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Against the Feature Bundle Theory of Case

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Case is usually taken to be represented in syntax by a feature or, more generally, a feature bundle. Case agreement consists in identity in feature. This view is implicit in virtually all theories of syntax. As we argue here, it is too simplistic. There is a large variety of facts which it cannot explain, not only Suffixaufnahme but also layered cases, which we find in most languages of this world. Moreover, there is no systematic theory of the interaction of functional and nonfunctional use of case markers, which additionally confuses the issue of case. In this paper we attempt to show that a much more sophisticated theory of (syntactic) case is needed. We shall also sketch the outline of such a theory.[1]

1.1 Introduction

The received view on the internal structure of syntactic categories is that they are sets ('bundles') of features. This has been an assumption

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in transformational grammar. Here is an example of a feature bundle in modern notation.

$$\begin{bmatrix} \text{verbal} & : & - \\ \text{nominal} & : & + \\ \text{bar} & : & 0 \\ \text{case} & : & acc \\ \text{number} & : & pl \end{bmatrix}$$

It specifies a plural noun in accusative case. We call the entries to the left 'attributes', the entries to the right 'values' (of their respective attributes) and the complex consisting of an attribute and a value a 'feature'. A *feature bundle* is a set of features with pairwise distinct attributes. There are in general many case features, but a single case attribute. Some linguists (notably Hjelmslev) have proposed, however, to regard cases as feature bundles. This means that the value of the case–attribute is a collection of several attributes. Nowadays, with the possibility of defining AV–structures recursively, one could also say that the *value* of the case–attribute is a feature bundle. This theory is of course more general, but we shall show that it too is insufficient. To our knowledge GPSG and HPSG, while endorsing a more complex notion of category, also take over the view that cases are features (or feature bundles). In HPSG, syntactic categories are recursive, but the recursion is used for subcategorization but not for case.[2] This is not necessary. In fact, the idea of using the recursiveness of feature structures to capture stacked cases appeared in Nordlinger (1998). Agreement in case (and other features) is explained as follows. A syntactic item is forced by some mechanism to contain the same agreement feature(s) as the agreement controller. This is achieved in GPSG by feature percolation rules, in HPSG by structure sharing and in MP by spec–head agreement and checking. In one or the other form, these theories implement the notion of *identity check* between two feature structures concerning a specific attribute and its respective values in the two feature bundles. We have noted earlier (see Kracht 1998) that these theories are incapable of dealing with coordinated phrases, since the emergence of a different agreement feature (dual or plural) on the coordinated DP *John and Mary* cannot be explained.

In this paper we shall deal with the question of the adequacy of these theories with respect to case. Certainly, many theories deal successfully with a great variety of phenomena. However, there are a number of facts that cannot be explained by them. We are thinking here of a phe-

[2] We have discussed the ins and outs of the HPSG representation — also with respect to case — in Kracht (1995).

nomenon called Suffixaufnahme[3] in Australian languages, which we will discuss briefly in Section 1.7. These are the theme of Nordlinger (1998), who actually proposes an account based on LFG. She argues that cases can project their own f–structure. Our present proposal is different in that in it cases do not build structure; rather, they simply serve as the phonetic carrier of the syntactic cases. For example, the syntactic case called 'accusative' on our account is nothing but the marker for it, and the marker in turn is simply the exponent of a morpheme called by the same name. This eliminates the need to posit an extra set of case features. Cases are not features, and they can be stacked. Moreover, the mechanism of stacking is not restricted to what is traditionally called a case. Any morpheme or sequence thereof can become a case marker simply by being selected by a head. All that it takes is that the head selects the exponent of that morpheme as its case feature. If we are on the right track, this proposal may well prove to be a novel way to treat functional categories in general, not just cases. This paper does actually *not* deal with Australian languages, but concentrates instead on locatives in a variety of European languages. Based on the investigation in Kracht (2001b) we shall show that not only are locatives at least bimorphemic, but that the corresponding cases consist of two independent cases stacked on top of each other, as in Suffixaufnahme.[4] This provides evidence that case stacks are not an isolated phenomenon but rather ubiquitous.

1.2 Cases as Signs

We shall work inside a sign based definition of language (see, for example, Kracht (2001c) and the more general setup in Oehrle (1988)). This notion is to the best of our knowledge theory neutral. A language is a (typically infinite) set of signs, which are composed using different functions, which we call **modes** (**of combination**). A **sign** is a triple $\sigma = \langle E, T, M \rangle$. E, called the **exponent** of σ, is usually some string. T, called the **category** of σ, may be taken to be some category in the sense of GB/MP or GPSG or some category in the sense of categorial grammar. M, the **meaning** of σ, is typically some λ–term. None of these choices is necessary, but they are illustrative of their use. Basic categorial grammar, for example, uses two modes of combination, forward

[3]Literally translated it means 'taking up of suffixes'. For the history of this term as well a survey of the languages with Suffixaufnahme see Plank (1995).

[4]There are many more cases for which a bimorphemic analysis is called for, for example the partitive in Finnish, as well as the essive and the translative. This must be left for another occasion, though.

application and backward application:

$$\begin{aligned}\langle E_1, T_3/T_2, M_1\rangle \circ_r \langle E_2, T_2, M_2\rangle &:= \langle E_1 \cdot E_2, T_3, M_1(M_2)\rangle\\ \langle E_1, T_1, M_1\rangle \circ_\ell \langle E_2, T_1\backslash T_3, M_2\rangle &:= \langle E_1 \cdot E_2, T_3, M_2(M_1)\rangle\end{aligned}$$

Here, $\cdot$ denotes concatenation (possibly, in the case of words, with a blank inserted), and $f(g)$ is function application. We shall agree to call a sign which is indecomposable into other signs a **morpheme** (or **basic sign**).

In what is to follow, we shall depart from that system by proposing new modes of composition. Moreover, we shall need more sophistication in dealing with the exponents. The exponent of a sign does not always consist in an additive exponent. There are several counterexamples; these are reduplication, for example in Bahasa Indonesia (to form the plural), or copying in Mandarin described in Radzinski (1990). Furthermore, even additive morphemes can often not be associated with a particular phonemic string. The plural morpheme of English surfaces in many forms. Hence, we shall assume that many morphemes (in particular those of functional elements such as cases) are *functions* over strings. Depending on the argument, the English plural consists in the addition of an 's', or zero, or even in changing the word-stem, to name a few. We generally assume that these functions take only one argument.[5] We shall use small caps to refer to signs. So, SHIP is the sign whose exponent is *ship*. However, exponents are for reasons given more abstract than strings. Therefore, we use slashes to denote the exponents. For example, /SHIP/ denotes the exponent of the sign SHIP. Somewhat more ambigously we also write /s/ in place of /pl/, because the plural sign PL is typically an added s. Likewise, the morpheme[6] SHIP has an exponent, which we may alternatively write *ship* or /ship/. /ship/ is actually not a function, it is a string, and so we have the identity /ship/ = ship. However, for the plural morpheme PL we have /PL/ = /s/ $\neq$ s. For exponents of signs we use $^\frown$ to denote a function, which is either the concatenation (with or without blank), if neither argument is a function, or if one argument, say f, is a function, it is the result of applying f to the other argument; or, finally, if both arguments are functions, the result is the composition of the two functions.[7]

[5] This is not a necessary assumption, but see also Kracht (1999) for justification.

[6] Morphemes are signs by our convention.

