Tops and Bottoms: Axial Nominals as Weak Definites

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1. AxPart as a functional category

Probably every language has constructions like those in (1), where a locative relation is expressed through a prepositional complex with a characteristic core element (*ante*, *taxat*, *pered*):

(1) a.   El   libro   está   **de-l-ante**   **de la**   **mesa**.
           the   book   is   from-the-front   of the   table
          The book is in front of the table.   Spanish, Fábregas 2007
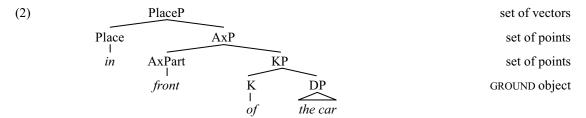
      b.   hu   haya   **mi-taxat**   **la-bayit/ha-bayit**.
           he   was   from-bottom   to.DEF-house/ DEF-house
           He was under the house.   Hebrew, Botwinik-Rotem 2008

      c.   **S-pered-i**   **ot**   **dom-a**   roslo derevo.
           off-front-LOC   from house-GEN   grew tree
           A tree grew in front of the house.   Russian, Mitrofanova and Minor 2013

Svenonius 2006, 2010 proposed an analysis of these elements as heading a functional projection that he calls AxPart ('axial part'):

(2)

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              PlaceP                                set of vectors
         /           \
      Place          AxP                            set of points
       |          /        \
      in      AxPart         KP                      set of points
               |          /      \
             front       K         DP            GROUND object
                         |        /  \
                        of     the  car
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Semantically, the AxPart takes the set of spatial points occupied by the ground object and maps it to the set of points corresponding to the axial part. The Place function then gives the vectors 'projecting' outward from this part. This influential analysis has been applied to a range of languages and constructions (Pantcheva 2006, Muriungi 2006, Svenonius 2006, 2010, Fábregas 2007, Takamine 2007, Botwinik-Rotem 2008, Roy and Svenonius 2009, Romeu 2014, etc.).

Svenonius shows that the AxPart *front* can be distinguished from the noun *front*. In contrast to the DP in *in the front of the car*, the AxP in *in front of the car* resists determination, pluralization, modification, pronominalization, and extraction.[1] For Svenonius this is evidence for a purely *functional* status of AxParts. In this paper, we will show that an analysis of AxParts as functional heads creates more problems than it solves. We offer a more general and more natural analysis of AxParts as members of a larger class of weak nouns (along with the nouns of PPs like *in bed*).

[1] Notice that similar distinctions were already made in descriptive grammars (Quirk, Greenbaum, Leech and Svartvik 1985), in grammaticalization studies (Heine, Claudi and Hünnemeyer 1991) and by Ross 1996.

2. Problems for a functional status

We define an AxPart, somewhat informally, as any clearly non-prepositional word that forms the core of a syntactically complex structure encoding a spatial relation. In more familiar languages an AxPart is usually linked to the ground by a genitive preposition or genitive case and preceded by another preposition, but either of these two elements can be optional, as can be the definite article preceding an AxPart. We recognize such deficient AxParts because the corresponding axial complexes form a semantically inter-related set. The question naturally arises of how AxParts and axial complexes relate to the larger set of similar constructions usually described as "complex prepositions" (e.g., *in spite of*, *in (the) light of* or *on behalf of*), but we will leave this question for future research.

2.1. AxParts can have nominal morphosyntax

The major problem for treating AxParts as purely functional (and not as nominal) is that they often exhibit the grammatical distinctions characteristic of nouns: definiteness, gender, number, case. If we look beyond English examples like *in front of* and *on top of* then we find examples with definite articles, like (1a) above and (3a) below. The presence of gender on AxParts is manifested on these articles as a result of gender agreement, as in (3a) vs. (3b), which is completely regular also in that in French we also find the *en/au* alternation (see Cornulier 1972, Zwicky 1987, Miller, Pullum and Zwicky 1997, Matushansky 2015a) characteristic of the interaction of the P+D complex with gender in French ((3c) provides the regular feminine variant, demonstrating that the gender of the AxPart is systematically the same as that of the corresponding object part, see Roy 2006 for the semantic distinctions between (3a) and (3c)). The genitive preposition appearing in English and Romance in these examples, as well as the genitive case in other languages, also suggest that the AxPart is nominal.

