Metaphoric and Literal Readings for Spatial Prepositions: The Case of Boolean Phrases

Francesco-Alessio Ursini
Stockholm University, Sweden

Abstract
This paper presents an account of how literal and metaphoric readings of spatial prepositions in so-called “Boolean Phrases” can arise. The account aims to explain how metaphoric and literal readings can interact, when two (spatial) prepositional phrases are the arguments of one phrase headed by Boolean connectives and or (e.g. in front of the car and over his problems). It is shown that these phenomena can receive a more thorough compositional analysis by assuming that both types of readings are part of a larger semantic domain for spatial prepositions, logical connectives and their combinations thereof.

Keywords: metaphor, spatial prepositions, Boolean connectives, Type-Logical Syntax, disjunction

1. Introduction
The literature on Spatial Prepositions (henceforth SPs) has been in steady increase. Cross-linguistic studies have investigated their syntactic structures (e.g. Asbury, 2008; Cinque & Rizzi, 2010), semantic properties (e.g. Levinson & Wilkins, 2006; Zwarts, 2008) and psycholinguistic aspects of their interpretation (e.g. Feist, 2000, 2006; Coventry & Garrod, 2004). Furthermore, building on seminal proposals such as Lakoff (1987, 1993, pp. 388-440), many works have also investigated in detail the polysemy of SPs and studied how metaphoric readings can arise in context (e.g. Evans & Tyler, 2001, 2004a, b). However, there are several phenomena that are still understudied, and warrant a more thorough analysis. One such problem is the interaction of SPs with so-called “Boolean” connectives and or, since their meaning is often modelled via the operators of Boolean Logic (e.g. Keenan & Faltz, 1985; Winter, 2001). In order to illustrate this
interaction, we offer some preliminary examples in (1)-(4):

(1) Mario is in front of the table and behind the chair
(2) Mario is in front of the table or behind the chair
(3) Mario is behind the table and under the scrutiny of the guards
(4) Mario is behind the table or under the scrutiny of the guards

(1)-(2) respectively involve the combination of and, or, with two SP phrases (SPPs) acting as conjuncts/disjuncts: in front of the table, and behind the chair. These SPPs have a literal reading: they denote a spatial relation holding between Mario and two distinct landmark objects, a chair and a table. The located entity (here, Mario) is usually labelled figure; the landmark objects, ground(s) (here, table and chair) (Talmy, 2000). These two SPPs form Boolean phrases, a label that we use for phrases headed by Boolean connectives and or (cf. Emonds, 1985, 2000; Keenan & Faltz, 1985). These Boolean phrases “receive” a literal reading from their conjuncts/disjuncts, which in turn is passed onto the whole sentences.

Examples (3)-(4), instead, involve the combination of these connectives with two SPPs receiving distinct types of interpretations. The SPP under the scrutiny of the guards does not denote a spatial relation, for Mario is understood as being under a state of scrutiny, rather than being in a given location. Thus, when SPPs denote non-spatial relations, they are said to have a metaphoric (non-literal) reading (e.g. Herskovits, 1986; Lakoff, 1987, 1993; Vandeloise, 2010; Evans, 2009, 2010a, b). Nevertheless, even if the other SPP conjunct/disjunct behind the table receives a literal reading, the two SPPs can certainly be conjuncts/disjuncts of and/or. Boolean phrases seem to accept both types of readings, for their argument phrases.

As matters stand, the interpretation of “Boolean phrases” such as those in (1)-(4) can be said to form a cline of increasing semantic complexity, and decreasing coverage in analysis. Although established syntactic and semantic accounts of sentences such as (1) exist, the semantic analysis of sentences such as (2) is more controversial. Analyses based on (Boolean) algebraic approaches suggest that or in (2) licenses an “inclusive” reading. Mario can be either in front of the table or behind the chair, or in a location that includes both (e.g. Partee & Rooth, 1983; Keenan & Faltz, 1985; Winter, 2001). Approaches based on “alternative” semantics instead suggest that or licenses an “exclusive” reading. Its disjuncts denote mutually exclusive alternative interpretations for a phrase: Mario is either in front of the table or behind the chair (e.g. Alfonso-Ovalle, 2006, 2008). Furthermore, the interplay between literal and metaphoric readings in Boolean phrases that (3)-(4) display has been observed only in passing in the literature (e.g. Lakoff, 1993, pp. 433-434). Therefore, a thorough analysis of (1)-(4), and with it a unified account of the polysemous nature of SP(P)s in Boolean phrases, is still lacking.