[7] Note that, as a matter of detail, the result is underdetermined in the third case, for $f^\frown g$ may either denote $f \circ g$ or it may denote $g \circ f$. We stipulate here that $f^\frown g = g \circ f$. We may also say that since we are can encode surface order by means of phonemic functions, it is needless to use directional slashes, a nondirectional slash would suffice. However, both types of slashes are needed. For otherwise verbal heads must position all their arguments by means of string functions. But this can be done

As for the types, we shall work inside categorial grammar, although this choice is an expository one only. A **basic category** is a feature bundle, which is formed by pairing attributes with (admissible) values. This is explicated as follows. We have a set $\mathbb{A}$ of attributes, a set $\mathbb{V}$ of values, a function $d : \mathbb{A} \to \wp(\mathbb{V})$, giving us for each $A \in \mathbb{A}$ the set of admissible values, and finally we let **BCat** be the set of all $H \subseteq \mathbb{A} \times \mathbb{V}$ such that (a) if $\langle A, V\rangle, \langle A', V'\rangle \in H$ then $A \neq A'$ or $V = V'$ and (b) if $\langle A, V\rangle \in H$ then $V \in d(A)$. A category is either a basic category or of the form α/β, $\beta\backslash\alpha$, where α and β are categories. (Other type constructors might be used in due course, and the definition is extended without notice.) In what is to follow, Σ is a variable for basic categories, α, β and γ variables for possibly nonbasic categories. We assume that $\textsc{case} \in \mathbb{A}$, which is the attribute that yields the (syntactic) case of the basic category. We shall employ the following notation alternatingly.

$$DP[\textsc{case} : acc] \qquad \begin{bmatrix} \textsc{cat} & : & d \\ \textsc{bar} & : & 2 \\ \textsc{case} & : & acc \end{bmatrix}$$

Both notations should be self–explanatory.

Cases too are signs. Therefore, in order to avoid misunderstanding, we should better speak of **case signs**. Being signs, they operate on all three dimensions of language. So they have exponents, types and meanings. Let us exemplify this. Hungarian /a házban/ 'in the house' consists of (at least) three elements: /a/ 'the', /ház/ 'house' and /ban/ (equivalent to English 'in'). The latter is the exponent of a case sign called 'inessive'. Depending on vowel harmony we may also find *ben* rather than *ban*. However, we have /ban/ = /ben/, since both refer to the same (sequence of) morpheme(s). Second, cases can appear as part of the category in the form of what we call a **case feature** or, following Mel'čuk, also **syntactic case**.[8] Words or phrases carrying some case feature γ are also called **marked (with the feature** γ**)**. For example, we distinguish nouns with nominative case feature from nouns with inessive case feature and so on. This distinction between nominative and inessive marked noun phrases has clear syntactic consequences. For example, some verbs select noun phrases in a particular syntactic case, and only noun phrases with identical syntactic case can be coordinated. Thirdly, cases have meanings. Hungarian /a házban/ does not simply mean 'the house', it means 'in the house'. (Actually, as shall argue below, it can mean one or the other, depending on the context.) The

(by our convention) for only one argument, see also Footnote 5.

[8]The latter term is better, since it avoids the association with the feature bundle paradigm.

meanings of case morphemes are also referred to as **case functions**.

Case signs need however not be affixes. They can also be clitics and adpositions. For example, in Latin, cases typically are affixes, in Japanese they are clitics, and in Tagalog they are prepositions. As we shall show also, languages use a mixture of all three means of case marking, and therefore the exclusive attention on either of the three is — in our opinion — a mistake. Most theories draw the dividing line either between affixes and clitics, or between clitics and adpositions. Mel'čuk (1986) defines the notion of morphological case. Although he does consider the notion of syntactic case being different from morphological case, he does not seem to allow languages to draw case systems from both sources. Likewise, in GB, there is a sharp difference between PPs and DPs carrying morphological case. For every preposition heads its own phrase, while an affix does not. This is because the elements are inserted into the structure with full inflection, after the morphological rules have applied. Therefore, in GB the difference between a case marked DP and a PP is a structural one as well. The binding domain of an DP inside a PP is the PP itself, while the binding domain of a case marked DP is larger (see von Stechow and Sternefeld 1987). However, Webelhuth (1992) has noticed that prepositions have many common characteristics of case markers, and he therefore proposes a rapprochement between the two. One of the arguments that is worth mentioning here is that the prepositions pass on the θ–role of the DP to the higher head rather than consuming it directly.

1.3 Some Data

We shall first present some data from Finnish and Hungarian. Both languages have a rich set of local cases. We will demonstrate that there is a clear difference between morphological case and syntactic case. Moreover, we will show that there is a competition between case function and syntactic case. If a case marker is used to signal a syntactic case it cannot at the same time be used with any of its case functions. Local cases are interesting since they are (at least) bimorphemic, as we have shown elsewhere (Kracht, 2001b); it will be seen here that the purported facts hold for the morphemes making up the cases, not for the case suffix as a whole.

The tests we will apply are the following.

1. *Coordination and Right Node Raising.* We assume that the phrase X *and* Y is well–formed only if the syntactic type of X and Y in this construction are identical. This means either that they are case marked arguments with identical case, or that they are

adessive	ablative	allative
talolla 'at the house'	talolta 'to the house'	talolle 'from the house'
inessive	elative	illative
talossa 'in the house'	talosta 'out of the house'	taloon 'into the house'

TABLE 1 Finnish Local Cases

adessive	ablative	allative
a háznál 'at the house'	a háztól 'from the house'	a házhoz 'to the house'
inessive	elative	illative
a házban 'in the house'	a házból 'out of the house'	a házba 'into the house'
superessive	delative	sublative
a házon 'on the house'	a házról 'from on the house'	a házra 'onto the house'

TABLE 2 Hungarian Local Cases

functors (e.g. verbs) looking for arguments with identical cases. So, *him and she* is ill–formed since the cases of the arguments never match in any construction.

2. *Question–Answer Pairs.* We shall assume that a wh–question and an answer consisting of a single constituent X match only if X has the type required by the wh–word. For example, the question *What is this? – 6 o'clock.* is not a matching pair, since *what* requires an object, but *6 o'clock* is a time point.

We use Finnish and Hungarian, which are quite similar with respect to local cases. Finnish has six local cases, displayed in Table 1.

Consider the case marked Finnish word /laivalta/. It is (morphologically speaking) in the ablative case, that is, it carries the case marker /lta/, which is taken to signal ablative case. Its basic meaning is 'from the ship'. However, it occurs in (at least) three distinct environments, in which it behaves quite differently.

(1) a. As an adverbial in the sentence

Hän menee laivalta.
He walks ship-ABL
He is going/walking from the ship.'

b. As a directional complement in the sentence

Hän löysi rahansa laivalta.
He found his money ship-ABL
'He found his money on the ship.'

c. As a selected DP in ablative case in the sentence

Tämä näyttää laivalta.
This resemble ship-ABL
'This looks like/resembles a ship.'

Intuitively, these three uses of the word *laivalta* are different. In the first example, the word enters with its full meaning, i.e. with the meaning 'from the ship'. In the second example, it enters only with its locational meaning, i.e. with the meaning 'on the ship', and in the third it enters only with its DP meaning, i.e. with the meaning 'the ship'. The following contrasts establish this difference.

(2) Hän menee alas.
'He is walking down.'

(3) Hän löysi rahansa *alas/alhaalta.
'He found his money *down /from downstairs.'

(4) Tämä näyttää *alas/*alhaalta.
'This resembles *down/*from downstairs.'

The locative adverbials /alas/ 'down' and /alhaalta/ 'from downstairs' demonstrate the difference between the first two and the last in terms of semantic category. Another test for this difference is replacing the DP by a question word. This test works better in Hungarian, however. Hungarian has a similar array of local cases, shown in Table 2. Here is an analogue of the above trias, using the word /hajóra/ 'onto the ship'. Its (morphological) case is called — somewhat confusingly — *sublative*.

(5) Béla a hajó-ra jön.
Bela the ship-SUBL comes.
'Béla is coming onto the ship.'

(6) Béla a hajó-ra le-ül.
Bela the ship-SUBL down-sit

'Béla is sitting down on the ship.'

(7) Béla a hajó-ra gondol.
Bela the ship-SUBL thinks
'Béla thinks about the ship.'