(3)　a.　en　tête　du　train　　　　　　　　　　　　　　French, Roy 2006
　　　　　in　head　of.the　train
　　　　　in the front section of the train

　　　b.　au　　　pied　de l'arbre
　　　　　to+the.M　foot.M　of the+tree
　　　　　at the foot of the tree

　　　c.　à　la　tête　du　train
　　　　　to　the.F　head.F　of.the　train
　　　　　in the front section of the train

While AxParts cannot be pluralized, the existence of inherently plural AxParts, like *alentours* in French and *orillas* in Spanish strongly suggests a link to pluralia tantum:

(4)　a.　aux　　　alentours　　　　de　la　ville　　　　　　　　　French
　　　　　to+the.PL　surroundings.PL　of　the　city
　　　　　around the city

　　　b.　La　casa　está　a　orillas　　del　río.　　　Spanish, Romeu 2014
　　　　　the　house　is　to　riverside.PL　of.the　river
　　　　　The house is at the river side.

Finally, AxParts in axial PP complexes can be overtly case-marked and it is the case assigned by the outer preposition. Furthermore, there are languages, like Russian, that reflect the locative versus directional interpretation of some PPs in the case on the NP (cf. Bierwisch 1988, den Dikken 2003, 2010, Zwarts 2005, 2006, Caha 2010). When describing a destination the noun for *city* has accusative case, but locative case when describing a location. The same contrast with the AxPart for 'front' is also reflected in nominal case marking (cf. Ursini 2014 for the same facts in Finnish).

(5)   a.   Marina   bežit v gorod.   /   v.perëd.   Russian

		Marina	runs	in	city.ACC	/	in.front.ACC	

Marina is running to the city   /   forward.

       b.   Marina   bežit v gorode.   /   v.peredi.

Marina   runs in city.LOC   /   in.front.LOC

Marina is running in the city.   /   in front.

Treating the AxParts *tête*, *alentours*, *orillas*, and *pered* as functional leaves no natural room for these nominal features. These features are clear evidence that these AxParts are nominal.

2.2. AxParts can have nominal content

There is also semantic evidence that the category AxPart cannot be functional. It is maybe possible to maintain that AxParts like *front* and *top* have the kind of schematic meaning that fits with functional heads, but there are many AxParts that have more descriptive content. Example (6a) shows that the AxPart *board* requires a complement that denotes a means of transportation. The AxPart *pied* in (6b) is also very specific in the kind of location that it describes, requiring a ground that is either more tall than it is wide or long, or that has a stereotypical location for feet:

(6)   a.   There is a defibrillator **on board this train/aircraft/spaceship/#theater**.

       b.   Les   fleurs   poussent   **au**   **pied** **de** **l'arbre**.   French

the   flowers   grow   at.the foot of the.tree

Flowers grow at the foot of the tree. [i.e., on the soil around the tree]

The fact that these meanings are highly idiosyncratic and semantically conditioned by the ground is not compatible with a functional element, but points to a lexical status.

2.3. AxParts can have nominal counterparts

Making an AxPart functional creates a sharp distinction with the corresponding noun, e.g., between the two words *top* in (7) and the two instances of *î-gûrû* in (8) and (9).[2]

(7)   a.   A hat is **on top of your head**.   AxPart

       b.   Your forehead is **at the top of your head**.   noun

(8)   Maria   a-mami   **î-gûrû ri-a**   **metha**.   Kîîtharaka, Muriungi 2006

1.Maria   SM1-sleep   5-top   5-AS   9.table

Maria is sleeping/lying on top of the table.

(9)   **Î-gûrû i-rî**   ciat-ir-w-e.

5-top   F-SM5   sweep-PERF-PASS-FV

The top [of something] was swept.

There are clear relations between the two uses of the same item, both in form (the preposition *of*, the noun class marker *i-*) as well as in meaning (the adjacency of the top region denoted by the AxPart and the object part denoted by the noun). Any account of AxParts needs to make the synchronic and diachronic relation between these items explicit. Bringing them into the same domain by treating them both as nouns allows for a more natural connection than putting them in entirely different category systems. Whereas there is obviously a historical route from lexical categories to prepositions, as shown in English by the verbal *bar*, *past*, and *during*, and the adjectival *near*, *short*, *like*, *worth*, and *opposite*,

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[2] Note that the presence of the noun class marker in (8) is another example of the nominal morphosyntax that can characterize AxParts, as is the presence of the associative morpheme.

it is far more difficult to find clear cases of denominal prepositions that retain a synchronic connection to nouns. The fact that prepositions derived from axial complexes (such as *above* or *beyond*) are considerably more frequent suggests that the route from nouns to prepositions is indirect.