The goal of this paper is to offer such an account, based on an analysis of the syntactic structure of SP(P)s and Boolean phrases couched in a Type-Logical (syntactic) analysis.
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This analysis is then connected to a variant of Situation Semantics (e.g. Barwise & Perry, 1999; Kratzer, 2007), which models literal, metaphoric and “mixed” readings by allowing the emergence of complex semantic types. Via this slender formal apparatus, we show that it is possible to straightforwardly account for the different readings displayed in (1)-(4), and the examples we are going to discuss. The paper is structured as follows. Section 2 presents a wider set of these understudied data, and motivates the need for a novel theoretical approach for this data. Sections 3 and 4 offer this approach, and section 5 concludes.

2. The Data

The goal of this section is to present a relatively thorough and yet concise picture of the data in need of an analysis (sections 2.1 and 2.2). We then outline previous analyses of specific aspects (e.g. metaphoric readings), and outline a set of desiderata for our account (section 2.3). Before we start our discussion, a precis on data collection is due. We collected the data via a simple elicitation task. British and American English native speakers (N=20) were asked to evaluate each sentence on a Lickert scale of “acceptability”, offering a value ranging from 1 (poor) to 5 (excellent) via 3 (average). Each sentence was introduced via a simple description of a context of use, against which participants had to evaluate its interpretation. For instance, participants were asked if (1) accurately described a character called Mario being in front of a given table and behind a given chair. We considered “uninterpretable” all the sentences that were scored below an average value of <1.9, and marked them via the symbol “#”, in the examples.

2.1 Basic literal and metaphoric readings of SPs

The polysemy of SPs is a well-documented phenomenon, and several analyses include a discussion of their metaphoric senses. Examples include works analyzing in and on (Vandeloise, 1994, 2010; Feist, 2000; Evans & Tyler, 2004b), over (Lakoff, 1987, pp. 418-466; Evans & Tyler, 2001), and around (e.g. Zwarts, 2004). A consensus is that spatial/literal sub-type of an SP represents its “central” or prototypical sense, and the other senses the “peripheral” ones (cf. Lakoff’s 1993 notions of “Idealized Conceptual Model” and “radial category”). These senses and their relations, taken together, form the sense network of an SP, defined as the collection(s) of senses and their relations constituting the possible interpretations of an SP (e.g. Evans & Tyler, 2001, 2004a, b; Evans, 2009). The macro-types of literal and metaphoric types forming this network can be further differentiated into sense sub-types, which we discuss in the remainder of this section.

Spatial (literal) taxonomies of SPs distinguish between two types of senses for SPs: locative and directional types (Cresswell, 1978; Jackendoff, 1983, 1990). Locative senses are further distinguished between projective and topological, or non-projective senses/types. SPs tend to have one sub-type as their principal sense, although both sub-types are usually possible. Examples of SPs with a mainly directional sense are to, from and
through. Examples of SPs with a mainly locative sense are *at, in, in front of* and *behind*. Some examples are in (5)-(8):

(5) Marco is at the beach
(6) Marco has arrived at the beach, finally
(7) Tarma is sitting in front of the desk
(8) Tarma has gone in front of the desk

As these examples suggest, the distinction between locative and directional senses seems sensitive to the senses of verbs and DPs. For instance, Marco can be or arrive *at* a given beach (viz. (5)-(6)), and Tarma can sit or go *in front of* the desk (viz. (7)-(8)). Thus, SPs seem to be inherently polysemous, since they can have at least two different but related types of senses (locative and directional respectively). However, their interaction with other categories (verbs and ground DPs) can determine a specific *reading*, defined as the sense type that emerges at a phrasal level: in these cases, at an SPP level. We will further discuss the notions of “sense” and “reading”, their relation and formal definition, as we proceed with our discussion.