Now, there are two types of question words: the inflected forms of /ki/ 'who' or /mi/ 'what' and the three locational question words /hol/ 'where', /hova/ 'whereto' and /honnan/ 'wherefrom'. As expected, you cannot ask for /hajóra/ in the last example using the word /hova/:

(8) Hova ül le Béla? – A hajóra.
Whereto sit down Bela? – Onto the ship.
'Where does Bela sit down on? – On the ship.'

(9) ??Mire leül Béla? – A hajóra.
Onto.what sit.down Bela? – Onto the ship.

(10) *Hova gondol Béla? – A hajóra.
Whereto thinks Bela? – Onto the ship.

(11) Mire gondol Béla? – A hajóra.
Onto.what thinks Bela? – Onto the ship.
'About what does Bela think? – About the ship.'

So, again the first two examples behave differently than the third. We assume that with the help of the *where*–type question words one cannot ask for a thing but only for a location, while for the *who/what*–type question words one can only ask for a thing and not for a location. This explains the facts straightforwardly.[9] [10] Thus, there is a clear difference in semantic category between the first two and the last. The reason why this test does not work as clearly in Finnish is that Finnish does not distinguish a special set of *where*–type question words.

Now consider VP–conjunction and right node raising. The Finnish verb /tuntua/ 'to resemble, to feel like' also governs the ablative.

(12) Tämä tuntuu ja (tämä) näyttää laivalta.

[9](9) is not ungrammatical, though somewhat odd. The verb expects a directional locative complement in what we shall call *cofinal case*. We shall say that /hova/ is in cofinal case, while /mire/ is not, but is instead the sublative form of /mi/. However, it might be that /mire/ can not only be understood as a truly case marked DP, but that it can be (re-)analysed as a directional locative, by applying the same combinatory laws as with an ordinary DP. This would explain why (9) is not judged as entirely out. This proposal is attractive insofar as it also explains why (10) is strictly ungrammatical. /hova/ can at best be seen as decomposed into /hol/ plus a suffix denoting cofinal case. The paradigm of /hol/ is defective, since it denotes a location and not a thing.

[10]The reader is asked to play with the English equivalents of these examples to see that the data are in fact quite similar.

'This feels like and (this) looks like a ship.'

(13) ?Tämä näyttää ja (hän) menee laivalta.
'This looks like and (he) is walking from the ship.'

(14) ?Tämä näyttää ja hän löysi rahansa laivalta.
'This looks like and he found his money on the ship.'

(15) ?Hän meneee ja hän löysi rahansa laivalta.
'He is walking from and found his money on the ship.'

All these constructions are considered odd or even deviant. Hence, the two conjuncts must be distinct, either semantically or syntactically.

In order to test for the identity in a construction we use DP–coordination. If two items can be coordinated without any problems, we consider them identical in syntactic category and in semantic type.

(16) Hän menee laivalta tai paariin.
'He is walking from the ship or into the bar.'

(17) Hän löysi rahansa laivalta tai autosta.
'He found his money on the ship or in the car.'

(18) *Hän löysi rahansa laivalta tai paariin.
*'He found his money on the ship or into the bar.'

(19) *Tämä näyttää laivalta tai autosta/paariin.
*'This looks like a ship/from a car/into a bar.'

This provides evidence that what we are dealing with here are three syntactically quite different objects. Furthermore, since in the first example with /menee/ we can have *any* of the six locatives be coordinated, in the second only locatives in the ablative and elative, and in the third only locatives in the ablative, we must conclude that the different occurrences of /laivalta/ have different syntactic case.

These facts can be explained as follows. We distinguish four types of entities: objects, events, times and locations. We can ask for locations by using *where*–type question words, and for things using *who/what*–type question words. A locative has the following structure.

$$[M\ [L\ DP]]$$

Here, L is an element called *localizer*, which turns an object into a location.[11] M turns a location into an event modifier, which defines the motion of some object with respect to the location. M is called a *modalizer*. This explains how the meaning of the phrase /laivalta/ in sentence (1.a) comes about. In sentence (1.b) the same case markers are

[11] To be exact, we get a time dependent set of locations, see Kracht (2001b). But we shall ignore this question of detail here.

present (and therefore the same M and L), but the complement of the verb /löytää/ denotes a location, and not an event modifier (see Kracht 2001b). The modalizer has lost its meaning. In sentence (1.c), finally, the complement denotes a thing, and so both formatives are semantically empty. We say that in (1.a) the DP /laivalta/ is syntactically caseless, that in (1.b) it is syntactically in the coinitial case, and that in (1.c) it is in the ablative case. We argue that the semantic emptiness is a consequence of selection by a higher head, which is accompanied by a reduction of alternatives. In (1.c), the ablative is selected by the verb, which means that the formatives contribute nothing to the meaning of the DP, because their presence is automatically predicted. In (1.b) the verb selects only the mode M (here: coinitial), but not L, which means that the latter can be chosen freely. Hence, we are free to use the elative as well (though evidently not with the same meaning).

Let us go back to the trias case marker/case feature/case function. We have identified a case marker (here /lta/), which signals among other the syntactic ablative case. However, when it does so, it does not signal any case function. And when it signals a case function, it does not signal a syntactic case. In other words: the case marker can either go with the particular function(s) it is associated with or else with the case feature. To put it once more: it is standardly assumed that cases are signs, which consist of three things at once: the exponent (the case marker), the type (the case feature) and the meaning (the case function). Here we advance the view that although the three are connected, the case feature competes with the function. Now, rather than assuming two different signs, one being the case marker without meaning, the other the case marker with meaning, we shall assume that there is only one sign, which is used in two different ways. The formal proposal we shall advance below simply distinguishes several modes of composition, which allow to compose cases in the same way as any other meaningful elements.

We have seen that one needs to distinguish the case marker from the syntactic case. These facts can be reproduced in other languages. Moreover, there is another vital point we wish to argue for, namely that for syntax the distinction between a case marked DP and a PP is marginal at best. This means that in particular with coordination that we can coordinate DPs and PPs as long as their categories are the same. To see that this is the case, look at the following Hungarian examples. (For the postpositions, see Section 1.4.)

(20) Béla a hajó-ba/ a hajó-ból/ a hajó al-á szaladt.
Béla the ship-ILL/the ship-ELA/the ship under-COF ran
'Béla ran into/out of/to under the ship.'

(21) Béla a hajó-ba/ * a hajó-ból/ a hajó al-á bújt el.
Béla the ship-ILL/*the ship-ELA/the ship under-COF hid PRT
'Béla was hiding in/*out of/to under the ship.'

(22) Béla * a hajó-ba/* a hajó-ból/* a hajó al-á gondol.
Béla the ship-ILL/*the ship-ELA/*the ship under-COF thinks
'Béla thinks *into/*out of/*to under the ship.'

In (20) the DPs and the PP are adverbials, in (21) they are directional complements, and in (22) they are complements. It is predicted that in (20) and (21), the elements freely combine as long as they are selected individually by the verb. This is borne out.

(23) Béla a hájóba vagy a hajó alá szaladt.
'Béla was running into or to under the ship.'

(24) Béla a hajóba vagy * a hajóból/ a hajó alá bújt el.
'Béla was hiding in or *out of/under the ship.'

(25) Béla a hajóra vagy * a hajóból/* a hajó alá gondol.
'Béla thinks about or *out of/*to under the ship.'

It follows that in the examples (20) and (21) the directional PP /a hajó alá/ has the same syntactic case as the DP /a hajóra/. For (20) we shall say that both have null case, for (21) we shall say that both are in *cofinal case*.