3. Proposal: AxParts are 'weak' nouns

Our conclusion is that AxParts are nouns. This helps to explain the presence of an article, gender agreement, number, case, noun class, the possibility of idiosyncratic 'lexical' restrictions on their meaning, and the close relation that they might have with corresponding nouns that refer to object parts.

At the same time we need to recognize that they can't be ordinary nouns, as demonstrated by Svenonius and others before him, because their syntax is much more restricted. However, this kind of deficiency is well known from other constructions where we find nouns occurring in restricted patterns, as what we might call *weak* nouns (cf. Ross 1996, Stvan 1998, 2007, Carlson and Sussman 2005, Aguilar Guevara and Zwarts 2010, 2013, Aguilar Guevara 2014, etc.). One type of construction involves prepositional constructions like those in (10):

(10) a. go **to bed**, be **at school**
      b. go **to the bank**, be **at the university**

Carlson and Sussman 2005 showed that the similarities between the bare nominals in (10a) and the definites in (10b) allow them to be treated as one and the same class of weakly referential nominals. This weak referentiality is reflected in their semantic behavior. Thus in (11a) *the hospital* can be a weak definite and the boxers might have been sent to different hospitals; this narrow scope reading is not available with the regular definite *the hotel* in (11b), and (12) shows that bare weak definites have it obligatorily. Aguilar Guevara and Zwarts 2010 further show that these nominals do not set up discourse referents (13), see also Scholten and Aguilar Guevara 2010, and allow sloppy identity readings (14).

(11) a.   Every boxer was sent to the hospital.
      b. # Every boxer was sent to the hotel.

(12) Every boxer was sent to school.

(13) Lola listened to the radio until she fell asleep. ?She turned it off when she woke up in the middle of the night.

(14) a.   Lola went to the hotel and Alice did too.   ✓same hotel, *different hotels
      b.   Lola went to the hospital and Alice did too.   ✓same hospital, ✓different hospitals

Interestingly, these weak nominals show the same syntactic restrictions as AxParts with respect to pluralization, modification, and pronominalization (Ross 1996). In both types of constructions the presence or absence of the definite article is intimately linked to the choice of the noun (15) vs. (16) and (17), subject to cross-linguistic variation.

(15) a.   at (#the) school
      b.   at *(the) hospital

(16) a.   **in (#the) front** of the car
      b.   **at *(the) foot** of the bed

(17) a.   **au/*à**   **pied**   du   lit
            to.DEF.M/to   foot.M   of.DEF.M   bed
            at the foot of the bed

      b.   **à/#au**   **côté**   de   chez   Swann
            to/to.DEF.M   side.M   of   at   Swann
            by the Swann's house

Another similarity is the importance of an outer preposition that licenses the weak nominal/AxPart and that can be subject to idiosyncratic restrictions. So, the kind of patterns that we see in (16) and (17) are similar to the patterns that are documented for weak nominals in PPs, as in (15) and (18).

(18)   a.   in/to/*on bed
      b.   in (#the) case

If AxParts are weak nouns, as we propose, then what needs to be worked out in a bit more detail is (i) what the weak nominal refers to in a PP like *in front of the car* (building on what we already know about weak nominals) and (ii) how the regular and the weak versions of a noun like *front* are related to each other. We start by answering the latter question, in terms of underlying axes.
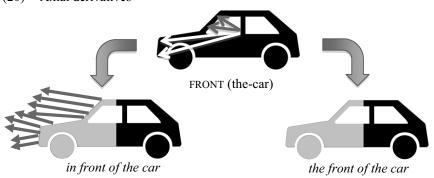
4. The axis of axial nouns

In both of its uses, the noun *front* is based on an underlying axis assigned to an object (cf. Herskovits 1986, Levinson 1996a, b and many others).[3] This axis is used to determine both what part of the relevant object (e.g., *a car*) *the front of the car* denotes, and what region *in front of the car* refers to. There are different ways to represent an axis, and for our purposes it works well to model it (using the framework of Zwarts and Winter 2000) as a set of vectors that point from the center of an object in a particular direction. For example, we can define a function FRONT that takes an object x and maps it to the set of vectors that start at the center of x and end at the boundary of x and that have a 'forward' direction (with respect to an intrinsic or relative frame of reference):

(19) $\text{FRONT} = \lambda x \in D_e . \lambda u \in D_v .$ START $(u) =$ CENTER (x) *and* END $(u) \in$ BOUNDARY (x) *and*
      FORWARD (u)

Each of the components in definition (19) is definable in terms of the Zwarts and Winter framework. So, FRONT(the-car) gives the set of vectors of which the car at the top in (20) gives a graphical impression. From this spatial core we can derive the **axial projection** and the **axial part object**, as also illustrated in (20).

