On the polysemy of Italian spatial prepositions

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Abstract

The goal of this paper is to offer an account of the polysemy of Italian spatial prepositions (e.g. *a, di fronte*, *verso*). It is shown that the several possible senses of these lexical items can be disambiguated in a phrasal context, a fact crucially hinging on the properties of prepositions as denoting sets of distinct but relations over locations. The account also suggests that an architecture of grammar in which morpho-syntactic structures inform other components of language (here, semantics) such as Distributed Morphology is better suited to handle polysemy data than syntax-free frameworks (e.g. Cognitive Linguistics).

KEYWORDS: prepositions • polysemy • Distributed Morphology • Italian

1. Introduction

Theories of language differ considerably with respect to how they analyse *polysemy*, defined as the property of a lexical item to have several distinct but related senses in a syntactic context (Riemer 2005, 2010: ch. 5). Polysemy, in turn, is conceptually contiguous to *underspecification*, defined as the property of an item also including a general sense in a syntactic context (cf. Pustejovsky 1998; Kearns 2006).[1] Theories differ on how they delimit and account for the patterns corresponding to these properties. Polysemy is often tested via the so-called 'definitional test', which works as follows. If a lexical item α is polysemous, then a set A of senses/glosses will be necessary to account for the meanings attested in a corpus of sentences and the syntactic contexts they offer. Works within Metaphor theory, Corpus Linguistics, Cognitive Linguistics and formal semantics use this test for testing polysemy (respectively Brugmann 1988; Geeraerts 1993; Evans 2009; Pustejovsky 2013).

Polysemy has been studied in lexical categories (nouns, verbs, adjectives), but studies on *Spatial Prepositions* (henceforth SPs) present a still incomplete picture. The status of this category as a lexical or functional category is controversial (cf. Svenonius 2010: 169-170). However, the polysemy of SPs is cross-linguistically well-attested (cf. English: Brugmann 1988; Dutch: Zwarts 2004; French: Vandeloise 2010). Interestingly, the polysemy of *Italian* SPs (henceforth ISPs) is still understudied, except for a few works based on the definitional test (e.g. Luraghi 2009, 2011). However, a problem with the definitional test is that it can be used to test both polysemy and underspecification, since it only individuates distinct senses. The existence of a general sense is not easily detected, and may be erroneously included among those detected via this test (Kearns 2006: 561-562).

A set of related tests generally falling under the 'logical test' rubric provide more accurate evidence for polysemy. In this paper, we concentrate on one sub-type known as the so-called 'coordination test'. When a lexical item is part of a coordinated phrase and it can receive two distinct senses, one for each conjunct, then it is polysemous. For instance, *play the piano and football* involves the polysemy of the verb *play* denoting two distinct types of actions (Kearns 2006: 562-563). Similarly, *playing darts but not playing Hamlet* involves two tokens of *play* with two distinct senses. Crucially, the two readings need to be zeugmatic: no general or single reading can be assigned to the lexical item, lest the sentence be uninterpretable. Since *play* is arguably associated to two distinct, non-overlapping senses when combining with each argument, it is polysemous in these syntactic contexts.

In order to explain how this and the definitional test apply to ISPs, consider (1)–(3):

[1]Vagueness is a semantic dimension orthogonal to polysemy and underspecification (cf. Kearns 2006: 561; Kennedy 2007), defined when a lexical item denotes a context-sensitive property (e.g. the adjective *expensive*). We do not discuss its role for ISPs for reasons of space. See Zwarts & Winter (2000: 174) for discussion on SPs and vagueness, and see Ursini & Giannella (2016) for a more through discussion on these notions.

(1) *Marco* *si* *siede/va* *a-l* *tavolo*
Marco SELF sits/goes A-the/to-the table
'Marco sits at the table'

(2) *Marco* *si* *siede* *di* *fronte* *a-l* *tavolo*
Marco SELF sits DI front A-the table
'Marco sits in front of the table'

(3) *I* *bambini* *vanno* *a-llo* *spiazzo* *ed* *a-l* *rifugio*
The children go A-the esplanade and A-the refuge
'The children go to the esplanade and into the refuge'

Before we discuss the examples, we make precise three notions. First, the complement DP[2] of an ISP denotes the landmark object or *ground* of the spatial relation that the ISP denotes. The DP denoting the located entity is known as the *figure*, instead (Talmy 2000: ch. 1). Second, we define a *reading* as the compositional sense of a phrase, after it combines with its arguments (Evans 2009; Ursini 2015b, 2016). SPs have senses, SPPs have readings. Third, we gloss each polysemous ISP by using capital letters (e.g. 'A' for *a*) for its (alleged) multiple senses.[3]

Consider now (1). The ISP *a* can combine with either a *locative* verb (*siede* 'sits'), denoting the location of a non-moving figure, or with *directional va* 'goes'. Locative/static verbs select a locative reading in the ISPP they combine with, while directional/dynamic verbs select a directional reading (Zwarts 2005). Thus, *siede* selects the locative sense of *a*; *va* 'goes' its directional sense. The same holds for *di fronte a* in (2). The status of ISPs as being 'ambiguous' with respect to this alternation is well-known, as Italian has been suggested to be a 'verb-framed' language (cf. Talmy 2000: ch. 4; Folli 2002). Even if based on the definitional test, these examples show that distinct ISPs (*a*, *di fronte a*) involve one pattern of polysemy. A general sense for 'direction' and 'motion', given their antonym-like nature, cannot be defined, so underspecification is ruled out.

Consider now (3). The two coordinated ISPPs, *allo spiazzo* and *al rifugio*, seem to have two partially distinct senses. The sentence describes a scenario in which some children reach an esplanade near a (mountain) refuge. They go inside the refuge, and outside the esplanade, since the esplanade (i.e. an open, unbounded place) cannot act as a location 'including' the children Thus, *a* in (3) has two partially distinct senses, one for each conjunct. Since *a* cannot have a general sense including internal and external locations, it displays a second, 'spatial' layer of polysemy.

A *precis* on our use of this test is necessary, before we continue. The coordination test applies to heads that can also take conjoined arguments. One example would be *I bambini siedono ai tavoli e banconi* 'the children sit at the tables and bars'. However, some works on polysemy consider the use of structures such as (3), involving two tokens of the same item, not to be crucial proof for polysemy. This is the case, since the two distinct senses do not surface within the span of a single phrase, in this case a single ISPP (cf. Riemer 2010: ch. 5 for discussion). However, this and other related works do not study the syntactic structures involved in polysemy patterns, nor they assess the relation between polysemy and underspecification. Thus, the status of SPs as polysemous lexical items is still debatable, with ISPs providing a particularly neglected set of data, as (1)–(3) show.

The goal of this paper is to solve this problem by offering a syntactic analysis of ISP(P)s in coordinated phrases, thus capturing the scope and coordination of their distinct readings. The paper is thus organized as follows. Section 2 offers a broader overview of the data and previous accounts. Section 3 offers a syntactic analysis based on a Distributed Morphology architecture, and a Type-Logical Syntax derivational account. Section 4 offers a semantic analysis based on Situation Semantics with a rich type system (Kratzer 2007; Asher 2011). Section 5 concludes.

[2] We use the label 'DP' for mere expository reasons, since our examples include ground NPs.
[3] Note that *a* also fuses with the definite article *il* to form the *preposizione articolata al* (Rizzi 1988: 496–497)

2. The Data

2.1 The Data: an Overview of the Polysemy of ISPs

ISPs can be divided into *simple* and *complex* ISPs. Simple ISPs or *preposizioni primarie* 'primary prepositions' are usually described as mono-morphemic syntactic heads that must take a complement DP to form an ISPP (Rizzi 1988: 498). Complex ISPs or *preposizioni avverbiali* 'adverbial prepositions' (Rizzi 1988: 498) involve the combination of two or more morphemes into a single lexical unit, and can undergo ellipsis of the complement DP (*argument demotion*: Merchant 2001: ch. 2). Simple ISPs can be part of complex ISPs (e.g. *a* in (2)). They also include 'Axial' nouns in a prepositional context, labelled *Axpart Ps* (e.g. *fronte* in (2): Pantcheva 2008). Simple ISPs, either as heads or 'segments' of complex ISPs, conflate with the definite article of a ground DP when present, except for *tra/fra* and *per*.[4] Consider (4) – (6):

(4) *Mario* *è* *a-l* *bancone*
Mario is A-the counter
'Mario is at the counter'

(5) **Mario* *è* *a(-l* *bancone)*
Mario is A(-the counter)
'Mario is at the counter'

(6) *Luigi va di fronte al bancone. Mario va dietro (al bancone)*
Luigi goes of front A-the counter. Mario goes behind (A-the counter)
'Luigi is in front of the counter. Mario is behind'

(4) – (5) show that simple ISPs require a ground DP, otherwise a sentence is ungrammatical. Complex ISPs, though, undergo demotion, viz. (6). The 'rightward' simple ISP is elided with the ground DP, leaving an Axpart P and the 'leftward' simple ISP to form an elided ISPP.