These facts square well with the fact that verbs can select not only case marked DPs, but also PPs. Furthermore, the dichotomy structural/inherent is also independent of the morphological identity. For example, Finnish and Hungarian have a lot of locatives, but none of them is structural. They are inherent. On the other hand, Austronesian languages use prepositions as case markers even for structural cases (for example Tagalog and Cebuano). A last point to note is that binding theory predicts that a DP inside a PP can only have a trivial binding domain. This is false (see von Stechow and Sternefeld (1987) for a discussion). Webelhuth (1992) argues that argument PPs have a lot in common with case marked DPs. For example, if a PP is an argument, it receives a θ–role from the verb. In order for the θ–role to arrive at the DP we must assume that the P head only acts as a θ–role transmitter, and does not itself assign a θ–role. If on the other hand a PP is an adjunct, the P head does assign a θ–role to its argument DP. In sum, argument P heads function in exactly the same way as argument case markers.

1.4 Segmentation

In this section we make a first attempt at providing a systematic explanation of the facts. This will be done using syntactic and morphological tools. Our proposal will be modified in several stages, when we look at DP internal agreement in Section 1.5 and at German in Section 1.6.

As has emerged in the previous section, Finnish locative cases are not simple. We can isolate the following signs in the locatives:[12]

$$\begin{array}{lcl} M & : & \textsc{sta(tic)}, \textsc{cof(inalis)}, \textsc{coi(nitialis)} \\ L & : & \textsc{at}, \textsc{in} \end{array}$$

The actual cases correspond to sequences of these two. Any combination of the two results in a local case of Finnish. (The symbol + is used rather loosely here.)

adessive STA + AT	ablative COI + AT	allative COF + AT
inessive STA + IN	elative COI + IN	illative COF + IN

Finnish also has an essive and a translative, which can be analyzed by proposing a morpheme ESS and proposing the cases to be produced as follows.

$$\text{essive} : \textsc{stat} + \textsc{ess}, \quad \text{translative} : \textsc{cof} + \textsc{ess}$$

(There is no case corresponding to COI + ESS.) Hungarian differs from Finnish only by adding a third localizer, namely ON. This much for semantic segmentation. We have seen in the previous paragraph, however, that this segmentation is also syntactically relevant. Therefore, we regard all these cases as bimorphemic. Our main assumption is cases are nothing but exponents of signs. However, this applies only to monomorphemic cases. Polymorphemic cases require more sophistication.

Definition 1 *Let L be a language. The set of admissible values for the attribute* CASE *in L is the set of sequences of exponents of signs of L. Such a sequence $\vec{\gamma}$ is a* ***syntactic case of*** *L if there is a head selecting an argument containing the feature* $[\textsc{case} : \vec{\gamma}]$.

We shall denote the concatenation of exponents by $\cdot$, to distinguish it from $^\frown$, which is in fact a different operation. The idea of this definition is that rather than postulating a feature for some case, say, accusative, we let the exponent of the accusative case morpheme itself be the syntactic case. The marking for the case consists in putting that very function

[12]This is a slight simplification. For example, the adessive can mean either *at* or *on* or *close to*. To account for this we might need to posit different signs in place of AT, namely ON and CLOSE. We shall ignore this matter of detail here, but see Section 1.5.

as the value of the attribute CASE. We shall explain in detail how this works. Notice also the following. It is not the signs themselves that are the syntactic cases, only their exponents. This avoids postulating distinct homophonous syntactic cases. Also, although there are infinitely many conceivable values for CASE, there are only finitely many cases in any given language, since languages have only finitely many basic signs.

Take again the word /laiva/ 'ship'. We assume that the root of this word, denoted here also by *laiva*, has the case ε, where ε is the empty string. $[\textsc{case} : \varepsilon]$ means that the item has what might be called 'zero case'. We may now add, for example, the morpheme /l/ and get the sequence /laiva/$^\frown$/l/. Two alternatives are open:

1. /laiva/$^\frown$/l/ means *at/on the ship*. Then the syntactic case of this unit is again ε, its semantic type is that of a location.
2. /laiva/$^\frown$/l/ means again *the ship*. Then the syntactic case of this unit is /l/, its semantic type is that of a thing.

By the universal principles of language (see Kracht 2001b), after a localizer we must have a modalizer. Suppose we have chosen the first alternative. Then again two alternatives are open:

1. /laiva/$^\frown$/l/$^\frown$/ta/ means *from the ship*. Then the case of this unit is again ε, its semantic type is that of an adverbial phrase.
2. /laiva/$^\frown$/l/$^\frown$/ta/ means again *at/on the ship*. Then the syntactic case of this unit is /ta/, its semantic type is that of a location.

Finally, if we have chosen the second alternative, we can — by semantic compatibility — only assume that the morpheme /ta/ is semantically empty, and that /laiva/$^\frown$/l/$^\frown$/ta/ means again *the ship*. Then the case of this unit is ablative (which is a shorthand for the sequence /l/ $\cdot$ /ta/). Its semantic type is that of a thing.

Now take a word that denotes a location, such as a question word. In Finnish, /mitä/ means 'what'. Interestingly, what you get is

(26)	missä	mistä	mihin
	where–INE	where–ELA	where–ILL
	'where'	'wherefrom'	'whereto'
	*millä	*miltä	*mille

This means that /mitä/ reduces in the locative to a question word for locations. In Hungarian, as we have mentioned above, we not only have all nine local cases of /mi/, but in addition a series of three words to ask for locations.

Finnish therefore must be assumed to have not six, but actually nine local cases, while Hungarian will have twelve in place of nine local cases. The missing three are in both languages the *stativus*, the *cofinalis* and the *coinitialis*. One should not think of the cases as forming a hierarchy. The allative is not a special kind of cofinalis. The cofinalis is a case for locations, as is the allative for things. Therefore there is no talk of a type hierarchy whatsoever. It might be a little funny to think that there are cases which are specialized to certain semantic types. But there are plenty of examples of this kind. For example, there is a morphological case in Hungarian, which is reserved for times: *nap-onta* means 'every day'. Here the case suffix is /onta/.[13] The Finnish essive and translative are reserved to properties. And so on. The notion of semantically restricted cases is therefore far from dubious.

The process which forms these different cases is not morphologically driven. To see this, take Hungarian. Hungarian has a handful of local postpositions, which come each in a threefold series:

(27)	al-att	al-ól	al-á
	under-STAT	under-COI	umnder-COF
	'under'	'from under'	'to under'

(28)	között	közül	közé
	'among'	'from among'	'to among'

These postpositions can be morphologically segmented into a localizer and a modalizer, just as case endings. Moreover, the use of these postpositions is determined in exactly the same way as the locative cases. A verb selecting a particular mode (*bújni* 'to hide') can be construed as well with a PP in that mode. Moreover, one can coordinate DPs in cofinal case with cofinal PPs, and so on. Therefore, we shall assume that the phrase /az ágy alá/ bears cofinalis.

(29) Béla az ágy alá bújt.
Bela the bed under-COF hid
'Bela was hiding under the bed.'

