V-PP Goal Motion Complexes in English: 
An HPSG Account

Pascal Denis Jonas Kuhn Stephen Wechsler
Linguistics Department
University of Texas at Austin
{denis,jonask,wechsler}@mail.utexas.edu

1 Introduction

In this paper, we investigate how English intransitive motion verbs and locational prepositions interact syntactically and semantically when they are combined to express goal motion events. A goal motion event here refers to a situation in which an entity (or ‘figure’) moves along a trajectory (or ‘path’) and reaches a goal (or ‘endpoint’) (cf. Talmy 1985). Below are two canonical examples:

(1) a. Sally arrived in Austin.
   b. Harry ran to the library.

A trademark of goal motion complexes such as (1a-b) has to do with their Aktionsart or ‘temporal constituency’: they are telic predicates (cf. Vendler 1957, Dowty 1979, Smith 1991, Krifka 1998). This can be shown, in mereological terms, by the fact that they lack the property of divisibility: that is, a (proper) subpart of a goal motion event can no longer be described by the same sentence. Another trademark of these constructions is that the PP element is an optional complement. Evidence that the PP is a complement in both (1a-b) comes from do-so anaphora, VP-fronting, as well as other tests (Baker 1988:239ff, Radford 1988 i.a.).

The basic question we will be concerned with in this paper is: Which PPs go with which verbs? An important postulate underlying this paper is that a large part of the selection process between the V and the PP is semantically determined. Section 2 of this paper discusses the factors influencing PP selection in goal motion constructions. Section 3 provides a formal account in the framework of Head-driven Phrase Structure Grammar (HPSG, Pollard and Sag 1994). Our account builds on work using lexical inheritance hierarchies to model the syntax-semantics interaction underlying argument structure (Wechsler 1995, 1997; Davis, 2001; inter alia). We follow these accounts in assuming that specific optional PP complements are not selected in the verbal lexical entries, but rather PP’s can be freely appended to the VALENCE-list of a verb. Whether or not a given PP is licensed depends on the compatibility of its semantic content with that of the verb, a compatibility forced by the compositional semantics. In this paper, we refine these accounts in two important ways: first, we show that part of PP selection is also aspectual, motivating an enriched representation of the content; and second, we show that type coercion (Pustejovsky 1995) is required.

2 Description and informal analysis

A first step toward understanding how verbs and PP interact in goal motion complexes is to consider the different types of verbs and prepositions found in these constructions.
2.1 VIDM verbs vs. MoM verbs

Let us start with verbs. Levin (1993) suggests that motion verbs can be split into two main classes depending on whether they lexicalize direction (i.e., Talmy’s ‘path’) or manner of motion. She thus distinguishes between what she calls Verbs of Inherent Directed Motion (or VIDM) verbs and Manner of Motion (here MoM) verbs. Some examples are given in (2):

(2)  
a. **VIDM verbs**: arrive, enter, fall, approach, descend, go, . . .  
b. **MoM verbs**: walk, run, roll, waltz, jump, canoe, . . .

The first class of verbs, which is also the smaller,\(^1\) encodes ‘direction of motion’; and these verbs do so inherently, meaning that these verbs include a specification of the direction (and/or goal) of motion even in the absence of an overt directional complement. (In this paper, we only consider verbs that lexically entail the achievement of the goal: e.g., arrive but not approach). By contrast, the second class inherently encodes a manner component (i.e., a particular mode of motion), but they need a preposition to express direction and/or goal.\(^2\) The distinction between these two classes can be seen in terms of semantic entailments. Thus, only VIDM verbs clearly entail change of location. This is shown by the fact that one can for instance run in place (hence overriding the entailment) but not *arrive in place.*

It is worth noting here that the PPs are optional with both classes of verbs. There are two related and crucial differences, however. The first one is that the PP complement with VIDMs is really a semantic complement (i.e., the PP is very much like an ‘understood object’ with verbs like eat). That is, it is existentially quantified when it is not overtly realized, as shown by the following entailment:

(3)  
Bill arrived \(\models \exists x \text{ s.t. } x \text{ Bill arrived at } x\)

This does not quite seem to be the case for the MoM verbs, which are often taken to be primarily intransitive:

(4)  
Bill ran \(\not\models \exists x \text{ s.t. } x \text{ Bill ran to } x\)

The second related difference is that VIDMs remain telic even if their PPs are not overtly realized. MoM verbs, on the other hand, are atelic when they stand on their own. One of the points of this paper will actually be to cast some doubts on these differences, and to assume that MoM verbs actually select for a *path* argument.