A list of simple and complex ISPs is offered in (7)–(8), respectively:

(7) **Simple ISPs=** {*a* 'at/to', *da* 'from', *di* 'of', *in* 'in/into', *per* 'through, within', *tra/fra* 'between', *su* 'on/to'}

(8) **Complex ISPs=** {*accanto* 'beside', *davanti* 'ahead of', *attraverso* 'through', *dentro* 'inside', *dietro* 'behind', *verso* 'towards', *di fronte a* 'in front of', *a destra di* 'to he right of', *sopra (a)* 'above', *in cima a* 'on top of', *nel mezzo di* 'in the middle of'…}

The list in (7) does not include lexical items *su* and *giú* (*contra* Rizzi 1988). This is the case, as these ISPs seem to have a distribution closer to particles (e.g. *up*, *down* in English, cf. Svenonius 2010), since they be part of phraseological verbs. Evidence for this fact is that they can undergo ellipsis (e.g. *Mario mette giú (la racchetta)* 'Mario puts down the racket'). Furthermore, the list in (8) does not include all the lexical items that belong to this category. The list includes complex ISPs that must distribute with *a* as its rightward simple ISP (*accanto*, *davanti*), but also ISPs that can optionally do so (e.g. *attraverso (a)*, *dentro (di), dietro (a)*). The list includes *verso*, which cannot combine with simple ISPs, and 'multi-morphemic' ISPs, which can include distinct pairs of simple ISPs within their structure (e.g. *di* and a in *di fronte a*, *nel* and *di* in *nel mezzo di*).

[4] In these syntactic contexts, *Raddoppiamento Sintattico* 'syntactic doubling' occurs, since the consonant of the right-branching constituent is lengthened (Napoli & Nevins 1987; Rizzi 1988: 497–498). Although this phenomenon suggests that P and D heads form a single unit, its role in our discussion is not crucial. See Ursini (2015a) for discussion.

At first glance, this may appear a heterogeneous set. However, the unifying trait is that these complex ISP sub-types do combine with simple ISPs when the ground DP is a pronoun (e.g. *Mario va verso di lui* 'Mario goes towards him'). This fact suggests that complex ISPs may involve silent exponents in their structure when they occur in certain syntactic contexts, as discussed in Ursini (2015a). Therefore, and for the treatment of polysemy we offer in this chapter, these three sub-types can receive the same underlying morpho-syntactic analysis.

Let us now discuss the semantics of this category. Simple ISPs involve two polysemy patterns, as suggested in the introduction. The first pattern involves the locative/directional alternation (Rizzi 1988; Folli 2002; Ursini 2015a). The second pattern involves their ability to denote distinct but related locations, and is mostly unexplored, with the notable exception of Luraghi's (2009, 2011) analysis of *da*. The polysemy of ISPs can be discussed by focusing on simple ISPs, since complex ISPs 'inherit' their polysemy from simple ISPs, as it will become clear via our discussion. Since (1)–(3) offer evidence regarding the polysemy of *a*, we begin our discussion from the second ISP in the list in (7), *da*.

As Luraghi (2009, 2011) suggests, *da* in its spatial interpretations can describe relations involving the origin of a static or moving figure. If the ground DP denotes an object conceived as having an internal part, then *da* can also cover the sense of English 'out of'. However, when *da* takes a ground DP denoting an animate referent, it can also denote the goal or position of a figure. These patterns are shown in (9)–(12):

(9) *Mario* *arriva* *da* *Roma/* *da-lla* *caverna*
Mario arrives DA Rome/ DA-the cavern
'Mario arrives from Rome/gets out of the cavern'

(10) *I* *bambini* *arrivano* *da-lla* *grotta* *e* *da-lla* *spiaggia*
The children arrive DA-the cave and DA-the beach
'The children arrive from the cave and from the beach'

(11) *Mario* *è/va* *da* *Luigi*
Mario is/goes DA Luigi
'Mario is at/goes to Luigi'

(12) #*Mario* *va* *da* *Luigi* *e* *da* *Roma*
Mario goes DA Luigi and DA Rome
'Mario goes to Luigi and from Rome'

The ground DP alternation in (9) shows that the sense of *da* can include movement from an internal location (i.e. the 'inside' of a cave), especially with verbs such as *uscire* 'exit'. This holds in (10) as well: the children can be described as getting out of the cave and coming from the beach. In (11), we understand that Mario goes to Luigi, or rather Luigi's location. When the ground DP denotes an 'animate location', the 'goal' sense translated via English 'to' is accessed. These opposite senses can be combined into a more general sense, as (12) shows ('#' stands for uninterpretability). Mario cannot be understood to move 'to' Luigi and 'away from' Rome. Overall, *da* features both layers of polysemy, as (9)–(12) show.

Consider now *di*: as a segment in complex ISPs, it can convey spatial relations, determined by the Axpart P that distributes with this head. Furthermore, *di* can distribute with a DP, and without an Axpart P, when the ground DP is an indexical, viz. (13)–(16):

(13) *Mario* *è/va* *di* *fronte* *a-lla* *macchina*
Mario is/goes DI front A-the car
'Mario is/goes in front of the car'

(14) *Marco* *si* *siede/va* *a* *destra* *de-l* *tavolo*
Marco SELF sits/goes A right DI-the table
'Marco sits to the right of the table'

(15) *I bambini* *siedono* *di* *fronte* *a-l* *tavolo* *ed* *a* *destra*
The children sit DI front A-the table and A right
de-l *divano*
DI-the sofa
'The children sit in front of the table and to the right of the sofa

(16) *Mario* *è/passa* *di* *qui*
Mario is/passes DI here
'Mario is from/passes through here'

(13)–(14) show that *di* can head complex ISPs denoting distinct spatial relations (e.g. a figure in front or to the right of the ground). Either a locative or directional reading can emerge, depending on the verb they combine with (e.g. *va* 'goes' vs. *siede* 'sits'). Coordinated phrases can include distinct complex ISP(P)s that conjoin these relations, as *di fronte al tavolo ed a destra del divano* in (15) shows. If *di* distributes with indexical *qui* 'here', as in (16), then two distinct senses are accessible, based on the verb it combines with. With locative verbs, (e.g. *è* 'is') the origin sense is accessed. With directional verbs (e.g. *passa* 'passes') a sense akin to English 'through' is instead accessed. Thus, (13)–(16) confirm that *di* is polysemous.

We move to *in*. First this ISP can alternate between a directional and a locative sense. Second, it can be used to convey inclusion relations, but also part-of relations between cities and countries' locations (cf. Rizzi 1988: 523–524). Third, *in* can be part of complex ISPs, one example being *in cima a* 'on top of' and *nel mezzo di* 'in the middle of'. In these cases, it can be said that *in* contributes different senses from inclusion, to the respective complex ISPs. These three properties are illustrated in (17)–(19), respectively:

(17) a. *I bambini* *dormono/vanno* *ne-lla* *caverna*
The children sleep/go IN-the cave
b. 'The children sleep in/go into-the cave'
c. 'The children sleep inside/go inside-the cave'

(18) *Roma* *è* *in* *Italia*
Rome is IN Italy
'Rome is in Italy'

(19) *I bambini* *siedono* *in* *cima* *a-lla* *collina* *e* *ne-l* *mezzo*
The children sit IN top A-the hill and IN-the middle
de-l *parco*
DI-the park
'The children sit on top of the hill and in the middle of the park'

Note that the second, spatial polysemy pattern is also attested for *in* as simple ISP, viz. (17b–c). The children may go into the cave, conceived as a single location, or they may go in one part of the cave. Overall, *in* also displays the locative/directional alternation and a wealth of other related senses also in coordinated phrases, *qua* a genuinely polysemous ISP.