We shall now proceed to an analysis. We will write at′, under′ etc. for the respective functions from DPs to locations, and stay′, to′ and from′ for the respective functions from locations to event modifiers, which define the motion with respect to the location. We have, for example

[13]However, by our definition, the suffix /onta/ does not form a syntactic case in Hungarian. The reason is that there is to our knowledge no verb selecting this particular element. It always enters with its full meaning and in free competition with other temporal adverbials denoting time points.

the following signs in Hungarian:[14]

$$\begin{array}{lcl}
\text{SUB} & = & \langle /\#\text{al}/, DP\backslash L, \text{under}' \rangle \\
\text{STAT} & = & \langle /\text{Vtt}\#/, DP\backslash L, \text{stay}' \rangle \\
\text{COF} & = & \langle /\acute{\text{V}}\#/, L\backslash ADVP, \text{to}' \rangle \\
\text{COI} & = & \langle /\acute{\text{V}}\text{l}\#/, DP\backslash L, \text{from}' \rangle \\
\text{INE} & = & \langle /\text{ban}\#/, DP\backslash ADVP, \text{stay}' \circ \text{in}' \rangle \\
\text{SUBLA} & = & \langle /\text{ra}\#/, DP\backslash ADVP, \text{to}' \circ \text{on}' \rangle
\end{array}$$

(Notice, that $f \circ g := \lambda x.f(g(x))$ is as usual function composition.) Here, $ADVP$ is the category of adverbial phrases (which can be either VP/VP or $VP\backslash VP$), L the category of locations, and DP the category of DPs. We have used V here to denote a vowel, and $\acute{V}$ to denote a long vowel. However, notice that what we really have is functions which, when applied to a string add the required string. Finally, # is the word boundary marker. We allow among other these modes of composition:

$$\begin{array}{lcllcl}
\langle E, \alpha/\beta, M \rangle & \circ & \langle E', \beta, M' \rangle & := & \langle E^\frown E', \alpha, M(M') \rangle \\
\langle E, \beta, M \rangle & \circ & \langle E', \beta\backslash\alpha, M' \rangle & := & \langle E^\frown E', \alpha, M'(M) \rangle \\
\langle E, \alpha/\beta, M \rangle & \bullet & \langle E', \beta/\gamma, M' \rangle & := & \langle E^\frown E', \alpha/\gamma, M \circ M' \rangle \\
\langle E, \gamma\backslash\beta, M \rangle & \bullet & \langle E', \beta\backslash\alpha, M' \rangle & := & \langle E^\frown E', \gamma\backslash\alpha, M' \circ M \rangle
\end{array}$$

(We do not distinguish between $\bullet_r$ and $\bullet_\ell$ notationally.) These are the usual modes of backward application and backward function composition. (We also allow mixed composition, but this is of no direct concern here.) With these signs we can successfully analyze the adverbial phrases /az ágy alá/, /a házban/, and so on.

With respect to the case signs, we have to work harder. As already said, we assume that the value of the feature CASE is not a single attribute but a sequence thereof. In order to manipulate these sequences, we introduce a variable $\bullet$ for a stack. By means of this variable, string substitutions are defined. In particular, our operations consist in adding something at the end or the beginning of the sequence or removing it from there. This definition can either be recursive (for all categories inside) or not. In the first case, this substitution must be carried out throughout the category, in the other case just in the target category. This motivates the following notation.

Definition 2 *(Full Stack Substitution) Let σ be a sequence of morphemes, and let Σ be a basic category. Then* $[\text{CASE} : \bullet \cdot \sigma]\Sigma$ *denotes the result of the following replacement. If Σ contains the feature* $[\text{CASE} : \rho]$*, then* $[\text{CASE} : \bullet \cdot \sigma]\Sigma$ *results from Σ by replacing that feature with*

[14] The semantics is given in λ–calculus. Some words on notation. ship$'$ is already a function and so ship$' = \lambda x.\text{ship}'(x)$. The difference between these notations is relevant for the eye only.

$[\text{CASE} : \rho \cdot \sigma]$. *Furthermore,*

$$\begin{array}{lcl} [\text{CASE} : \bullet \cdot \sigma](\beta/\gamma) & := & ([\text{CASE} : \bullet \cdot \sigma]\beta)/([\text{CASE} : \bullet \cdot \sigma]\gamma) \\ [\text{CASE} : \bullet \cdot \sigma](\gamma\backslash\beta) & := & ([\text{CASE} : \bullet \cdot \sigma]\gamma)\backslash([\text{CASE} : \bullet \cdot \sigma]\beta) \end{array}$$

Similarly, $[\text{CASE} : \sigma \cdot \bullet]\Sigma$ *denotes the result of the following replacement. If* Σ *contains the feature* $[\text{CASE} : \rho]$*, then* $[\text{CASE} : \sigma \cdot \bullet]\Sigma$ *results from* Σ *by replacing that feature with* $[\text{CASE} : \sigma \cdot \rho]$.

Notice that while $[\text{CASE} : \bullet \cdot \sigma]\alpha$ denotes a substitution on α, $\alpha[\text{CASE} : \sigma]$ is a category which has syntactic case σ. There is a gap in the definition as regards the case when the case feature is not present. We shall assume then that the substitution is undefined. This requires that nouns have the case feature ε in the lexicon already. If one dislikes this option, one can change the setup accordingly. The present discussion does not depend on this choice. We also need the following.

Definition 3 *(Head Stack Substitution) Let* σ *be a sequence of morphemes, and let* Σ *be a basic category. Then* $\{\text{CASE} : \bullet \cdot \sigma\}\Sigma$ *denotes the result of the following replacement.*

$$\begin{array}{lcl} \{\text{CASE} : \bullet \cdot \sigma\}\Sigma & := & [\text{CASE} : \bullet \cdot \sigma]\Sigma \\ \{\text{CASE} : \bullet \cdot \sigma\}(\beta/\gamma) & := & (\{\text{CASE} : \bullet \cdot \sigma\}\beta)/\gamma \\ \{\text{CASE} : \bullet \cdot \sigma\}(\gamma\backslash\beta) & := & \gamma\backslash(\{\text{CASE} : \bullet \cdot \sigma\}\beta) \end{array}$$

Dually, $\{\text{CASE} : \sigma \cdot \bullet\}\Sigma$ *is defined:*

$$\begin{array}{lcl} \{\text{CASE} : \sigma \cdot \bullet\}\Sigma & := & [\text{CASE} : \sigma \cdot \bullet]\Sigma \\ \{\text{CASE} : \sigma \cdot \bullet\}(\beta/\gamma) & := & (\{\text{CASE} : \sigma \cdot \bullet\}\beta)/\gamma \\ \{\text{CASE} : \sigma \cdot \bullet\}(\gamma\backslash\beta) & := & \gamma\backslash(\{\text{CASE} : \sigma \cdot \bullet\}\beta) \end{array}$$

These replacement operations are different from unification, since they operate in a specific way on sequences. Now consider the following mode:

Definition 4 *(Stacking Mode) The operation* Ⓢ *is defined as follows.*

$$\begin{array}{lcl} \langle E, \alpha, M\rangle \circledS \langle E', \beta\backslash\gamma, M'\rangle & := & \langle E^\frown E', [\text{CASE} : \bullet \cdot E']\alpha, M\rangle, \\ \langle E', \gamma/\beta, M'\rangle \circledS \langle E, \alpha, M\rangle & := & \langle E'^\frown E, [\text{CASE} : \bullet \cdot E']\alpha, M\rangle. \end{array}$$

Otherwise, $\sigma \circledS \sigma'$ *is undefined.*

The combination rules are quite free as they stand. We assume however that morphological considerations restrict the applicability of these rules. Here are instances of Hungarian basic signs that give us the morphological local cases.[15]

$$\begin{array}{lcl} \textsc{on} & = & \langle /\mathrm{r}/, DP\backslash L, \mathrm{on}' \rangle \\ \textsc{in} & = & \langle /\mathrm{b}/, DP\backslash L, \mathrm{in}' \rangle \\ \textsc{at} & = & \langle /\mathrm{t}/, DP\backslash L, \mathrm{at}' \rangle \\ \textsc{cof} & = & \langle /\mathrm{V\#}/, L\backslash ADVP, \mathrm{to}' \rangle \\ \textsc{stat} & = & \langle /\mathrm{Vn\#}/, L\backslash ADVP, \mathrm{stay}' \rangle \\ \textsc{coi} & = & \langle /\mathrm{\acute{V}l\#}/, L\backslash ADVP, \mathrm{from}' \rangle \end{array}$$

This generates on the one hand case marking postpositions and on the other case suffixes in the appropriate way. Using the primitive sign

$$\langle /\text{hajó}/, DP[\textsc{case} : \varepsilon], \mathrm{ship}' \rangle$$

the illative case marked DP *hajóra* is generated as follows

$$\begin{array}{cl} & (\textsc{hajó} \circledS \textsc{on}) \circledS \textsc{cof} \\ = & (\langle /\text{hajó}/, DP[\textsc{case} : \varepsilon], \mathrm{ship}' \rangle \circledS \langle /\mathrm{r}/, DP\backslash L, \mathrm{on}' \rangle) \\ & \quad \circledS \langle /\mathrm{V\#}/, L\backslash ADVP, \mathrm{to}' \rangle \\ = & \langle /\text{hajór}/, DP[\textsc{case} : /\mathrm{r}/], \mathrm{ship}' \rangle \circledS \langle /\mathrm{V\#}/, L\backslash ADVP, \mathrm{to}' \rangle \\ = & \langle /\text{hajóra}/, DP[\textsc{case} : /\mathrm{r}/ \cdot /\mathrm{V\#}/], \mathrm{ship}' \rangle \end{array}$$

Notice that there is no allative case marker */tV#/; rather, the allative is marked by /hoz/. So, we have $/\mathrm{t}/^\frown/\mathrm{V\#}/ = /\mathrm{hoz\#}/$. This is of course handled by the string functions.