(20)   Axial derivatives

FRONT (the-car)

in front of the car   *the front of the car*

The object part meaning of *front* (for *the front of the car*) involves an additional component, schematized as the function OBJECT in (21), that maps an axis to the unique object occupying it:

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[3] These axes can be assigned on the basis of different factors, corresponding to different *frames of reference*: intrinsic (based on features of the object), relative (based on a point of view), absolute (based on the environment). How these frames of reference correspond to AxParts is an interesting question that we have to leave for another occasion, but the correspondence does not seem to be systematic (e.g., *left* can be either intrinsic or relative, while *top* is absolute, except in space).

(21) $[\![\text{front}_{\text{PART}}]\!] = \lambda x \in D_e . \text{OBJECT} (\text{FRONT} (x))$

This gives a singleton-set denotation for the nominal *front* $_{\text{PART}}$ *of the car*, which naturally accounts for the obligatory presence of a regular definite article. See the right-hand side of (20).

For the AxPart version of *front* (*in front of the car*), we need to 'project' the internal axis outward to the set of external vectors that point in the same direction as the axis:
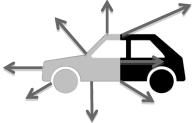
(22) $[\![\text{front}_{\text{PROJ}}]\!] = \lambda x \in D_e . \text{PROJECT} (\text{FRONT} (x))$

(23) $\text{PROJECT} = \lambda f \in D_{\langle v, t \rangle} . \lambda u \in D_v . \exists w [f(w) \text{ and } \text{START} (u) = \text{END} (w) \text{ and } \text{DIR} (u) = \text{DIR} (w)]$

This gives the phrase *front* $_{\text{PART}}$ *of the car* the denotation that is illustrated at the left-hand side of (20), which is the normal type of denotation of locative PPs in the framework of Zwarts and Winter 2000). Let's set aside the question of how *in* comes in for a moment.

The relation between the abstract axis and the corresponding object part is simplified in the lexical entry in (21): the object part denotation is systematically richer (cf. the interpretation of *foot* as both an body part and as that side of the ground object that is the lowest (including lowest in significance, as in, e.g., *the foot of the table*)) in a way that cannot be achieved by the simplistic composition in (21). The formulation in (21) is used to only make clear that the abstract axis notion forms a semantic part of all these lexical entries and serves as the basis for the same lexicalization. While the same notion lies at the core of the axial part in (22), there the connection to the abstract axis notion is a lot more transparent.

The way we define the AxPart solves a serious problem in the semantics of Svenonius, who does not apply his version of the PROJECT function to an axis, but directly to the spatial part (as a set of points). As illustrated in (24), this leads to vectors pointing in all directions, including the interior of the car, because the spatial part does not carry any information about where its 'outside' and 'inside' are.[4]

(24) why projecting the axial object is wrong

PROJECT (the-front-of-the-car)

By making axes the underlying semantic component of both versions of *front* (and similar nouns) we make explicit what is axial about both nouns, but we also solve a problem in how axis are projected outward.

It is important to realize that not all AxParts might require PROJECT. In example (25) there is location at the boundary, i.e., contact. If TOP gives us the vectors pointing to the top surface of the table, then that could also be the required region for location. The alternative is to introduce a version of PROJECT that restricts the length of the vectors in an appropriate way.

(25) on top of the table
      TOP (the-table)

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[4] Svenonius (2008:74) writes "Place [...] can simply project vectors 'away' from the denotation of the AxPart phrase, the coordinate system having been established at the AxPart level." This latter qualification clearly requires that the AxPart denote something richer than the spatial regions that he assumes they denote.