The next ISP is *per*, which can be glossed as 'through', since it captures a directional sense involving a figure traversing a ground, or moving within its 'internal' space. Differently from the other simple ISPs, its locative sense is limited in distribution, and involves figures distributed 'along' one or more grounds. These patterns are shown in (20)–(22):

(20) *Le macchine* *passano* *per* *la vallata*
The car pass PER the valley
'The cars pass through the valley'

(21) *I turisti* *passeggiano* *per* *la città*
The tourists stroll PER the city
'The tourists stroll through the city'

(22) *Le macchine* *sono parcheggiate* *per* *la strada*
The cars are parked PER the street
'The cars are parked along the street'

Thus, *per* involves a weak form of polysemy, since only the directional/locative alternation, or first layer of polysemy, can be attested.

Consider now the two allomorphs *tra/fra*, which can be glossed as 'between', 'across', 'among/between' or 'within'. For simplicity, we only use *fra* in our examples in (23)–(25):

(23) *Mario* *si* *siede/cammina* *fra* *i* *due gruppi* *di* *persone*
Mario SELF sits/walks FRA the two groups DI people
'Mario sits/walks between the two groups of people'

(24) *Mario* *cammina* *fra* *i campi*
Mario walks FRA the fields
'Mario walks across the fields'

(25) *Mario* *cammina* *fra* *i campi* *e* *fra* *le macchine*
Mario walks FRA the fields and FRA the cars
'Mario walks across the fields and amongst the cars'

In (23), *fra/tra* can be interpreted as denoting Mario's position or trajectory between two distinct groups of people. In (24), his trajectory involves crossing certain fields, hence covering a different type of trajectory than the one described in (25). As these examples show, then, *tra/fra* is polysemous, since it can denote distinct but related 'shapes' of locations or trajectories that a figure can occupy, with respect to a ground.[5]

We move to *su*, the last simple ISP in (7). *Su* can participate in the directional/locative alternation, and can capture distinct 'vertical' or 'support' senses, overlapping in distribution with *sopra* 'over/above'. Hence, *su* acts as a 'general' vertical term, as shown in (26)–(27):

(26) *Mario* *siede/va* *su-l* *palco*
Mario sits/goes SU-the stage
'Mario sits on/goes onto the stage'

(27) *I bambini* *siedono* *su-l* *palco* *e* *su-lla* *collina*
The children sit SU-the stage and SU-the hill
'The children sit on the stage and on top of the hill'

The polysemy of *su* also confirms that simple ISPs can display the directional/locative alternation *and* several distinct senses associated to each ISP.

[5] Note that *per* and *tra/fra* seem to partially share their directional senses, since they both involve movement of a figure 'traversing' a ground. The role of the ground DPs and their senses plays a role in these patterns, but we lack the space for discussing this pattern in detail.

We can now discuss the polysemy of complex ISPs, although in compact manner. Complex ISPs display the locative/directional alternation, like simple ISPs, and can display a limited form of 'spatial' polysemy. Complex ISPs usually involve an Axpart P, and include an underlying direction or 'axis' in their sense, specified with a so-called 'reference system' (Zwarts & Winter 2000; Svenonius 2010: 172–174). We make these notions precise via (28):

(28) *I bambini* *vanno* *a* *destra* *de-lle* *macchine* *e*
The children go A right DI-the cars and
a *destra* *de-i* *trattori*
A right DI-the tractors
'The children go in front of the cars and to the right of the tractors'

In (28), *a destra delle macchine* and *a destra dei trattori* can have two distinct senses. To see why this is the case, consider a situation in which cars and tractors are oriented with opposing engines. If the children are located to the right of the cars, then they can be to the left of the tractors. However, this would count as 'right' to an observer (respectively intrinsic to the ground; relative to the speaker). The reverse configuration can also hold, thereby licensing the co-existence of distinct uses of this complex ISP. At the same time, both complex ISPs have a directional reading because of *vanno*'s sense, and include *di* and *a* in symmetric positions ('left' and 'right' of the Axpart P). Simple ISPs as part of complex ISPs seem to also work as lexical items denoting the distinct but related locations partaking in a spatial relation. Overall, the possibility that complex ISPs can also be used to describe locations with respect to distinct reference systems suggests that these ISPs are polysemous.

Let us take stock. ISPs display two polysemy patterns: the locative/directional alternation, and the ability to denote distinct 'types' of locations. Simple ISPs seem richly polysemous, even though the combinations of senses are distinct from one lexical item to another (cf. *in* vs. *tra/fra*). Complex ISPs display a reduced but important spatial polysemy pattern. They must be interpreted with respect to a reference system: relative, intrinsic (and absolute, for ISPs such as *a nord di* 'to the north of'). Note that the emergence of distinct senses, related to zeugmatic readings, is not strictly necessary (cf. (20)–(22), (28)); even as a possibility, though, it confirms the polysemy of ISPs. Also, the morphological and syntactic structures underpinning both types of ISPs seem to play a crucial role in the emergence of polysemy. An open question, then, is whether previous accounts of ISPs can offer a platform on which to build a polysemy account.

2.2 Previous Analyses of ISPs

ISPs have been a neglected category. Recent works (e.g. Tortora 2006; 2008; Folli 2008) have investigated the syntactic structure and aspectual properties of few complex ISPs such as *sotto*. These feature an optional simple *a* (e.g. *sotto* vs. *sotto a*), with *a* claimed to denote 'bounded' locations. This alternation is shown in (29):

(29) *Mario* *è* *sotto* *a-l/il* *bancone*
Mario is below A-the/(P) the counter
'Mario is under the counter'

According to their analysis, the alternation between *sotto al* and *sotto il* can be understood as an alternation between an 'unbounded' relation of vertical subjacency, and a bounded one. While in the first case Mario can be at any point under the counter, in the second case he is at a specific point under the counter.

These facts are accounted for by assuming that ISPs include one position, called ASP(ect), at which (un)boundedness is computed. Overt movement produces the linear order observed in ISPs, viz. (30a–b) (cf. Tortora 2008: 283-284). The analysis proposed in Folli (2008), as shown in (31b), includes the standard heads 'Path' and 'Place' as the two positions that make up an ISP (Jackendoff 1983, 1990;

Kracht 2002). Depending on which lexical item appears (i.e. silent 'P' or *a*), an unbounded or bounded reading emerges. As shown in (31b), Folli (2008) generalises by having a relational head 'R' to take a ground DP as its argument, in turn forming the RP complement of a P (here, *sotto*):

(30) a. $[_{CP}$ (P) $[_{AspP}$ a $[_{FP}$ (P) $[_{Place}$ sotto $[_{DP}$ il bancone]]]]] (before movement)
b. $[_{CP}$ (P) $[_{AspP}[$ sotto $]_j$ a $[_{FP}$ (P) $[_{Place}$ t_j $[_{DP}$ il bancone]]]]] (after movement)

(31) a. $[_{Path}$ sotto $[_{Place}$ (P) $[_{DP}$ il bancone]]]
b. $[_{PP}$ sotto $[_{RP}$ (R) $[_{DP}$ il bancone]]]

As discussed in Ursini (2013, 2014, 2015a, b), these analyses are problematic, if extended to the broader set of data discussed so far. If each simple ISP is an expression of a specific position (e.g. *a* of a Asp head, *di* of a Place head), then two complex ISPs such as *di fronte a* and *a destra di* would present symmetric sequences of heads. A complex analysis involving movement and *ad hoc* stipulations would be necessary. Furthermore, the alternation involving simple ISP *a* covers the *specificity* or uniqueness of a figure's position with respect to the ground. That is, the figure occupies one location defined as *sotto* 'under', which may nevertheless occupy one vaguely defined ('unbounded') space. Lexical aspect is not the semantic dimension at stake, in ISPs.

If syntactic matters seem partly understudied, then the polysemy of ISPs is a particularly neglected topic. For instance, Luraghi (2009, 2011) only discuss the polysemy of *da* and *di*, but only by discussing definitional test-based examples. Syntactic matters, and more accurate diagnostics such as the coordination test, are glossed over. A similar problem arises in Ursini (2015a), which offers a more thorough analysis of the syntax and semantics of ISPs, but explicitly leaves a treatment of their polysemy aside. As matters stand, an account of the polysemy of ISPs is still outstanding. Sections 3–4 then, aim to provide such an account.