Finally, we can now also generate the intermediate example, namely the cofinalis.

$$\begin{array}{cl} & (\textsc{hajó} \circ \textsc{on}) \circledS \textsc{cof} \\ = & (\langle /\text{hajó}/, DP[\textsc{case} : \varepsilon], \mathrm{ship}' \rangle \circ \langle /\mathrm{r}/, DP\backslash L, \mathrm{on}' \rangle) \\ & \quad \circledS \langle /\mathrm{V\#}/, L\backslash ADVP, \mathrm{to}' \rangle \\ = & \langle /\text{hajór}/, DP[\textsc{case} : \varepsilon], \mathrm{on}'(\mathrm{ship}') \rangle \circledS \langle /\mathrm{V\#}/, L\backslash ADVP, \mathrm{to}' \rangle \\ = & \langle /\text{hajóra}/, DP[\textsc{case} : /\mathrm{V\#}/], \mathrm{on}'(\mathrm{ship}') \rangle \end{array}$$

Thus, the present proposal captures the facts of Hungarian cases quite adequately. However, as we shall show in the next section, even this is not enough when we want to analyze the data of Finnish. The problem lies, curiously enough, in the DP internal case agreement.

1.5 DP Internal Agreement

Now let us look at the difference between Finnish and Hungarian. Finnish shows case concord, Hungarian does not.

[15] Actually, we have to distinguish the Hungarian sign ON from its Finnish counterpart, which has a different exponent, and most likely also a different semantics. Nevertheless, to avoid being overly pedantic, we shall denote both by ON. The context will make clear which sign is meant.

(30) Jussi on iso-lla laiva-lla.
Jussi is big-ADE ship-ADE

(31) Jussi a nagy hajó-n.
Jussi the big ship-SUP
'Jussi is on the big ship.'

Let us assume that the addition of case suffixes works in the same way with adjectives as with nouns. The case markers are morphemes attached with the help of $\circledS$. In this case, the difference between Finnish and Hungarian can only be explained as follows. Case particles of Hungarian are *phrasal affixes*, and Finnish case particles are *word affixes*. Therefore, in Finnish the adjective must bear case. Moreover, it must bear the same case as the noun since otherwise it cannot combine with the noun. In Hungarian, however, the affix can only combine with the phrase, not with the words individually. If it combines with the noun first then the adjective and noun do not agree in case and cannot be composed. Thus, despite the fact that the case ending is a suffix, it must be attached to the noun phrase, not to the noun.

Now, this actually means that we have to revise our picture of Finnish. Take a look at (32).

(32) Jussi löysi raha-n-sa iso-lta laiva-lta.
Jussi found money-ACC his big-ABL ship-ABL
'Jussi found his money on a/the big ship.'

We have argued that the noun phrase is syntactically not in the ablative case but in the coinitialis. Suppose we assume that the noun too is syntactically in the coinitialis. Then the structure of the noun phrase can be analyzed as follows.

$$((\textsc{iso} \circ \textsc{at}) \circledS \textsc{coi}) \circ ((\textsc{laiva} \circ \textsc{at}) \circledS \textsc{coi})$$

In our notation, the meaning of this complex is the following.

$$(\mathrm{at}'(\mathrm{big}'))(\mathrm{at}'(\mathrm{ship}'))$$

Analyzing the meaning we find something like: 'at a/the big one and at a/the ship'. There are several reasons why this is the wrong analysis. First, it is not clear that $\mathrm{at}'(\mathrm{big}')$ is again something which can modify the expression $\mathrm{at}'(\mathrm{ship}')$, because both are locations. Second, it is not clear how we can derive the correct reading *on the big ship*, primarily because the adjective, when put together with the morpheme AT produces a location, and so does the noun, and we get the intersection of the locations of big things with the location of ships, rather than the location of big ships. (This is so since the adjective 'big' depends in its denotation also on the class of objects denoted by the noun. Big mice are for example much smaller than small elephants let alone big ones.) So, the adjective must in fact apply before the suffix AT is attached. A third problem is the polysemy of cases. Cases typically have more than one meaning. However, the meaning of a case cannot be chosen differently with the adjective and the noun. In fact, in place of AT we could also have ON with the meaning 'on'. Then we would get the following additional analyses, of which only the last gives actually the desired, normal interpretation.

$$((\text{ISO} \circ \text{AT}) \circledS \text{COI}) \circ ((\text{LAIVA} \circ \text{ON}) \circledS \text{COI})$$
$$((\text{ISO} \circ \text{ON}) \circledS \text{COI}) \circ ((\text{LAIVA} \circ \text{AT}) \circledS \text{COI})$$
$$((\text{ISO} \circ \text{ON}) \circledS \text{COI}) \circ ((\text{LAIVA} \circ \text{ON}) \circledS \text{COI})$$

The inevitable conclusion is that we must first form the semantics of the DP before we form the location. (For syntactical reasons it is dangerous to assume that the case affix at the noun is phrasal, and so of a completely different type than that of the adjective. This will effectively mean that adjectives can never combine with nouns, since they do not agree in case.) Hence, we must assume that the directional locative is formed in two stages.

1. The case suffixes ON and COI are applied to all revelant members of the DP, turning the DP into an adessive DP.
2. An empty preposition P^* is added which turns the adessive DP into a locative adverbial.

So the structure is this:

$$[P^* \quad [\text{ISO} \circledS \text{ON} \circledS \text{COI} \quad \text{LAIVA} \circledS \text{ON} \circledS \text{COI}]]$$

Now, what sort of entity is this empty preposition? We assume that it is nothing but the morpheme ON, however now composed with the DP to recover the original meaning. We propose therefore a new mode of composition, Ⓡ.

Definition 5 *(Unstacking Mode) Ⓡ is defined as follows (with $\bullet$ a variable over admissible values).*

$$\begin{aligned} &\langle E^\frown E', \alpha[\text{CASE} : E' \cdot \bullet], M\rangle \circledR \langle E', \alpha\backslash\beta, M'\rangle \\ &\quad := \quad \langle E^\frown E', \beta[\text{CASE} : \bullet], M'(M)\rangle \\ &\langle E', \beta/\alpha, M'\rangle \circledR \langle E'^\frown E, \alpha[\text{CASE} : E' \cdot \bullet], M\rangle \\ &\quad := \quad \langle E^\frown E', \beta[\text{CASE} : \bullet], M'(M)\rangle \end{aligned}$$

$\sigma \circledR \sigma'$ is undefined unless σ and σ' have the form above.