2.2 Static vs. Dynamic prepositions

Prepositions are also often assumed to fall into two main categories. These two classes are referred to as *dynamic* (or path-denoting) and *static* (or location-denoting) prepositions:

(5)  
a. **Dynamic prepositions**: to, into, onto, from\(^3\), through\(^4\), . . .  
b. **Static prepositions**: at, in, on, behind, under, . . .

The crucial difference between the two classes of prepositions is that only the latter can be found with stative verbs (i.e., copular be) or positional verbs like *lie* or *stand:*

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\(^1\)According to Talmy (1991), English is a so-called ‘satellite-framed’; that is, a language that tends to lexicalize its path information not into the verb root but into an external element, such as a PP.

\(^2\)In some cases, NPs can specify the endpoint entailed by the verbs, as with *enter (*into) the room. This verb, it seems, can only take a PP complement when it describes metaphorical motion: e.g. *enter (into) an agreement.*

\(^3\)This preposition has also a static use, as in *James is from Texas.*

\(^4\)Under one of its readings.
Among dynamic prepositions, we will restrict our attention to those that express endpoint (e.g., *to* but not *from*), since our focus is on goal motion complexes.

### 2.3 The Null Theory of PP selection

One may phrase the question we are investigating as follows: Which PPs go with which verbs? Given the two classifications above, one might posit the following very intuitive theory of PP selection for goal motion complexes—which we will dub the Null Theory of PP Selection (or NTPPS, for short):

\[
\text{(7) NTPPS: VIDM verbs select for PPs headed by static prepositions, whereas MoM verbs select for PPs headed by dynamic prepositions.}
\]

The intuitive idea behind the NTPPS is the following: (i) since VIDMs already entail an endpoint, they select for a location-denoting PP specifying this endpoint; and (ii) since MoM verbs do not entail an endpoint, they require a path-denoting PP to express goal-motion.

As shown below, the NTPPS makes some correct predictions:

(8) Bill arrived at the party/*to the party (VIDM+static PP)

(9) Bill walked to school/*at school (MoM+dynamic PP)

### 2.4 Shortcomings of the NTPPS

However, by positing a one-to-one relation between verb classes and preposition classes, the NTPPS wrongly excludes the following perfectly fine examples:

(10) Bill fell (on) to the ground. (VIDM+dynamic PP)

(11) Bill ran under the porch (when it started to rain). (MoM+static PP)

Before moving further, it is worth noting that the complexes formed with a MoM verb and a static PP, often have an additional non-goal reading. That is, a reading where the PP spatially *locates* the motion event described by the verb. That is, a sentence like (11) allows for the two following informal paraphrases, which we will refer to, respectively, as Goal Motion Reading (GMR) or Located Motion Reading (LMR):

(12) a. The event of Bill running results in Bill being under the porch (GMR)
    b. The event of Bill running took place under the porch (LMR)

We will be mainly concerned with the GMR here. Examples (10) and (11) suggest that the relation between verb classes and preposition classes is in fact many-to-many, contrary to the null theory. In particular, they show that: (i) VIDM verbs can combine with dynamic PPs, and (ii) MoM verbs can combine with static PPs (and yet denote goal of motion).

Let us look further into the two examples above, because they each suggest an interesting point. What examples like (10) show is that information about the path can be *redundantly* specified by both the verb (*fall*) and the PP (*to or onto*). Example (11) in its goal motion reading (12a) illustrates the opposite problem. Namely, there seems to be a *compositional gap*, since neither the verb nor the PP inherently encode the path-goal information, an observation that goes back to Carter (1988).