3. The Analysis: Syntax

3.1 Syntactic Assumptions

We start by outlining the theoretical framework for our analysis. For the architecture, we choose one variant of the Minimalist program, *Distributed Morphology* (DM, e.g. Halle & Marantz 1993; Harbour 2007; Harley 2012). Other theoretical analyses are certainly possible, but we leave a discussion of this topic aside, for reasons of space. Our choice is based on two of DM's core assumptions, which are germane to our goals. First, one operation, *merge*, recursively combines morphemes and generate larger structures (words, phrases, sentences). Second, the semantic and phonological components cyclically receive the outputs of morphology/syntax, in turn generating semantic (meanings) and phonological (utterances) outputs.

To make derivations formally explicit, we use *Type Logical Syntax* (TLS: Moortgat 2010; Morryll 2011) as a formal apparatus. In TLS, the merge of lexical items into larger units is captured by assigning *types* to items, which can either be *incomplete* types (e.g. $s\backslash np$) or *complete* types (e.g. *s*, *np*). Incomplete types must merge with a (matching) *input* type, to form a complete type. For instance, an intransitive verb such as *sleeps* is assigned the type $s\backslash np$. This reads: if *sleeps* merges with an NP (type *np*, e.g. *Harlock*), then a sentence of type *s* is derived. If two lexical items have non-matching types, they cannot be merged. Thus, **runs sleeps* is ungrammatical, as both verbs are assigned type $s\backslash np$, which cannot be merged.

The notion of *merge* is thus made formally precise via the use of the connectives '/' (right division), '•' (product) and '⊢' ('proves'). Division is a *binary*, *associative*, *idempotent* connective, while product is only *binary* and *associative*. Division allows us to capture the fact that some lexical items (e.g. affixes) must combine with other items to form 'complete' items. Instead, product allows us to represent morphemes as the product of more basic morphological features. We then define *merge* as a *ternary* and *associative* operation. Merge takes two lexical units and 'proves' a third syntactic unit (e.g. a phrase), in which

either constituent may determine the type of the larger constituent (associativity). Constituents are merged in a hierarchical ('top-down'), incremental manner: *Harlock* is merged with *sleeps* on its 'right' side.

We now turn our attention to types. Differently from standard TLS approaches (e.g. Moortgat 2010), we do not use 'naïve' types such as *s*, *np* and similar others. DM research on lexical categories has shed light on how categories can be conceived as derived from the combination of more basic features and structural configurations (e.g. Harbour 2007; Acquaviva 2014). Our discussion of ISPs suggests that their structures involving basic features merged recursively. We thus define $\boldsymbol{p}$ as a general type for phrases, whether they be lexical items or complex structures. Types and connectives are defined in (32):

(32) 1. *Given a Lexicon L, $p \in L$ is a morphological type* (Lexical type)
2. *If x is a type and y is a type, then x/y is a type* (Type formation: division)
3. *If x is a type and y is a type, then $x \bullet y$ is a type* (Type formation: product)
4. *If x/y is a type and y is a type, then $(x/y)\bullet y \vdash x$, $y\bullet(x/y) \vdash x$* (Merge: forward application)
5. *Nothing else is a type;* (Closure property)

Given a basic type $\boldsymbol{p}$ (rule 1), complex types can be defined as the division or product of more basic types (rule 2, 3). When two complex types are merged, the result is a type, in which matching information is discarded (rule 4). No other rules are employed (rule 5). These rules allow us to define a minimal type set $TYPE=\{p, p/p, p\bullet p/p/p\bullet p, p\bullet p\}$ for our analysis. For feature sub-types, we use minimalist accounts of features and feature percolation (Adger 2010), representing sub-types as indexes. Therefore, we introduce type $\boldsymbol{p_s}$, with $\boldsymbol{s}$ a spatial feature that can carry a polysemous interpretation.[6] Its precise use will become clear in the next section.

Before we move to the analysis, we introduce an *Index Set I* for the distinct steps in a derivation, with $I=\{t,t+t,t+2,...,t+n\}$. The symbol '+' represents *addition*, an operation that derives progressive intervals of time in sentence production. In each derivation, the operation *Lexical Selection* (LS) represents the selection of a lexical item as an active unit in the derivation, while *Merge Introduction* (MI) represents the merge of two input constituents, and the resulting output constituent.

3.2 The Analysis: Derivations

We begin by outlining the types of structures that we assume for ISPs, ISPPs and sentences, as the output of the derivational rules introduced in the previous section. For reasons of space, we leave aside a discussion on the complex debate regarding the structure of SPs (but see Cinque & Rizzi 2010: ch. 1 for discussion). Here we opt to analyse ISPs according to the 'P-within-P hypothesis' (Hale & Keyser 2002: ch. 3-4). In this account, SPs involve a possibly silent SP head that takes a ground DP as its complement, and another SP as its specifier. This extension of this analysis to simple and complex ISPs is shown in (33a-b):

(33) a. $[_{SPP}[_{SPP}$ a] (P)-la$_{SPP}$ $[_{DP}$ macchina]]
b. $[_{SPP}[_{SPP}$ $[_{SPP}$ di $[_{NP}$ fronte]] a-lla$_{SP}$ $[_{DP}$ macchina]]

The structures in (33) read as follows. First, we do not analyse how the 'SP' and 'D' heads are merged. Second, the SPs *a* in (33a) and *di fronte* in (33b) are treated as specifiers of the head SP, respectively '(P)-la' and *alla*. Second, the 'internal' SPP *di fronte* is formed when the axial noun *fronte* (an NP) is reassigned prepositional status as the complement of the 1-place (I)SP *di* (cf. Pantcheva 2008; for a similar proposal). Note that we consider fused preposition and article, silent or not (e.g. *(P)-la* and *alla*), as forming a single head. Since this account assumes that functional heads can have flexible valence, it in-

[6] Psycholinguistic evidence on sentence production also supports a *merge right* account (Levelt 1989; Phillips 2006), a point that we also take to be in favour of our proposal, though not a crucial one.

directly predicts the structures in (33) as possible structures for ISPs, with ISPs displaying distribution as 0-, 1- or 2-place heads (e.g. *a*, *di*).

This account can also be extended to coordinated SPPs without supplementary assumptions, since *e* 'and' and other Boolean connectives are coordinating prepositions (e.g. Winter 2001; Romeu 2014: ch. 5). Given that Boolean connectives are syncagorematic, the resulting phrases with ISPPs as arguments have the properties of ISPPs, as shown in (34):

(34) $[_{\text{ISPP}}\ [_{\text{ISPP}}$ sul palco] e $_{\text{P}}\ [_{\text{ISPP}}$ sulla collina]]

Crucially, a fuller argument for a 'P-within-P' analysis can be given once demotion data are addressed. Before we do so, however, we must motivate a type assignment for ISPs, which allows us to prove how ISPPs and other structures, as well as the scope of polysemous readings, are derived. Consider the assignment in (35):

(35) a. $\boldsymbol{p_n}$:= {*I bambini, Mario,…*}; $\boldsymbol{p_s}$:= {*a, in, parco, fra, di fronte, al tavolo, nel parco,…*};
b. $p_s/p_n/p_s$:= {(P), *a, di, da, e,…*}; $p/p_s/p_n$:= {*siede, va, è, è andato,…*};

The assignment reads as follows. The type $\boldsymbol{p_n}$ is assigned to figure DPs, *qua* phrases carrying nominal features. Type $\boldsymbol{p_s}$ is assigned to ground DPs, simple ISPs and ISPPs, *qua* phrases carrying spatial features. The asymmetry between figure and ground DP is justified by the fact that ground DPs denote grounds *qua* locations, and in the case of toponyms/place names (e.g. *London*), they explicitly carry these features (Ursini 2016a, b, for details).

The type assignment in (35b) assigns the type $p_s/p_s/p_s$ to ISP heads, including the silent P head, those simple ISPs that can act as heads of complex ISPs (e.g. *a*, *di*), and syncagorematic *e*. The structural relation that connects this assignment for *a* to the one in (35a) can be captured via the *residual rule* (Moortgat 2010 §2.1; Morryll 2011: ch. 2). The residual rule formally represents Hale & Keyser (2002)'s approach to flexible valence. It shows that type polymorphism/valence change patterns are highly constrained. A lexical item carrying certain features (e.g. $p_s \bullet p_n$) can become an affix to phrases carrying these features (e.g. p_s/p_n: we have $p_s \bullet p_s \vdash p_s/p_s$). An affix, in turn, can become a head merging with phrases with given features as its arguments ($p_s \bullet p_s/p_s \vdash p_s/p_s/p_s$). In other words, there is a tight relation between simple ISPs as arguments of silent P heads and simple ISPs as affixes or heads in complex ISPs.

