useful in the domain of medicine

as well as in other domains such as the recording and analysis of dance since these domains require making reference to different types of postures. Moreover, we have represented the relevant object axes and the part of the body which is supported as first-level (i.e. nonembedded) attributes of the theme argument of the PV. In a more structured frame representation these attributes would be part of attribute bundles referring to the composition and spatial configuration of the theme argument. For the sake of simplicity, we have not considered structural aspects of this kind which, however, are of major importance to purposes such as knowledge representation and inference systems.

The suggestions above indicate that the frame approach to posture verbs and locative verbs in general can be extended in many different directions. In spite of the sketchy character of the analysis outlined above, we consider it a promising framework for a further investigation of these phenomena.

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Abbreviations

NOM nominative
IND indicative
LOC locative
PV posture verb

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