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5Hereafter, we will use the terms static PPs and dynamic PPs as shortcuts for PPs headed by a static preposition and PPs headed by a dynamic preposition, respectively.
2.5 More about $V_{\text{MOM}}$-static PP complexes

Let us zoom in on the compositional gap problem. A vexing question regarding motion complexes composed of a MoM verb and a static PP is the following: Where does the goal information come from? At first glance, it comes from neither the verb nor the PP, since when used on their own neither of them express a goal: a sentence like *Bill ran* does not entail any goal and static PPs are used with stative verbs where they express locations (e.g. *Bill stood under the porch*). Ideally, one would actually like to capture these two different uses of static prepositions under a single entry for these prepositions. That is, one would like to avoid positing ambiguous entries for static prepositions. The assumption of ambiguous entries would miss the important generalization that all static prepositions can actually be used to denote goals with motion verbs. Put another way, static PPs appear to be context-sensitive: they denote locations with static verbs and bounded paths with motion verbs.

The idea that static PPs are context-sensitive is directly reflected in our analysis. In particular, we assume that static PPs, whose primary meaning is taken to be a location or place can be type-coerced into a path. This coercion, we assume, is triggered by motion verbs. We assume that all motion verbs (including MoM verbs) actually select for a path argument. Since they require a path argument, they will be able enforce this type onto their complement PP.

The conceivable alternatives to a coercion account face problems, as we discuss in the following. One class of accounts (e.g. Fong & Poulin 1998) posits that MoM verbs are ambiguous between a manner-of-motion sense (the verb is intransitive) and a directed motion sense (the verb selects a location PP). We consider this approach to be problematic for a number of reasons. First, it is not clear what would motivate a lexical distinction of two senses of, say, *walk*. Second, since this account assumes distinct verbs it would most probably rule out coordination and gapping examples like the following:

(13) a. Bill runs to work on Mondays and at the track on Wednesdays.
   b. Bill runs to work, and Sally, at the track.

Finally, this account presumably has to posit a third entry for MOM verbs, since most of these verbs can also take path-denoting nominal complements instead of a PP:6

(14) a. Sally walked the Barton Creek trail. [adapted from Tenny (1994)]
   b. Bill canoed the Colorado River.

Another alternative to the coercion account is to assume that static PPs are always ambiguous between a location and a goal. This option is proposed by Folli (2001), following an earlier proposal by Higginbotham (1995) (see also Jackendoff 1983, 1990). Under this kind of account, a preposition like for instance *in* is in effect ambiguous between an in sense and an into sense. But this account faces problems too. First, static PPs are not ambiguous with other types of intransitive verbs like *laugh* or *sing*. That is, *Bill laughed under the bridge* has only one reading; namely, the LMR one. One might of course object to this argument by saying that the GMR is ruled out on pragmatic grounds. But there is still another problem. Namely, there are contexts where *in* cannot substitute for *into*; this should not be the case if *in* has indeed a into sense. Specifically, the substitution is not possible with sound emission verbs like *whistle* and *rumble*. It is well-known that these verbs, like MOM verbs, are able to take up a directed motion reading with certain prepositions like into, as in (15):

(15) The train whistled into the station.

Now, if *in* had indeed an into sense, one would expect that it could also trigger such a reading. But crucially, it does not, as shown below:

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6These examples will not pose any problem for our account, since we simply assume that MoM verbs semantically select for a path argument.
The train whistled \textbf{in} the station. (#GMR/LMR)

This provides a very strong case against a lexical ambiguity account, because it shows that the shift from location to path is conditioned by the type of verb that has been used. Under our coercion account, one can explain these facts by assuming that MoM verbs select for a path argument, while sound emission verbs do not.