This part of the type assignment also shows that verbs and prepositions differ in the type and order of arguments they take. Verbs such as *siede* 'sits' and *va* 'goes' take a complement of type $\boldsymbol{p_s}$, (i.e. an ISPP). ISPs and conjunction *e* 'and', *qua* spatial prepositions and heads, take a specifier and complement of type $\boldsymbol{p_s}$ instead. Although finer-grained analyses of syncagorematic heads can be offered (viz. Partee & Rooth 1983; Winter 2001), this restricted assignment allows us to straightforwardly account the derivation of our data.

We can now start our analysis by showing how ISPPs are derived. The derivations include *al tavolo* and *di fronte al bancone*, from (1)–(2) and (7) respectively. The definite article is directly merged with each ISP; we defer the reader to (Ursini 2015a), for a simple but long discussion on how to derive *preposizioni articolate*. Consider (36)–(37):

(36) *t.* $[\ a_{ps}]$ (LS)
t+1. $[\ (P)_{ps/ps/ps}]$ (LS)
t+2. $[\ a_{ps}] \bullet [\ (P)\text{-}l_{ps/ps/ps}] \vdash [_{ps/ps}[\ a_{ps}]\ (P)\text{-}l_{ps/ps/ps}]$ (MI)
t+3. $[\ \text{tavolo}_{ps}]$ (LS)
t+4. $[_{ps/pn}[\ a_{ps}]\ (P)\text{-}l_{ps/ps/ps}]] \bullet [\ \text{tavolo}_{pn}] \vdash [_{ps}[\ a_{ps}]\ (P)\text{-}l_{ps/ps/ps}\ [\ \text{tavolo}_{ps}]]$ (MI)

(37) *t.* $[_{ps/pn}$ di] (LS)
t+1. $[_{pn}$ fronte] (LS)
t+2. $[_{ps/pn}$ di $] \bullet [_{pn}$ fronte $] \vdash [_{ps}$ di fronte] (MI)

t+3. [al$_{ps/ps/ps}$] (LS)
t+4. [$_{ps}$ di fronte]•[al$_{ps/p/ps}$]⊢[$_{ps/ps}$[$_{ps}$ di fronte] al$_{ps/ps/ps}$]] (MI)
t+5. [bancone$_{ps}$] (LS)
t+6. [$_{ps/ps}$[$_{ps}$ di fronte] al$_{ps/ps/ps}$]]•[bancone$_{ps}$]⊢[$_{ps}$[$_{ps}$di fronte] al$_{ps/ps/ps}$[$_{ps}$ bancone]] (MI)

In (36), *a* as a specifier ISP merges with a silent head P plus the definite article *–l* (steps *t* to *t+2*), and the result merges with the DP *tavolo* (steps *t+3* to *t+4*). The result is the ISPP *al tavolo*, also of type $\boldsymbol{p_s}$ like *a*. The intuition behind the 'P-within-P' label is now made formally precise, and so is the structural relation between simple and complex ISPs. The type $\boldsymbol{p_s}$ represents the spatial features of ISPs that license a spatial polysemous reading. In (37), a supplementary step involves the derivation of *di fronte* as an Axpart P (cf. Pantcheva 2008; Ursini 2013, 2014). Since *di* can become an affixal element via the residual rule, it can also act as a 'spatial marker'. That is, this simple ISP acts as an affix assigning a new category to *fronte* to form this type of SP (steps *t* to *t+2*).

We now concentrate on ISPPs in coordinated phrases, thus deriving *I bambini vanno allo spiazzo ed al rifugio* 'to the esplanade and into the refuge' from (3) in (38):

(38) *k*. [$_{\boldsymbol{ps}}$ allo spiazzo] (MI)
k+1. [e$_{\boldsymbol{ps/ps/ps}}$] (LS)
k+2. [[$_{\boldsymbol{ps}}$ allo spiazzo]]•[e$_{\boldsymbol{ps/ps/ps}}$]⊢[$_{\boldsymbol{ps/ps}}$[$_{\boldsymbol{ps}}$ allo spiazzo][e$_{\boldsymbol{ps/ps/ps}}$]] (MI)
k+3. [$_{\boldsymbol{ps}}$ al rifugio] (LS)
k+4. [$_{\boldsymbol{ps/ps}}$[$_{\boldsymbol{ps}}$ allo spiazzo][e$_{\boldsymbol{ps/ps/ps}}$]]•[$_{\boldsymbol{ps}}$ al rifugio]⊢[$_{\boldsymbol{ps}}$[$_{\boldsymbol{ps}}$ allo spiazzo] e$_{\boldsymbol{ps/ps/ps}}$[$_{\boldsymbol{ps}}$ al]] (MI)

This derivation has been compressed, since the conjunct ISPPs *allo spiazzo ed al rifugio* are directly merged as typed phrases. The result, nevertheless, is a phrase of type $\boldsymbol{p_s}$, which can then involve the computation of a corresponding spatial, polysemous reading.

We can now offer derivations of full sentences. Consider (39)–(40), the derivations of (1) and its alternations with respect to the verbs:

(39) *t*. [Marco$_{\boldsymbol{pn}}$] (LS)
t+1. [siede$_{\boldsymbol{p/ps/pn}}$] (LS)
t+2. [Marco$_{\boldsymbol{pn}}$]•[siede$_{\boldsymbol{p/ps/pn}}$]⊢[$_{\boldsymbol{p/ps}}$[Marco$_{\boldsymbol{pn}}$] siede$_{\boldsymbol{p/ps/pn}}$] (MI)
t+k. [$_{\boldsymbol{ps}}$ al tavolo] (MI)
k+1. [$_{\boldsymbol{p/ps}}$[Marco$_{\boldsymbol{pn}}$] siede$_{\boldsymbol{p/ps/pn}}$]•[$_{\boldsymbol{ps}}$ al tavolo]⊢[$_{\boldsymbol{p}}$[Marco$_{\boldsymbol{pn}}$] siede$_{\boldsymbol{p/ps/pn}}$[$_{\boldsymbol{ps}}$ al tavolo]] (MI)

(40) *t*. [Marco$_{\boldsymbol{pn}}$] (LS)
t+1. [va$_{\boldsymbol{p/ps/pn}}$] (LS)
t+2. [Marco$_{\boldsymbol{pn}}$]•[va$_{\boldsymbol{p/ps/pn}}$]⊢[$_{\boldsymbol{p/p}}$[Marco$_{\boldsymbol{pn}}$] va$_{\boldsymbol{p/ps/pn}}$] (MI)
t+k. [$_{\boldsymbol{ps}}$ al tavolo] (MI)
k+1. [$_{\boldsymbol{p/ps}}$[Marco$_{\boldsymbol{pn}}$] va$_{\boldsymbol{p/ps/pn}}$]•[$_{\boldsymbol{ps}}$ al tavolo]⊢[$_{\boldsymbol{p}}$[Marco$_{\boldsymbol{pn}}$] va$_{\boldsymbol{p/ps/pn}}$[$_{\boldsymbol{ps}}$ al tavolo]] (MI)

These compressed derivations show that when the ISPP *al tavolo* merges with *va* or *siede*, the directional sense of this ISPP is selected (step *k+1*). Once the 'skeletal' VP is formed, either the locative or directional readings for the ISPP are selected, as shown in (38)–(39). As (36)–(40) show, the scopes of the two polysemy patterns are slightly different (VP vs. ISPP), but they are tightly connected to the merge of ISPs and their spatial features with other items.

We can now offer an account of the argument demotion data, which motivated the P-within-P approach. Consider the derivations in (38), which repeat the patterns in (4)-(6):

(41) a. *k*. $[_{p/ps}[$ Marco$_{pn}]$ siede$_{p/ps/pn}]\bullet[_{ps}$ di fronte $]\vdash[_{p/}[$ Marco$_{pn}]$ siede$_{p/pn/ps}[_{ps}$ di fronte$]$ (MI)

b. *k*. $[_{p/ps}[$ Marco$_{pn}]$ siede$_{p/ps/pn}]\bullet[_{ps/ps}[_{ps}$ a $]$ (P)-l$_{ps/ps/ps}]]\vdash$* (MI: derivation halts)

c. *k*. $[_{p/ps}[$ Marco$_{pn}]$ siede$_{p/ps/pn}]\bullet[_{ps/ps}[_{ps}$ di fronte $]$ al$_{ps/p/ps}]]\vdash$* (MI: derivation halts)

The derivation in (41a) shows that an Axpart P, *di fronte* 'in front' can be merged with a verb to form a minimal VP, since it has type $\boldsymbol{p}_s$ The derivations in (38b–c) show that the simple ISP *al* and the 'partial' complex ISP *di fronte al* lack a DP as a type to form an ISPP, thereby halting the derivation: no complete, interpretable sentence is formed.