Using Ⓡ, the meaning of the morpheme ON can be recovered even if it has functioned earlier only as a case marker. We shall analyze (32) in detail. Here are the relevant signs.[16]

$$\begin{aligned}
\textsc{laiva} &= \langle/\text{laiva}/, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : \varepsilon \end{bmatrix}, \text{ship}'\rangle \\
\textsc{iso} &= \langle/\text{iso}/, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : \varepsilon \end{bmatrix} / \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : \varepsilon \end{bmatrix}, \text{big}'\rangle \\
\textsc{on} &= \langle/\text{l}/, [\textsc{cat} : n]\backslash[\textsc{cat} : \ell], \text{on}'\rangle
\end{aligned}$$

The DP *isolta laivalta* in (32) is analyzed as follows.

$$(((\textsc{iso} \circledS \textsc{on}) \circledS \textsc{coi}) \circ ((\textsc{laiva} \circledS \textsc{on}) \circledS \textsc{coi})) \circledR \textsc{on}$$

The reader is invited to check that

$$(\textsc{iso} \circledS \textsc{on}) \circledS \textsc{coi} = \langle/\text{isolta}/, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\text{l}/ \cdot /\text{ta}/ \end{bmatrix} / \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\text{l}/ \cdot /\text{ta}/ \end{bmatrix}, \text{big}'\rangle$$

(Notice in particular that we need full stack substitution here to make the result come out right.) Further,

$$(\textsc{laiva} \circledS \textsc{on}) \circledS \textsc{coi} = \langle/\text{laivalta}/, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\text{l}/ \cdot /\text{ta}/ \end{bmatrix}, \text{ship}'\rangle$$

If we compose these two we get

$$\langle/\text{isolta laivalta}/, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\text{l}/ \cdot /\text{ta}/ \end{bmatrix}, \text{big}'(\text{ship}')\rangle$$

Finally, we compose with ON using the mode Ⓡ and obtain

$$\langle/\text{isolta laivalta}/, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\text{ta}/ \end{bmatrix}, \text{on}'(\text{big}'(\text{ship}'))\rangle$$

as required. Of course, the meaning of the phrase *isolta laivalta* can also be 'at the big ship', or 'somewhere close to the big ship', as we could have chosen different meanings for the adessive. In fact, unless we can argue that the different meanings of the adessive discussed here can be analyzed as a single one we will have to assume that there are at least three different signs, AT, ON and CLOSE, which are syntactically, phonologically and morphologically identical, but different in meaning. This is no problem with the present analysis. However, we must make sure that the incorrect analyses of (32) cannot be generated. One obvious restriction is that Ⓡ must be allowed to combine only with phrases. A closer analysis will have to be done, though, to find out if this is enough.

[16]To make matters simple, we ignore the fact that we have to assume an empty D–head in Finnish to turn an NP into a DP. Moreover, we pay no attention to bar–levels. Thus the type assignment of ON is slightly different from its Hungarian counterpart, though only for expository reasons.

The reader may notice that the modes Ⓡ and Ⓢ are in some sense inverses of each other. Namely, we have the following identity if $\sigma_1 \circ \sigma_2$ is defined.

$$(\sigma_1 \,Ⓢ\, \sigma_2) \,Ⓡ\, \sigma_2 = \sigma_1 \circ \sigma_2.$$

Moreover, we have

$$(((\sigma_1 \,Ⓢ\, \sigma_2) \,Ⓢ\, \sigma_3) \,Ⓡ\, \sigma_2 = (\sigma_1 \circ \sigma_2) \,Ⓢ\, \sigma_3,$$

and similarly with more intervening case markers. The mechanics of these operations is therefore quite transparent. By applying Ⓢ we store the morpheme in the form of a case marker, which at any time can be converted into the meaning by applying Ⓡ, whereby the case suffix is removed and the meaning function is applied.

It may be thought that the system overgenerates, and moreover that the parsing problem becomes undecidable.[17] We shall indicate why this is not so. Assume first that there are no phonetically empty elements. Consider a string of length n. It is then a sequence of n items. It is known that there exist in the worst case exponentially many analyses using $\bullet$ and $\circ$. (Basically, a sequence of $n-1$ items of category α/α, α basic, followed by an item of category α has as many analyses as there are binary bracketings. This number is exponential in n.) Now, forming a constituent using Ⓢ concatenates the strings and increases the length of the case feature. The operation Ⓡ reduces the length of the case feature, but does not manipulate the phonetic content. So, as no operations reduces the parsed string, the parse contains at most $n-1$ operational signs. Now we consider what happens if empty elements exist. It is easy to see that if σ is phonetically empty then $\sigma_1 \,Ⓢ\, \sigma$ if defined equals σ_1, and likewise for $\sigma \,Ⓢ\, \sigma_1$. Hence, empty signs, although contributing to the ambiguity, do not increase the complexity of the parsing problem in presence of Ⓢ and Ⓡ.

1.6 Layers of Case

In this section we shall deal with German locatives. German has four morphological cases, nominative, genitive, dative and accusative. Prepositions can select any case but the nominative. There are about a dozen spatial prepositions which can either take the dative or the accusative. The rule as for which case must be used is the following. If the locative is static, dative must be used. If the locative is cofinal, then accusative must be used. Examples are /in/ (*in*), /an/ (*at*), /über/ (*above*), /unter/ (*under*).[18]

[17] I thank an anonymous referee for bringing up this issue.

[18] The nouns carry a zero case marker, which means that they can be either nominative, accusative or dative. Therefore, we do not annotate them here for case.

(33) Peter steht an der Wand.
Peter stands at the-DAT.SG wall-SG
'Peter is standing at the wall.'

(34) Peter stellt das Bild an die Wand.
Peter puts the picture at the-ACC.SG wall-SG
'Peter puts the picture at the wall.'

It is also the case that prepositions for the coinitial mode consistently take the dative. But this fact is of no particular concern here. Many verbs take PP complements, and additionally they can take PPs with prepositions taking either accusative or dative. However, if they do so, there is no choice between these two cases; only one of them is correct. For example, the verb /sich täuschen/ (*to be mistaken*) requires a complement with /in/ and a DP in the dative case. Accusative is ungrammatical.

It is not predictable which of the two cases is required. This is shown by the following examples.

(35) Ich glaube nicht an Deinen Gott.
I believe not at your-ACC.SG god-SG
'I do not believe in your god.'

(36) Ich bin nicht interessiert an Deinem Gott.
I am not interested at your-DAT.SG god-SG
'I am not interested in your god.'

We shall assume that the verb can select a complement for a case feature. This case feature can — but need not — contain a proper sequence. We can write the category of /glauben/ as follows:

$$\langle/\text{glauben}/, [\textsc{cat} : v] \,/ \begin{bmatrix} \textsc{cat} & : & n \\ \textsc{case} & : & /\textsc{acc}/ \cdot /\text{an}/ \end{bmatrix}, \text{believe}'\rangle$$

On the other hand, /interessiert sein/ has the following entry.

$$\langle/\text{interessiert sein}/, [\textsc{cat} : v] \,/ \begin{bmatrix} \textsc{cat} & : & n \\ \textsc{case} & : & /\textsc{dat}/ \cdot /\text{an}/ \end{bmatrix}, \\ \text{be-interested}'\rangle$$

When we want to produce a proper complement for /glauben/, we have to do the following. First, each element of the noun phrase is composed with the case particle for the accusative. This produces a DP with syntactic accusative case. Next, the preposition /an/ is combined using the operation Ⓢ. This produces a DP with case feature [CASE : /ACC/ · /an/]. Similarly for /interessiert sein/.