The above discussion made it clear that neither the verbal predicate nor the PP is \textit{per se} the locus of ambiguity and expresses the goal information. Rather, it suggests that the GMR only arises through the interaction of the verb and PP semantics. How does one capture this without positing \textit{ad hoc} constructions? One way is to assume that: (i) MoM verbs always have an extra argument of type \textit{path} (i.e., a MoM verb is a function from paths to sets of events), and (ii) static PPs, which normally denote locations (or \textit{places}), are type-shifted into \textit{paths}. More precisely, we assume that, since they require a \textit{path} argument, MoM verbs are able force (i.e., to \textit{coerce}, see Pustejovsky 1995: 111) this type onto their complement PP.\footnote{See Goldberg (1995: 159) for a point along these lines.}

This explanation seems appealing for a number of reasons. For one thing, one does not need to posit ambiguity, neither in the verb nor in the preposition; and one does not need constructions either. Second, this explanation captures the intuition one has that static PPs are context-sensitive: they denote \textit{locations} in the context of static verbs, but \textit{paths} in the context of motion verbs. Furthermore, notice that there is a very close semantic relationship between the two types, one akin to meronymy. That is, a static PP denoting a location \(l\) cannot be coerced into just any kind of path, but is specifically coerced into bounded path whose endpoint is \textit{that} location \(l\).

2.6 Why \textit{path} size matters

In the introduction, we noted that part of the selectional process between the verb and the PP in motion complexes is also aspectual. What do we mean by that? Different types of prepositions seem to impose direct requirements on the Aktionsart of the verb they compose with or, at least, give rise to distinct situation types as a result of their composition with the verbs.

First, let us consider the following example (inspired by Beavers, 2002):

(17) \begin{itemize}
  \item a. *Bill stepped to the office.
  \item b. Bill stepped \textbf{in(to)} the office.
  \item c. Bill stepped \textbf{on(to)} the box.
\end{itemize}

Along with Beavers (2002), we take these examples as evidence that path PPs like \textit{to}-PPs and \textit{\{in/on\}to}-PPs impose sortal aspectual restrictions on their verbs.\footnote{The analysis here suggests that PPs are reified as paths (i.e., they are not treated as predicative); our HPSG analysis in section 3 will treat the PPs as predicative while maintaining the type-coercion account.} However, we differ from his account in a substantial way.

Before pursuing that, note that the examples above cast doubt on any theory of prepositions that derives the meaning of \textit{into} and \textit{onto} as \textit{to-in} and \textit{to-on}, an idea found in Gruber 1965 and more recently in Jackendoff 1983, 1990. This kind of account has no explanation for why \textit{step-to} is out, while \textit{step-\{in/on\}to} are good, and one therefore has to either posit an idiosyncrasy or provide a pragmatic explanation. The latter is undesirable, however, since there is nothing pragmatically awkward in “stepping to an office”: it is pragmatically fine to be \textit{at the office} as a result of taking a step.

\footnote{Note that Beavers’ account is primarily concerned with resultative PPs, i.e. metaphorical uses of the PPs; his account does not say anything about static PPs. Related ideas about AP resultatives have been proposed by Wechsler (2001).}
The main difference between Beavers’ account and ours is the following. According to Beavers (2002), only to-PPs impose sortal restrictions on verbs: they require their verb to be durative (cf. Smith 1991). Into-PPs, on the other hand, put no restriction on their verbs. This account is incomplete, in that it fails to capture the fact that, although into- and onto-PPs allow all Aktionsarten, they give rise compositionally to achievements (i.e. punctual telic situation types) and not to accomplishments (i.e. durative telic situation types) as has often been assumed from Dowty 1979 onward. This is supported by all the classical aspectual tests, including Dowty’s (1979) perfective-to-progressive entailment test (Denis to appear). According to this test, accomplishments but not achievements license the entailment of the form VP-ed in an hour \(\models\) VP-ing for that hour. As shown in (18), this test indicates that to-PPs give rise to accomplishment predicates, whereas into-PP give rise to achievement predicates:

(18) a. Bill ran to the library in an hour \(\models\) Bill ran to the library during that hour  
b. Bill ran into the office in an hour \(\not\models\) Bill ran into the office during that hour

As noted in Denis (to appear), the same situation holds for static PPs; that is, they also give rise to achievement predicates:

(19) Bill ran in the office/under the bridge/behind the house…in an hour \(\not\models\) Bill was running in the office/under the bridge/behind the house…during that hour

The generalization that emerges from these observations can be summarized as follows:

(20) While motion complexes constructed with to-PPs give rise to accomplishment predicates, those constructed with into-PPs and static PPs (e.g., under, in, out of) give rise to achievement predicates.