We can conclude this section by offering a compressed derivation of a sentence including a coordinated phrase. Consider (42)–(43), based on (3) and (28) respectively:

(42) *k*. $[_{p/ps}[_{pn}$ I bambini $]$ vanno$_{p/ps/pn}]\bullet[_{ps}$ allo spiazzo ed al rifugio $]\vdash$
$[_{p/}[_{pn}$ I bambini $]$ vanno$_{p/ps/pn}[_{ps}$ allo spiazzo ed al rifugio $]]$ (MI)

(43) *k*. $[_{p/ps}[_{pn}$ I bambini $]$ vanno$_{p/ps/pn}]\bullet$
$[_{ps}$ a destra delle macchine ed a destra dei trattori $]\vdash$
$[_{p/}[_{pn}$ I bambini $]$ vanno$_{p/ps/pn}[_{ps}$ a destra delle macchine ed a destra dei trattori $]]$ (MI)

Since coordinated phrases are assigned the same type of their conjuncts, they can merge with verbs of motion (here, *vanno* '(they) go'). If each conjunct contributes a distinct sense for *a* in (38), and *di* and *a* in (39), then their coordination and merge with *vanno* selects a directional reading. Thus, while these ISPP conjuncts can have one part of their readings to be identical (the directional reading) at a sentential level, they denote distinct locations *qua* arguments within the scope of a coordinated phrase, as per predictions.

Overall, these derivations show that ISPPs and coordinated ISPPs, as phrases of type $\boldsymbol{p}_s$, involve features that affect how polysemous readings are accessed. At the level of ISPPs, whether they involve one or two coordinated phrases, the polysemy layer involving locations is computed; the distinct senses of conjuncts are computed within this scope. Since coordinated phrases nevertheless involve (coordinated) ISPPs, they count as defining the scope of an ISP as a polysemous ISP (*contra* e.g. Riemer 2010: ch. 5). The directional/locative alternation, as the 'first' polysemy layer, is computed when an ISPP merges with a verb, within the scope of a VP. Thus, the two distinct layers of polysemy are shown to have distinct but connected scopes. These data are accounted for in the next section.

4. The Semantics

4.1 The Tools

We begin by introducing our simplified variant of Situation Semantics. Situations can be seen 'bits of information' that lexical items can carry. More specific types of situations such as individuals, locations or events can be defined, as senses of specific parts of speech. The domain of situations is a partially ordered set S. The *part-of* relation holds: $s \leq s'$ holds if $s \cap s' = s$ and $s \cup s' = s'$. If a situation is part of another situation, then their intersection is the sub-set situation, and their union is the super-set situation. Situations include sub- and super-types, with situations s being the universal type, d and l the sub-types of individuals and locations, respectively. *Qua* distinct types, their intersection forms the empty set (i.e. we have $d \cap l = \varnothing$), and their union a more general type (here, events: we have $e = l \cup d$). The resulting structure is $*S = \langle S = \{d,l,s\}, \cap, \cup, \leq \rangle$, a Boolean algebra: a partially ordered set (Landman 1991: 65-69; Szabolcsi 1997, 2010: ch. 1). The recursive definition of types is in (44):

(44) 1. *Given S a type set, $s \in S$ is a type* (Lexical type)

2. *If a is a type and b is a type, then $a \rightarrow b$ is a type* (Functional type)

3. *If a is a type and b is a type, then a×b is a type* (Compound type)
4. *If a⟶b is a type and b is a type, then (a⟶b×a⊨b* (Function application)
5. *Nothing else is a type* (Closure property)

Given a basic type of atomic situations (rule 1), a complex set of types can be defined by combining situations either via functional or compound type formation (rules 2, 3). *Function application* can then be defined as a rule for type reduction (rule 4), together with a closure principle (rule 5). The smallest type set that we can define via this definition is the set $TYPE'=\{s,s\rightarrow s,s\rightarrow(s\rightarrow s),s\times s\}$, which closely mirrors the syntactic type set. Product types can be used to represent sub-types: we can have s_σ, a situation belonging to a sub-type σ.

The definition of a mirror set of rules for the syntax and semantics of ISPs stems from the use of TLS as a derivational system. We offer this mapping in (45):

(45) MORPHOLOGY⇒SEMANTICS⇒INTERPRETATION

$$\boldsymbol{p}/\boldsymbol{p}/\boldsymbol{p} \Rightarrow s\rightarrow(s\rightarrow s) \qquad \Rightarrow \lambda x.\lambda y.s:(x\leq y)_{s\rightarrow(s\rightarrow s)}$$

$$\boldsymbol{p}_{\boldsymbol{p}} \Rightarrow s \qquad \Rightarrow s_s,\ s_s:(a\leq b)$$

In the mapping, we employ a standard form of λ-calculus. Heads denote relations, which are defined as situations in which a part-of relation between other situations holds (i.e. we have $\lambda x.\lambda y.s:(x\leq y)_{s\rightarrow(s\rightarrow s)}$). Phrases, instead, denote either situations belonging to a given sub-type (e.g. *l* for location, as in the case of Axpart Ps), or situations corresponding to saturated relations. An ISPP such as *al tavolo* 'at the table', in this analysis, denotes a location sub-type of situation in which a (spatial) relation between a table and other locations holds. Before we further present our analysis, however, we introduce our account of polysemy.

Our account consists of two assumptions, adapted from recent developments in type composition logic and GL (Asher 2011; Pustejovsky 2013; respectively).

First, we also model locations as forming a Boolean algebra $^*L=<L,\cap,\cup,\leq>$ (cf. Asher & Sablayrolles 1995; Nam 1995): a set of locations *L* includes sum locations (i.e. $\cup l$), and is ordered via the part-of relation '≤'. Sum locations are defined as unions of more basic locations: $l=a\cup b$ is the location *l* that includes the union of locations *a* and *b*. Apart from sum locations, *atomic* locations play a key role. We assume that our algebra has 12 atomic locations (hence, $2^{10}=1024$ sum locations), which correspond to edges of opposing semi-axes (e.g. 'front', 'back', 'in', 'out' locations). SPs can denote these idealized locations or sums thereof, thus partitioning this (mental) model of space (Zwarts & Winter 2000; Levinson & Meira 2003; Ursini & Giannella 2016).

Second, we model polysemous ISPs as denoting sum locations. Consequently, their senses can identify any of the locations making up a sum. Given our discussion in section 2, the sense of *a* corresponds to the sum of the sense of *di fronte* 'in front', *dietro* 'behind', *in* 'in', *fuori* 'out', and so on. Thus, the sense of *a* corresponds to the *identify function* $I(a)_l=a_l$, the function that identifies this specific sum location (cf. Landman 1991: 62-64; Asher 2011: 60-70). Via *distributivity*, we have the identity $I(a)_l=I(fr)_l\cup I(bh)_l\cup I(in)_l\cup I(out)_l\cup\ldots$ (cf. Landman 1991: 65-69; Szabolcsi 1997, 2010: ch. 1). Hence, *a* can have several related senses, one per location in its denotation: $I(fr)_l$ for the frontal location, $I(bh)_l$ for a posterior location, $I(in)$ for the internal location, and so on.

Overall, we reconstruct the treatment of polysemous items as involving 'networks' of senses found in cognitive linguistics frameworks (e.g. Evans 2009), but from the model-theoretic perspective of type composition logic/GL and situation semantics. Note that, in our account, polysemy and underspecification are defined as distinct properties. Polysemy involves lexical items forming a set of senses belonging to the same type (e.g. $I(\alpha_s)=I(\cup\{\alpha,b,\ldots\}_s)$). Underspecification would also involve a general sense as part of the sense of an item, related to the other sense (e.g. $I(\cup l_s)\subseteq I(\alpha_s)$). Thus, the account of the data in the next section also shows why our data involve polysemy, and not underspecification.