To conclude this section on the relation between the AxPart and the object part interpretations of axial nouns, something should be said about the direction of historical change. While we emphasize that synchronically the AxPart denotation is not derived from the object part denotation, or vice versa, historically the direction of grammaticalization of body parts is clear (see Heine and Reh 1984, Heine et al. 1991, Svorou 1994, etc.). Our intuition is that this process is only made possible by the identification of the formal directional component (i.e., the axis) in the semantics of the relevant body part, but further research is needed to confirm or disprove this intuition.

5. Weak axial nouns as generic

We now return to the problem we already mentioned: if *front$_{\text{PROJ}}$ of the car* denotes a set of vectors (a region or location), as illustrated in (26) below, then why wouldn't it behave like a locative (e.g., like *home* or *over the car*)? Why is an additional outer preposition necessary?

(26)   front$_{\text{PROJ}}$ of the car
         PROJECT (FRONT (THE-CAR))

Note first that in many languages (some) axial nouns do in fact not need prepositions:

(27)   Maria   a-kari   **ru-ngu**   rw-a   ndagaca.   Kîîtharaka, Muriungi 2006
       1.Maria   SM1-sit   11-under   11-AS   bridge.9
       Maria is sitting under the bridge.

(28)   yeš   hadaš   **taxat**   la-šemeš.   Hebrew
       there.is   new   bottom   to.DEF-sun
       There is something new under the sun.

(29)   The town is located **north of the border**.

The grammatical locations *ru-ngu rw-a ndagaca*, *taxat la-šemeš*, and *north of the border* have the same structure as the ungrammatical location **front of the car*. So, why is there an outer preposition in *in front of the car*?

The problem becomes even deeper when we recall the AxParts that require a (weak) definite article, such as *at the foot of the bed* or Spanish *de-l-ante de la mesa* 'in front of the table'. We would expect *ante de la mesa* to directly give us the region, and have no way yet to bring in the definite article and the outer preposition in a natural way.[5]

This is where we need to return to the analogy that we drew earlier between AxParts and (other) weak nominals, like those in *to the hospital* and *in bed*. The weak nominals *the hospital* and *bed* do not seem to refer at the ordinary object level. Carlson and Sussman 2005 demonstrated that the weak definite *the hospital* does not refer to a unique hospital. Rather, it refers to something like the 'property', the 'concept', the 'kind' of the hospital, a more abstract level of reference. One version of this is the proposal of Aguilar Guevara and Zwarts 2010 that weak nominals refer to kinds. Such a level is also relevant for incorporation analyses (cf. Carlson 2010). Crucially, reference at this level is usually 'governed' by a preposition or verb.

Extending this idea in an informal way, we could propose something along the following lines. There is a class of weak nominals that do not pick out a referent, but refer to the underlying concept. Let's call this 'concept reference'. Weak nominals like *hospital* (*in hospital* BrE, *in the hospital* AmE)

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[5] A potential objection at this point might be that *delante* in Spanish is introduced as-is from the lexicon. Two counter-arguments can then be raised. On the one hand, the clear connection between *delante* 'in front of', *alante* 'in front' and *ante* 'before' still requires an explanation. On the other, the real definite article was obviously present at some stage of historical development (and is detectable with other axial complexes and in other Romance languages), and so an explanation for it would be required anyway. The proper analysis of the specific lexical item *delante* and similar items in Spanish (see Fábregas 2007) is left for future research.

have concept reference. Whether there is a definite article or not is not deeply related to the semantics, but a feature of the noun.[6] Concept reference has no free distribution over argument positions (because arguments require the corresponding referents of a concept), but dedicated prepositions and verbs can handle weak nominals like *(the) hospital* at the concept level, without directly accessing their referents.[7]

In the same way we would like to suggest that phrases like *front of the car* and *the foot of the bed* are weak nominals that have concept reference: there are no spatial referents involved. There is also no way in which these phrases can be entered in the compositional semantics unless 'incorporated' with a suitable preposition, in this case the prepositions *in* and *at*, respectively. What makes *front of the car* different from *north of the border* is that the latter phrase does directly map to the referential level, where we find the northward vectors.

Apart from space limitations, the non-existence of a framework formalizing these intuitive ideas for the spatial domain allows us only to give a hint of the semantic structures of some constructions.

We need to revise our earlier characterization of *front*$_{\text{PROJ}}$ to make its concept-level reference explicit. Instead of using the PROJECT function that we assumed above, we use the underlying concept, that we simply represent as PROJECT$_\text{C}$ here, for need of an explicit characterization. It gives us the concept that corresponds to the front region.