The way our account proposes to capture this generalization is by assuming that the difference between accomplishments and achievements (i.e. durativity vs. punctuality) can be determined in terms of the internal structure of the path complement. Roughly put, we argue in the present context that an accomplishment predicate consists of a movement along a ‘long’ path (i.e., what we dub an extended path), whereas an achievement is a movement along a ‘short’ (or minimal) path. That is, we propose to enrich the ontology of paths (e.g. Jackendoff 1983, 1990), which as it stands only recognizes one type of bounded endpoint paths, with a further subdivision between minimal (into/onto-PP) and extended paths (to-PP) (see Beavers, 2002 for similar notions and their formal definitions). Informally, a minimal path has a very minimal (i.e., binary) internal structure: it can be thought of as a transition from one location (the set complement of all points denoted by the endpoint location) into another location (the set of points denoted by the endpoint location; cf. Dowty’s BECOME operator). Strictly speaking, a minimal path is a structure that only has two atomic subparts, a source and a goal (see Beavers, 2002). An extended path, on the other hand, has a more complex internal (i.e., it contains at least three subpaths). As for static PPs, we assume that they normally denote locations but can be type-coerced into minimal paths. That is, we argue that the coercion is minimal: from a location to a minimal path that contains it (as its second element).

A final piece of evidence for distinguishing two different types of paths comes from the fact that only extended to-PPs can be combined with measure phrases like five miles. This is shown in (21):

(21) a. Newman ran five miles to the post-office.
    b. *Newman ran five miles in(to) the post-office.
3 The HPSG account

The HPSG formalization we propose in this section relies on Pollard & Sag (1994), but it adopts a richer notion of semantic content, following work on the interface between syntax and lexical semantics by Wechsler (1995, 1997) and Davis (2001). An HPSG sort inheritance hierarchy is used to model the specialization relation between the syntactically relevant aspects of semantic relations. This hierarchy is related to another inheritance hierarchy for the lexical items (verbs, prepositions etc.) for a language. To the extent that syntactic subcategorization is semantically determined, the cross-hierarchy relation will be systematic; however, the general architecture allows for idiosyncrasies as well.

A crucial idea from Wechsler (1995) that we will follow here is that the content specification for verbs and prepositions may be of the same or compatible sorts; hence the composition of a verb and a PP complement can be simply modeled as the unification of their content specifications. According to Wechsler (1995, 1997), (optional) PP complements can be freely appended to the V’s ARG-ST of the verb (as shown in (22)). They are not c-selected (i.e., they are not part of the argument-structure of the verb) but they are s-selected: compatibility of the semantic content representations determines their usability.

(22) Schematic verbal entry with optional PPs added (note the Kleene star)

\[
\begin{array}{c}
\text{ARG-ST} \\
\text{CONT}
\end{array}
\oplus
\begin{array}{c}
\text{PP} \\
\text{PP}^*
\end{array}
\]

We argue that this analysis can be extended to the seemingly problematic case of static PPs, which can be used with either stative verbs or dynamic verbs ((23) and (24))—without having to postulate a disjunctive lexicon entry for the preposition.

(23) Bill was in (the office).

(24) Bill ran in (the office).

The crucial assumption for our account is that these “static” prepositions are compatible with either verb semantics—despite the aspectual difference. This is achieved by assuming (i) a generalized, underspecified representation for the prepositions and (ii) an account for V-PP combination based on a variant of the standard multiple-inheritance-based unification operation, which we call “Nested Structure Merging”.

3.1 Type hierarchies

For the representation of semantic relations denoted by verbs and prepositions, we use a slightly enriched version of Davis’ (2001) lexical decomposition theory. Davis’ framework is inspired by Jackendoff’s conceptual structure and uses proto-role attributes like ACTor and UNDdgoer. Davis proposes to represent both motion verbs and dynamic prepositions as motion relations; that is, they are of sort motion_rel. In their type declaration, motion_rels have an ACTor attribute, an UNDdgoer attribute, and a GRound attribute.