4.2 The Semantic Analysis

We start our analysis by offering a semantic type assignment to our constituents. Since we have made a distinction between nominal and spatial phrases, this distinction is mirrored in the semantics by having these types to respectively denote individuals *d* and locations *l*, in (46a). Thus, figure DPs and Axial nouns are assigned type *d*, and ground DPs, simple ISPs and Axpart Ps are assigned type *l*. Note that, in our derivations, we directly use sub-types for arguments (i.e. *d*, *l*) rather than sub-scripts, as in (47). In (47), we offer a fragment of the interpretations for the lexical items in derivations. As always, '[[.]]' stands for the interpretation function:

(46) a. s_d:= {*Mario,i bambini,…*}; p_s:= {*a, in, tavolo, parco, di fronte, al tavolo, nel parco,…*};
b. $s_l \longrightarrow (s_l \longrightarrow s_l)$:= {(P), *a, di, da,e,…*}; $s \longrightarrow (s_l \longrightarrow s_d)$:= {*siede, va, è,…*};

(47) a. [[a]]⊨a_l; [[in]]⊨in_l; [[di fronte]]⊨fr_l, [[bancone]]⊨b_d; [[tavolo]]⊨t_d;
b. [[(P)]]⊨$\lambda x.\lambda\, y.s:(x \leq y)_{\wedge \rightarrow (l \mapsto l)}$; [[al]]⊨$\lambda x.\lambda y.l:(x \leq y)_{\wedge \rightarrow (l \mapsto l)}$; [[e]]⊨$\lambda x.\lambda y.s:(x \cap y)_{\wedge \rightarrow (l \mapsto l)}$

We do not address the locative/directional alternation before addressing the examples, thereby offering slightly simplified senses. The senses of simple ISPs acting as arguments, viz. *a* and *in*, minimally differ in the locations that they include in their denotation (e.g. *a* vs. *in* as sum locations). While *a* covers the sense of other ISPs, as a 'general' preposition, *in* excludes the possibility that a figure is located outside of a ground (i.e. $I(in)_l$ lacks the out_l location). Simple ISPs, in virtue of being polysemous, can also cover or include the senses of Axpart Ps in their domain. *Di fronte* denotes a location *fr*, but *a* can also individuate this location as part of its sense. This point will become clear as we discuss the data, in any case.

The senses of heads (here, silent P, *al* as in *di fronte al*, and *e*) correspond to situations in which relations between locations hold, hence being interpreted as 'spatial' situations. In the case of *e*, the corresponding situation is the conjunction of two distinct spatial relations that two conjuncts denote. Our fragment does not cover all lexical items in our derivations, as the interpretation of some items (e.g. verbs) is better discussed via derivations.

Let us turn to the examples. We begin by offering the interpretation of (36) in (48):

(48) *t*. [[a_{ps}]]⊨a_l (Int)
t+1. [[$(P)_{ps/ps/ps}$]]⊨$\lambda x.\lambda\, y.s:(x \leq y)_{\wedge \rightarrow (l \mapsto l)}$ (Int)
t+2. [[a_{ps}]]×[[$(P)\text{-}l_{ps/ps/ps}$]]⊨$(a_l) \times \lambda x.\lambda\, y.s:(x \leq y) = \lambda\, y.s:(a \leq y)_{l \mapsto l}$ (FA)
t+3. [[$tavolo_{ps}$]]⊨t_l (Int)
t+4. [[$_{ps/ps}$[a_{ps}] $(P)\text{-}l_{ps/ps/ps}$]]×[[$tavolo_{ps}$]]⊨$\lambda\, y.s:(a \leq y)_{l \mapsto l} \times (t_l) = s:(a \leq t)_l =$
$s:(fr \leq t)_l \cup s':(int \leq t)_l \cup s'':(out \leq t)_l \cup s:(fr \leq t) \cup s''':(bh \leq t) \cup \ldots$ (FA, Distributivity)

The derivation shows that a silent P head takes *a* as an argument, interpreted as a sum of possible locations related to the ground (steps *t* to *t+2*). Once the ground DP is merged, the range of possible readings for this ISPP is computed via distributivity (steps *t+3*, *t+4*). This ISPP denotes a relation in which a figure can occupy the part corresponding to the external location of a table (i.e. *out*), its internal (i.e. *int*), or frontal (i.e. *fr*), or posterior (i.e. *bh*) location, and so on. Each of these corresponding possible relations, and the situations they represent (e.g. *s*, *s'*, *s''*) are possible senses of *alla tavola* in this syntactic context. The connective '$\cup$' representing sum locations doubles as a connective linking 'alternative' locations of the figure, with respect to the table (i.e. in *or* out a ground). This is possible because in Boolean algebrae, sum and disjunction reduce to the same operation/connective (Szabolcsi 1997; Winter 2001).

Let us now turn to our first complex ISP. We drop syntactic sub-scripts, for simple reasons of space. Consider (49), the interpretation of (37):

(49) *t*. [[di]]$\vDash \lambda x.(x)_{d \mapsto l}$ (Int)

t+1. [[fronte]]$\vDash fr_d$ (Int)

t+2. [[di]]×[[fronte]]$\vDash \lambda x.(x)_{d \mapsto l} \times (fr_d) = fr_l$ (FA)

t+3. [[al]]$\vDash \lambda x.\lambda y.a:(x \leq y)_{\wedge \to (l \to l)}$ (Int)

t+4. [[di fronte]]×[[al]]$\vDash (fr_l) \times \lambda x.\lambda y.a:(x \leq y)_{\wedge \to (l \to l)} = \lambda y.a:(fr \leq y)_{l \to l}$ (FA)

t+5. [[bancone]]$\vDash b_l$ (Int)

t+4. [[di fronte al]]×[[bancone]]$\vDash \lambda y.a:(fr \leq y)_{l \to l} \times (b_l) = a:(fr \leq b)_l =$
$a:(fr \leq b)_l \cup a':(fr \leq b)_l \cup \ldots$ (FA; Distributivity)

The derivation in (49) says that *a* in *di fronte a(l)* denotes a polysemous relation: a relation that involves distinct locations defined as 'fronts' of the ground. The use of $x.\lambda y.a:(x \leq y)_{\wedge \to (l \to l)}$ in step *t*+2 marks this polysemy, since *a* corresponds to a sum of locations (i.e. we have $a = \cup\{int, out, \ldots\}$). This relation is obtained once *fronte* is assigned the type *l* of locations, via the contribution of *di* as a spatial marker (steps t to *t*+2). In turn, *di* can be interpreted as a spatial marker (i.e. a 1-place function: $\lambda x.(x)_{d \to l}$) via the residual rule, which connects this interpretation to its relational (2-place) interpretation. This holds for *a* as well, since its argument and head interpretation are similarly connected.

Thus, in step *t*+4, at least two possible readings can be accessed, here represented as *a* and *a'*. The relation is defined with respect to the intrinsic front of the ground, or relative with respect to the figure's position. In our analysis, this restricted type of polysemy for complex ISPs is connected to the semantic contribution of simple ISPs. If these elements can have distinct but related senses, complex ISPs will 'inherit' part of these senses, once the interpretation of Axpart Ps is factored in. The reduced polysemy of complex ISPs corresponds to their ability to identify distinct but related locations being 'fronts', 'backs' and so on, with respect to different referent systems.

We now turn to the interpretation of coordinated ISPPs. Recall that *a* can identify internal and external locations, as in the case of *allo spiazzo ed al rifugio* 'to the esplanade and into the refuge'. Its interpretation is shown in (50):

(50) *k*. [[allo spiazzo]]$\vDash s_l:(a \leq p) = s_l:(out \leq p)$ (Int, Distributivity)

k+1. [[e]]$\vDash \lambda x.\lambda y.s'':(x \cap y)_{l \to (l \to l)}$ (Int)

k+2. [[allo spiazzo]]×[[e]]$\vDash$
$(s_l:(out \leq p)) \times \lambda x.\lambda y.s'':(x \cap y)_{l \to (l \to l)} = \lambda y.s'':(s_l:(out \leq p) \cap y)_{l \to l}$ (Int)

k+3. [[al rifugio]]$\vDash s'_l:(in \leq gl) = s'_l:(int \leq r)_{l \to l}$ (Int, Dist.)

k+4. [[allo spiazzo e]]×[[al rifugio]]$\vDash \lambda y.s'':(s_l:(out \leq p) \cap y) \times (s'_l:(int \leq r)) =$
$s_l'':(s_l:(out \leq p) \cap s'_l:(int \leq r))$ (FA)

The distinct senses of *allo/al* are computed when the two grounds *spiazzo* and *rifugio* (denoted as the locations p_l, r_l respectively) are merged with the two tokens of this ISP. In each conjunct, a distinct reading is computed via distributivity, as in the case of (49)–(50). This because an ISPP represents the scope for the disambiguation of a polysemous ISP, or token thereof. Thus, the two distinct but related senses of *a* are first computed, and then conjoined. Note, then, that if the first conjunct would receive the same reading of the second conjunct (i.e. $out \leq pr$), then a paradoxical reading would be licensed: the boys would be 'in' the esplanade. We reconstruct the coordination test as a constraint on the coordination of senses of a lexical item.