(30) a.   in front of the table
      b.   de-l-ante de la mesa
      c.   INST (PROJECT$_\text{C}$ (FRONT (THE-TABLE)))

This concept then needs to be mapped to the vectors that actually 'instantiate' it, which is what the INST function does (compare this to the realization function that relates kinds to objects). The overt definite article in the Spanish example (30a) and its absence from its English counterpart (30b) reflects the usual variation found with weak nominals.

6. More about the outer preposition

One might wonder why different AxParts require different Ps (*in*, *to*, *on*)? There are different options here to explore in future work. The semantics might be same for all these prepositions (instantiation of a spatial concept, INST) but the realizations would be different in function of the noun they combine with. An alternative is that the prepositions have their normal semantics and that the choice depends on how the axial concept is conceived of, in relation to notions like 'container' (*in*), 'contact' (*on*), etc. Several arguments can be advanced for the former hypothesis. First of all, *in front* is compatible with a measure phrase while *in* itself is not. Secondly, the semantics of the preposition *to* in *to the left of* and *to the north of* seems to require access to the ground object in order to enable composition with measure phrases. Thirdly, there seem to be no straightforwardly identifiable semantic or cognitive differences between the projective AxPart *front* requiring *in* and the equally projective AxParts *left* or *side*, requiring *to*. Since, however, we are aware of no independently motivated mechanism for conditioning the realization of INST in function of the nominal head of the DP it combines with, we leave this question for future research.

There is one class of outer prepositions, the source prepositions, that might not relate to INST. We often find outer source prepositions with AxParts across languages:

(31) a.   El   libro está **de**-l-ante   de la   mesa.
            the book   is   from-the-front   of the   table
            The book is in front of the table.   Spanish, Fábregas 2007

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[6] Following the hypothesis advanced by Matushansky 2015b for proper names, the relevant feature might be gender, with its absence resulting in a bare nominal.

[7] A lot more is there to be said about the relation between weak nominals and their governors, as it is generally the stereotypical use that makes a weak nominal possible (see Zwarts 2014).

> b. hu haya **mi**-taxat la-bayit/ha-bayit.
> he was from-bottom to.DEF-house/ DEF-house
> *He was under the house.*   Hebrew, Botwinik-Rotem 2008

> c. **S**-pered-i ot dom-a roslo derevo.
> off-front-LOC from house-GEN grew tree
> *A tree grew in front of the house.*   Russian, Mitrofanova and Minor 2013

It is surprising that a source preposition like *mi-* is used to describe a location, but an explanation for its appearance here might be that it lexicalizes the PROJECT function:

(32)   mi.taxat ha-bayit
       PROJECT (BOTTOM (the-house)))

After all, there is a close conceptual relation between *projecting* from the ground (the locative notion) and *moving* away from the ground (the directional notion).

This also allows for an alternative analysis for the Spanish *delante* case, which features the ablative preposition *de*:

(33)   de-l-ante de la mesa
       PROJECT (INST (FRONT$_C$ (the-table)))

The system allows instantiation to apply to the concept of the internal axis, as in (33), or to the concept of the projected axis, as in (30) above. Determining which option is taken when is an issue for future work.

7. Conclusion

We have shown that the usually assumed syntactic structure in (2) does not account for the patterns that we observe in the domain of prepositional complexes. It is lexically inadequate because axial elements are lexical and not functional and it is descriptively inadequate because axial complexes do not all have the same syntax. What we propose here is that AxParts are nominal and that they are weak.

We sketched a semantics of AxParts that is based on existing locative notions, but at the same time demonstrates the need for reference to spatial 'kinds'/'concepts'/'properties', as already shown for other domains. The semantics reformulates Svenonius' PROJECT component, that may but need not be syntactically present. In general, our approach is to take functional elements appearing in axial complexes at face value.

There are many remaining issues of which we mention a few. It is still not clear why different AxParts would require different Ps (**in** front of the house, **to** the side of the house, etc.). Languages and individual AxParts might differ as to how much of the semantic structure is syntactically projected and how much is in the lexicon. Finally, the extent to which frames of reference are sensitive to the distinction between AxParts (*on top of the car*) and axial object nouns (*on the top of the car*) (Herskovits 1986, Landau and Jackendoff 1993) is an issue which requires much more empirical study.

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