For stative and positional verbs like be and stay, we assume a sort of location relations: loc_rel, with attributes UND and GRND. The GRND value for a loc_rel differs from the GRND value of a motion_rel: in the former case, we have a place, in the latter it is a path. We assume that both are subsorts of a more abstract spatial_matrix sort. To capture the commonalities between the two types of spatial relation, we introduce a common super-sort spatial_rel. This leads to the following specification of the inheritance hierarchy:
That is, motion relations like `run_rel` and `dance_rel` have three proto-role attributes: an `ACTor` and an `UNDergoer` (whose values are token-identical, reflecting the fact that these are self-motion relations) and a `GRND` (whose value has to be of type `path`). On the other hand, location relations like `be_rel` or `stay_rel` have two proto-roles: an `UND` and a `GRND`. The value for the latter is now of type `place`.

The `CONTENT` value of spatial prepositions will generally be a structure of sort `spatial_rel` or one of its subsorts too, which makes the unification account of V-PP complexes possible. For a more fine-grained distinction of preposition types (and verb types) we introduce further sub-distinctions for the two subsorts of `spatial_matrix`. Following Jackendoff’s (1990) typology of paths, one can recognize three different kinds of paths: (i) `SOURCE` paths (e.g., `from the library`), (ii) `VIA` paths (e.g., `through the room`), and (iii) `ENDPT` paths. In Jackendoff’s theory, these different paths are conceptual constructs. Here, they are semantic objects which we can arrange in a type-hierarchy:

```
path
  ↓  
source_path  via_path
  ↓  
endpt_path
    ↓  
min_path  ext_path
    ↓  VIA  linear_obj
```

Notice that the original ontology of paths proposed by Jackendoff has here been enriched. As discussed in sec. 2.6, we propose to refine this ontology by having two distinct `ENDPT` paths, a minimal `ENDPT` path and an extended path. These two new kinds of paths correspond to the new sub-types `min_path` and `ext_path` in the hierarchy above.