Note here that the two computed senses partially 'overlap', since they both carry a directional reading, not explicitly represented in this derivation. One could see this as evidence for an underspecification approach. For instance, the 'complete' readings of these conjuncts can be represented as $a = \cup\{dir, out\}$ and $b = \cup\{dir, int\}$, since both conjuncts have a directional reading, via the contribution of

vanno (here omitted). By definition, we would have the relations $a=\cup\{dir,out\}\not\subset dir$ and $a=\cup\{dir,int\}\not\subset dir$ to hold, however: no general reading can include both readings, so *a* is not underspecified, in this context. Underspecification would hold if the general sense of *a* in this context would be the *union* of the two conjoined senses (i.e. $a=\cup\{\{dir,out\},\{dir,int\}\}$) rather than their *conjunction*, contrary to the standard sense of *e* 'and' as a Boolean connective (cf. Winter 2001: ch. 2 for discussion). Thus, polysemy and underspecification are distinct phenomena, and require distinct accounts.

We can now capture how the other polysemy pattern, the alternation between directional and locative readings, is resolved. For this purpose, we enrich the senses of ISPs as involving the identifying function $\pm dir(s)$, which individuates a situation in which a spatial relation can involve directed movement. We also introduce this function as a restriction on the semantic type of complements that a verb can take (cf. Hale & Keyser 2002 on s-selection; Asher 2011: ch. 4 on argument type selection). This simplified treatment is nevertheless consistent with the proposals on semantics of directional readings (cf. Zwarts & Winter 2000; Zwarts 2005; among others). Consider now (51), the interpretation of (39):

(51) *t*. [[Marco]]$\vDash m_d$ (Int)

t+1. [[siede]]$\vDash \lambda\, x.\lambda y.s:$***sit'***$(x,y)$ (Int)

t+2. [[Marco]]$\times$[[siede]]$\vDash (m_d)\times\lambda\, x.\lambda y.s:$***sit'***$(x,y) = \lambda y.s:$***sit'***$(m,\text{-}dir(y))$ (FA)

t+k. [[al tavolo]]$\vDash \pm dir(a)_f(a\leq t)$ (Int)

k+1. [[Marco siede]]$\times$[[al tavolo]]$\vDash \lambda y.s:$***sit'***$(m,\text{-}dir(y))\times(a_f(a\leq t)) =$
$s:$***sit'***$(m,+dir(\pm dir(a)_f(a\leq t))) = s:$***sit'***$(m,\text{-}dir(s'_f(out\leq t)))\cup s:$***sit'***
$(m,\text{-}dir(s''_f(out\leq t)))\cup\ldots$ (FA, D.)

The derivation in (51) says that a locative verb such as *siede* can take an ISPP denoting a spatial relation as its argument, but restricts its interpretation to a locative reading (i.e. $\text{-}dir(y)$). When *al tavolo* is composed with this verb, only the *-dir* value for the spatial relation it denotes (i.e. $\text{-}dir(a_f)$) produces an interpretable sentence, which can have distinct locative readings (cf. step *k+1*). If *va* 'goes' is inserted in place of *siede*, a corresponding directional reading is selected. Thus, one polysemous level can be resolved at a sentential level, while the spatial reading can remain ambiguous, but at the ISPP level: no specific sense is computed, in context.

The semantic side of the argument demotion data can be now captured, too. We show when and how demotion can produce interpretable sentences in (52):

(52) a. *k*. [[Marco siede]]$\times$[[di fronte]]$\vDash s_f:$***sit'***(m,fr) (FA)

b. *k*. [[Marco siede]]$\times$[[a (P)-l]]$\vDash s_f:$***sit'***$(m,\lambda x.s_l':(fr\leq x))_{t\mapsto l}$ (FA: Derivation halts)

c. *k*. [[Marco siede]]$\times$[[di fronte al]]$\vDash s_f:$***sit'***$(m,\lambda x.s_l':(fr\leq x))_{t\mapsto l}$ (FA: Derivation halts)

In (52a), the interpretation of (41a), we have an Axpart P to act as the argument of the verb *siede*, thus denoting the location in which Mario, the figure, sits. Although it is possible in a discourse context to retrieve the ground whose front Mario occupies, our simplified interpretation aims to show that a well-formed and interpretable location is derived, in this case. Since in (52b–c) no argument is fed to the relation that *al* and *di fronte al* denote, the derivation is halted, and no fully interpretable sentence can be formed.

We can now offer a sentential interpretation of coordinated phrases. We can also show how coordinated phrases receive the same reading with respect to the directional/locative alternation. Consider (53)–(54), the interpretations of (42)–(43):

(53) *k*. [[I bambini vanno]]$\times$[[allo spiazzo ed al rifugio]]$\vDash$
$s:$***go'***$(*b,(+dir(s''_f(s_f(out\leq p)\cap s'_f(int\leq r))))$ (FA, Distributivity)

(54) *k*. [[I bambini vanno]]×[[di fronte alle macchine e a destra dei carri]]⊨
*s:**go'**(*b,(+dir(s'':(a*$_r$*:(fr≤*m)∩s'*$_r$*:(rt≤cr))))* (FA, Distributivity)

The compressed derivation in (53) says that *allo spiazzo ed al rifugio* have a shared directional reading but distinct spatial readings, as per discussion of (50). In (54), the two complex ISPs *di fronte alle* 'in front of' and *a destra dei* 'to the right of' can identify the intrinsic or relative positions of the children (denoted as the plurality **b*: Winter 2001) with respect to the park and the carriages, respectively. Crucially, *di* and *a* play two distinct semantic functions in each ISP. *A* is the head introducing both distinct senses for *di fronte* in the first conjunct, while *di* has this function in the second conjunct. Both simple ISPs have 'marking' functions as well, thereby assigning type *l* to their corresponding Axial nouns (*fronte*, *destra*). Distinct but related senses (and sense types) are composed into these examples, as per predictions of the model.

Let us take stock. Our account can capture the polysemy patterns attested in ISPs when they occur in coordinated phrases, an instance of the coordination test. This is crucial evidence that ISPs are polysemous, as discussed in previous literature (cf. Kearns 2006). Previous accounts of polysemy cannot directly handle these data, whether they are couched in a cognitive linguistics (e.g. Evans 2009), formal semantics (e.g. Pustejovsky 2013) or other frameworks. By lacking a theory of syntax to underpin their analysis, these accounts would simply lack the tools to pin-point the scope of these polysemy patterns (e.g. Luraghi 2009, 2011). Arguably, a key improvement of our account over previous accounts is precisely the ability to compute distinct polysemy scopes. It is likely not the case that they rely on the definitional test, thus incurring in the problem of blurring polysemy and underspecification. An account of polysemy that builds on a precise analysis of ISPs and their syntax, as in the case of our DM-based account, seems to easily account the data, reaching our goal.

5. Conclusions

This paper has offered an account of the polysemy of Italian Spatial Prepositions (ISPs), focusing on so-called simple ISPs: *a*, *in*, *di*, and *da*. The central claim is that these ISPs can carry several senses in virtue of their ability to denote sums of possible locations that a figure occupies, with respect to a ground. Furthermore, the specific interpretation of these ISPs is computed within the scope of an ISP phrase, once an ISP merges with a head and the ground argument. Thus, if the sense of *a* can identify several locations that a figure can occupy, *al tavolo* may identify a specific location, via the distributivity property. Since the polysemy of complex ISPs is a consequence of the polysemy of simple ISPs, this account can be extended to this type, too (e.g. *di fronte al tavolo*). Overall, our account is a preliminary step for a broader analysis of the syntax and semantics of ISPs, which can be possibly extended to other Romance languages and dialects. However, we leave such a goal to future research.

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