However, it might be argued that what we have is rather two prepositions, say $\textsc{an}_a$, which selects accusative, and $\textsc{an}_d$, which selects dative. All that it takes for the verb is to select one of these homomophonous prepositions. However, if we assume that we lose the possibility of accounting for the regular semantic behavior of these prepositions. Instead, we shall show that we can account for this behavior as well. In order to do this, we must assume that spatial prepositions are generally bimorphemic, as we did for Finnish and Hungarian. We propose that the dative selecting AN is composed from a basic spatial sign $\textsc{an}_0$ and the sign STA. (Notice, once again, that the German STA is not the same sign as the Finnish or Hungarian STA. They have — among other — different exponent.) The entry for $\textsc{an}_0$ is the following.

$$\textsc{an}_0 = \langle /\mathrm{an}/, \begin{bmatrix} \textsc{cat} & : \mathit{lp} \\ \textsc{case} & : \varepsilon \end{bmatrix}, \mathrm{at}' \rangle$$

The category *lp* is the category of locative prepositions. Next, we shall assume these signs.

$$\begin{aligned} \textsc{sta} \quad &= \langle /\varnothing/, \left([\textsc{cat} : \mathit{adv}] \,/\, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\textsc{dat}/ \end{bmatrix} \right) / \begin{bmatrix} \textsc{cat} & : \mathit{lp} \\ \textsc{case} & : \varepsilon \end{bmatrix}, \mathrm{stay}' \rangle \\ \textsc{cof} \quad &= \langle /\varnothing/, \left([\textsc{cat} : \mathit{adv}] \,/\, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\textsc{acc}/ \end{bmatrix} \right) / \begin{bmatrix} \textsc{cat} & : \mathit{lp} \\ \textsc{case} & : \varepsilon \end{bmatrix}, \\ &\qquad \lambda \mathcal{Q}.\lambda \mathcal{P}.\mathrm{to}'(\mathcal{Q}(\mathcal{P})) \rangle \end{aligned}$$

to$'$ has three arguments. The first is a location, the second a thing and the third a time interval. It says that the thing is moving to the location within the specified time. We will need only the first argument here. Notice that the signs are phonetically empty. The way the types are formed, these signs can only compose with elements of category *lp*. For example, we get

$$\textsc{cof} \circ \textsc{an}_0 = \langle /\mathrm{an}/, [\textsc{cat} : \mathit{adv}] \,/\, \begin{bmatrix} \textsc{cat} & : n \\ \textsc{case} & : /\textsc{acc}/ \end{bmatrix}, \lambda \mathcal{P}.\mathrm{to}'(\mathrm{at}'(\mathcal{P})) \rangle$$

The semantics of the result is again a three argument function; however, the first argument is now a thing. The resulting sign is a preposition in the standard sense, looking for a case marked DP.

Let us return now to the verbs /glauben/ and /interessiert sein/. We shall change their case–frame a little bit in order to account for the reformulation of the type system.

$$\langle\text{/glauben/}, [\textsc{cat} : v] \,/ \begin{bmatrix} \textsc{cat} & : & n \\ \textsc{case} & : & /\textsc{acc}/ \cdot /\textsc{an}_0/ \cdot /\textsc{cof}/ \end{bmatrix}, \text{believe}'\rangle$$

$$\langle\text{/interessiert sein/}, [\textsc{cat} : v] \,/ \begin{bmatrix} \textsc{cat} & : & n \\ \textsc{case} & : & /\textsc{dat}/ \cdot /\textsc{an}_0/ \cdot /\textsc{sta}/ \end{bmatrix}, \text{be-interested}'\rangle$$

The need for this change is seen as follows. A case marker can by definition only have a composite type. However, $\textsc{an}_0$ has only a simple type. Therefore, we must first compose it (using $\circ!$) with STA or COF to form the preposition AN, which now selects either an accusative or a dative marked DP. This preposition can now form a case marker in the normal way. Notice that we could alternatively write down the syntactic case of /glauben/ as $/\textsc{acc}/ \cdot /\textsc{an}_0/ \cdot /\textsc{sta}/$, but the result is actually the same.

1.7 Case Stacking in Australian Languages

One of the main motivations for case stacks was originally provided by Australian languages. Lets take an example from Kayardild.

(37) Maku-ntha yalawu-jarra-ntha yakuri-naa-ntha
woman-OBL catch-PAST-OBL fish-MABL-OBL
dangka-karra-nguni-naa-ntha mijil-nguni-naa-ntha
man-GEN-INST-MABL-OBL net-INST-MABL-OBL
'The woman must have caught fish with the man's net.'

In this example, every item is marked at the outside with oblique case (OBL), which signals in this case the non–indicative mood. The subject is otherwise unmarked. The object is additionally marked with the modal ablative case (MABL) and the instrumental adjunct by the instrumental (INST), and — finally — the possessor phrase by an additional genitive (GEN). What distinguishes Kayardild from, say, European languages is that cases are stacked. Nordlinger (1998) has studied this phenomenon in detail and proposed a model within LFG. The basic idea is that in languages with stacked cases, cases can project their own f–structure, so that the usual bounds on their occurrence are lifted. For if they do not project their own f–structure, two case markers on a noun conflate to one, which will create an inconsistency. If on the other hand they do project their own f–structure, then two different case markers are interpreted as belonging to different f–domains, and so no conflict arises and the interpretation can correctly be put together. In Ebert and Kracht (2000) a somewhat simpler model was proposed, that uses basically the Zeevat–

Merge of DRSs and a mode of composition that is much like Ⓢ. This proposal directly translates into the present one. However, the freedom of word order is lost. This is however mainly due to the different type system and semantics chosen. If the semantics of the quoted paper is used, no complications arise.[19] The assumption is simply that cases in Kayardild are always interpreted as adding themselves to the case–stack. This means that the operation that is used to combine cases with stems is consistently Ⓢ. This is however the case regardless of whether the case is semantically interpreted or not, and in this respect Kayardild differs from the languages we have looked at so far. This obviously requires defining different modes of composition. However, we shall refrain from adding explicit details here. Furthermore, we must assume that case markers are word affixes; otherwise, it is possible to combine a verb first with its argument before it combines with the oblique case marker, for example. This allows either the verb or its complement to be without oblique case suffix. To rule this out, we must insist that case suffixes are word affixes. This is a morphological condition on merge. If on the other hand cases are consistently phrasal, then we get the case marking of Japanese, Hungarian, Turkish or Sumer (for an analysis of the latter see Kracht 2001a). This provides a sketch of how Australian languages are analyzed here. Our present proposal has some features worth looking at. For example, notice that adding a case to a head changes the case requirements on all of its arguments. They must carry this case in addition to the case they are assigned by the head prior to the addition of the case. Such an operation has to our knowledge never been discussed but is needed if we want to have word order restrictions together with case stacks, which we do seem to have in Kayardild. Thus, in distinction to the proposals by Nordlinger as well as by Ebert and Kracht, the present proposal allows to have structure besides Suffixaufnahme.

1.8 Conclusion

In this paper we have tried to show that the typical view of cases as feature bundles is not particularly helpful for natural languages. While it is easily shown to fail for Australian languages, here we have concentrated on showing that it fails to be adequate even for more familiar languages. It has emerged that if one is trying to capture the distribution and semantics of cases in a unified way, the feature bundle theory

[19] Free word order with respect to DPs in conjunction with modification is a problematic issue from a semantic point of view for all proposals we know of. It is not clear to us how we can ensure that non–intersective adjectives like *good* can take proper scope if they can appear anywhere in the sentence, as may happen in Warlpiri (but also in Latin, where this is no less of a problem).

comes out less favorably than a theory based on case stacks. This is so since many languages in addition to having case morphology also use prepositions. Moreover, heads may govern a preposition which in turn governs a particular case. This needs to be accounted for. Furthermore, as we have shown in detail with Finnish, in languages with a rich case system and DP internal agreement, the semantics of cases cannot come out right if morphological cases are also assumed to be morphologically simple. Our particular proposal was to regard the exponents of primitive or composite signs themselves as the cases. There are specific compositional modes that manipulate signs in such a way that we get the effect of case marking. This saves us from postulating additional case features for the morphological cases.[20] Although these modes overgenerate if applied freely, there are ways to constrain them such that only the intended effects remain. It would be interesting to study the fine tuning of this system, but this has to be left for another occasion.

The present system is actually more than a theory of cases. If we are on the right track, then it provides the germ of a theory of formal (or functional) categories in general. They too show a natural duality between functional and non–functional use, the latter accompanied by the meaning of that item, the former typically accompanied by a null semantics.

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