Following Jackendoff (1990) again, one can recognize different types of `place` (functions); these are partially summarized in the following hierarchy (see also Verspoor, 1997):

```
place
  ↓  
at_place  in_place  under_place
    ↓  AT  IN  UNDER
```

```
3.2 Basic lexical entries

The following is an abbreviated lexical entry for the static preposition *in*:

\[(25) \begin{align*}
\text{ARG-ST} & \left< \text{NP} \right. \text{NP} \right> \\
\text{CONT} & \left[ \begin{array}{c}
\text{UND} \text{\_spatial\_rel} \\
\text{GRND} \text{\_place\_in}\text{\_nom\_ref}\end{array} \right]
\end{align*} \]

This entry reflects two important assumptions. First, static prepositions are assumed to be *predicative*, that is, they have a subject argument, corresponding to the first item in the ARG-ST list. See Wechsler (1997) for evidence for this assumption, from anaphoric binding. Second, these prepositions denote a *spatial_rel* with a GROUND attribute of sort *place* (or *place* in this particular case). The canonical realization of this spatial relation is a (static) *loc_rel*. This accounts for the semantic compatibility of static PPs with static verbs like *be* or *stay* (as in *Bill was/stayed under the bridge*), based on the unification in (22).

The lexicon entry for the dynamic preposition *to* is specified as follows:

\[(26) \begin{align*}
\text{ARG-ST} & \left< \text{NP} \right. \text{NP} \right> \\
\text{CONT} & \left[ \begin{array}{c}
\text{UND} \text{\_mot\_rel} \\
\text{GRND} \text{\_ext\_path} \text{\_at\_place}\end{array} \right]
\end{align*} \]

In contrast to static prepositions whose CONTENT structure includes a *place*-valued GRND attribute, dynamic prepositions have a CONTENT value of sort *mot\_rel*. This means that its GRND attribute will generally be of sort *path*, which makes dynamic prepositions semantically compatible with motion verbs (i.e., their CONT values can be unified). MoM verbs like *run* have lexical entries like the following:

\[(27) \begin{align*}
\text{ARG-ST} & \left< \text{NP} \right. \right> \\
\text{CONT} & \left[ \begin{array}{c}
\text{ACT} \text{\_run\_rel} \\
\text{UND} \text{\_path}\end{array} \right]
\end{align*} \]

That is, MoM verbs c-select for a unique subject argument (\(\square\)), but they s-select for an additional *path* argument.

Notice that in (26) the second argument of *to* is of sort *ext\_path*, i.e. a subtype of *endpt\_path*. That is, *to* contrasts with *into*, whose second argument is a *min\_path*:\n
\[(28) \begin{align*}
\text{ARG-ST} & \left< \text{NP} \right. \text{NP} \right> \\
\text{CONT} & \left[ \begin{array}{c}
\text{UND} \text{\_mot\_rel} \\
\text{GRND} \text{\_min\_path} \text{\_in\_place}\end{array} \right]
\end{align*} \]

---

10 The elements of the ARG-ST list are mapped to the VALENCE list, which takes care of their syntactic realization, by linking principles (cf. Davis 2001).

11 Note that by contrast with Jackendoff (1983, 1990), the relation expressed by *into* is here not strictly speaking the result of embedding the place function *in* under the path function *to* (compare our discussion in sec. 2.5).
Under the assumption that a punctual verb like \textit{step} contains a lexical specification of its path as a \textit{min\_path}, the contrast of (17a) vs. (17b/c) can be derived as a consequence of the sort compatibility of (26) vs. (28). A verb like \textit{run} will be compatible with either of the two prepositions.

However, if \textit{run} is modified by an additional PP like \textit{for five miles} (as in (21a,b)), the contribution of the verb and both prepositions are unified (following (22)). A durative PP will only be compatible with a \textit{ext\_path} \textit{GRND} as provided by \textit{to}, so *Newman ran five miles into the post-office is excluded.

### 3.3 Nested Structure Merging

What happens when we try to combine a “static” PP (with a \textit{GRND} value of type \textit{place}) and a dynamic verb (with a \textit{GRND} value of type \textit{path})? In other words, how is an example like \textit{Bill ran in the office} (compare (11)) treated? An identification of the content values leads to a sort clash.

For the goal motion reading we can observe type coercion: although \textit{in} does not specify a path relation itself, its place relation can be used to specialize the endpoint of a path representation contributed by another element in the clause, specifically the verb.

Technically we can account for this as follows: Recall that we assumed that MoM verbs introduce a \textit{GRND} attribute with a \textit{path} value. Since the \textit{endpt\_path} introduces a \textit{ENDPT} attribute with a value of type \textit{place}, the \textit{in\_place} relation of the “static” preposition \textit{in} can be merged at this deeper level of embedding.

The flexibility in the nested-structure level of merging the two relations can be captured by assuming that the relation underlying the combination of the verb and PP semantics in (22) is not token identity (or “unification” as it is common to say, using a procedural metaphor), but the following more general merging relation:

\begin{equation}
\text{(29) Nested Structure Merging}
\end{equation}

\[
A \sqcup_{\text{NSM}} B \text{ denotes a feature structure } \alpha \text{ if }
\begin{cases}
\text{a. there is an attribute-path extension } B' \text{ of the attribute-value matrix (AVM) } B, \text{ such that } \\
A \sqcup B' \text{ denotes } \alpha, \text{ or } \\
\text{b. there is an attribute-path extension } A' \text{ of } A, \text{ such that } A' \sqcup B \text{ denotes } \alpha.
\end{cases}
\]

\begin{equation}
\text{(30) Attribute-path extension (recursive definition)}
\end{equation}

\[
\begin{cases}
\text{a. Any standard AVM counts as an attribute-path extension of itself; } \\
\text{b. } [\text{ATTR}_j \ X]_{\text{sort}_i} \\
\text{is an attribute-path extension of an AVM } X, \text{ where } \text{ATTR}_j \text{ is appropriate for sort } \text{sort}_i, \text{ and } \\
X \text{ is of the right sort for } \text{ATTR}_j; \\
\text{c. for an attribute-value matrix } [\text{ATTR}_1 \ X_1]_{\text{sort}_i}, \text{ the matrix } [\text{ATTR}_1 \ X'_1]_{\text{sort}_i} \text{ is an } \\
[\text{ATTR}_2 \ X_2]_{\text{sort}_i} \ldots [\text{ATTR}_n \ X_n]_{\text{sort}_i} \\
\text{attribute-path extension iff } X'_1 \ldots X'_n \text{ are attribute-path extensions of } X_1 \ldots X_n.
\end{cases}
\]

Nested Structure Merging (NSM) essentially allows for the addition of additional attributes to make the paths in an attribute-value matrix longer. Note that it does not allow for any other way of adding information. Conceptually, the NSM is related to functional-uncertainty paths from LFG (Kaplan & Zaenen 1989). The operation may appear very powerful at first blush, but there are strong restrictions: Since standard identity is applied on the result of attribute-path extension, only structures that satisfy the
appropriateness conditions of the sort definitions will be allowed. Multiple solutions will be possible only in the special situation where a sort embeds a value of a type compatible with itself under a attribute path. Furthermore, the operation is applied on lexically grounded semantic representations, which restrict the possibility of attribute addition to the semantic type coercion phenomena we are interested in.

The application of NSM in the CONT specification of a verb with optional PP complements (22) can be schematically depicted as: \( \text{[ } \text{verb-semantics} \cup_{NSM} \text{ [ PP}_1\text{-semantics] } \cup_{NSM} \text{ [ PP}_2\text{-semantics] } \cup_{NSM} \ldots \cup_{NSM} \text{ [ PP}_n\text{-semantics] } \text{] } \). So, for (11)—*Bill ran in the post-office*—the CONT values of (25) and (27) are combined by the NSM operation. At the outermost attribute structure, they are compatible, but the values of GRND are of sorts *place vs. path*. But of the substructure \( place[\text{IN } \# nom\_ref] \) in (25) is expanded to \( path[\text{ENDPT place[IN } \# nom\_ref]] \), an identification is possible. Hence, the same analysis as for an into-PP emerges.

There is additional empirical evidence for positing an operation like NSM, that comes from causative motion constructions, like *Bill jumped the horse over the fence*. As noted by Davis (2001), this use of the MoM verb is problematic for the CONT-sharing view of V-PP constructions because it supposes that we also have a ‘causative’ preposition. Given that the CONT of the causative verb has a CAUSE operator embedding the motion relation, one also needs an entry of the preposition that has the relation denoted by the preposition embedded inside a CAUSE operator. Our NSM suppresses the need for this rather *ad hoc* solution (i.e., having an extra causative preposition); the feature structure for the preposition can simply be ‘extended’ to fit the verb’s CONT.

### 3.4 “Lazy” Nested Structure Merging

The version of NSM in (29) will not exclude ungrammatical examples of “filling compositional gaps” like the goal motion reading of (16) *The train whistled in the station* (assuming that the GRND attribute introduced by an in-PP is generally compatible with verb relations like the whistle relation). It seems to be possible however to derive this fact if we assume NSM to be constrained by a notion of economy, or “laziness”. We can define an operation \( \cup_{LNSM} \), based on \( \cup_{NSM} \). When there are several solutions to \( A \cup_{NSM} B \), only the one(s) that posit the minimal amount of additional structure are included in \( A \cup_{LNSM} B \). The goal motion reading for (16) is excluded—or *blocked*—by the fact that it is “cheaper” to add the static loc_ref version of in to the whistle relation.

The avoidance of unnecessarily complex additions will also predict the path created in the GMR of *Bill ran in the office* is a *minimal path* rather than an *extended path*. This prediction is correct, given that *Bill ran five miles in the office* is infelicitous under the GMR.

The economy-based LNSM operation adds a component of comparison to the HPSG formalism, which makes it possible to derive blocking effects in a very intuitive way. Generally, the notion of comparison bears the danger of introducing an unwanted derivational sensitivity to a declarative framework. However the LNSM operation we propose has a clear declarative definition, and it is applied in a very focused way on semantic representations (rather than interacting freely with the structure sharing in morphosyntax).

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\(^{12}\)One has to be careful not to confuse attribute structure descriptions and the denoted attribute structure objects in the model. The size comparison has to be done on the model objects. Note that this way it is possible to give a declarative definition that avoids dependence on the order of building the structures that are combined by \( \cup_{LNSM} \).
References