Non-spatial or metaphorical sub-types of senses, instead, are usually divided into temporal (e.g. *at 5 p.m.* (Evans, 2009, 2010), and “state” (e.g. *in love*) sub-types (Goatly, 1997; Langacker, 2008; Evans, 2009, 2010). Other non-metaphoric senses are involved when “fictive motion” readings emerge in context (e.g. Talmy, 2000; Lakoff, 1987; Taarema, 2013). Some examples illustrating these senses are in (9)-(12):

(9) Fio arrived at 5 p.m., and Marco at 6 p.m.
(10) Marco was at the mercy of Morden’s troops
(11) Fio answered along the lines of not knowing the exact destination
(12) Fio will rise above her problems, and complete the mission easily

In (9), *at* denotes a relation between Fio, Marco and their respective arrival moments, expressed via the DPs *5 p.m.* and *6 p.m.* In (10), the DP *the mercy of Morden’s troops* denotes a psychological attitude of a group of individuals, general Morden’s troops, towards Marco. Hence, the SPP *at the mercy of Morden’s troops* does not denote a location, but rather a relation between Marco and this “state”. The same reasoning applies to (11)-(12), which involves fictive readings. For instance, in (12) Fio does not literally move above the putative location of her problems; she simply overcomes them. Since none of these examples involve SPPs with spatial or literal readings, they can be said to have metaphoric, or non-spatial readings.

Overall, as in the case of literal readings, metaphoric readings can be directly associated to the polysemous nature of SPs. Both macro-types of senses include sub-types that seem to systematically emerge at the phrasal level (e.g. directional and fictive sub-types). This is the case, because verbs (e.g. *answered, rise*) and in particular DPs...
(e.g. 6 p.m., her problems) can play a role in the emergence and selection of these senses at a phrasal level. The corresponding readings can then be combined when they act as “arguments” of the connectives that and or denote, when their corresponding SPPs are conjuncts/disjuncts of a Boolean phrase. The empirical question that we address next, then, is precisely how these senses can be combined.

2.2 Readings in Boolean phrases
Analyses of Boolean phrases across languages usually acknowledge that these phrases partake in at least three syntactic patterns, each corresponding to a slightly distinct semantic interpretation (e.g. Partee & Rooth, 1983; Winter, 2001; Camacho, 2003; Zhang, 2010). The first pattern involves or and and as heads that take two phrasal arguments. A second pattern involves a head (e.g. an SP such as behind) taking a Boolean phrase as a complement. A third pattern involves a head (e.g. an SP such as of) taking a Boolean phrase as a specifier. Each of these patterns seems to be understudied, at least when SPs are involved as arguments. In particular, no works seemingly address the occurrence of SPs in the third pattern. We illustrate these three patterns and their interaction with SP(P)s in (13)-(18):

(13) Mario walks along the river and near the forest
(14) Mario walks along the river or near the forest
(15) Mario sits behind the table and the chair
(16) Mario sits behind the table or the chair
(17) Mario walks ahead and to the left of the chair
(18) Mario walks ahead or to the left of the car

In (13), we understand that Mario’s path of walking is at the same time parallel to the river, and relatively close to a forest. Instead, (14) involves a slightly different sense, since it can also describe scenarios in which Mario may be walking near the forest but not along the river, and vice versa. Thus, (13)-(14) display the first pattern, as the SPPs act as conjuncts/disjuncts of heads and or. In (15)-(16), we understand that chair and table are positioned in such a way that Mario is behind both (or either) of them. Hence, (15)-(16) display the second pattern: the ground DPs the table and the chair act as conjuncts/disjuncts of a Boolean phrase, which is the complement of the SP head behind. In (17)-(18), instead, the Boolean phrase sits in the specifier position of a complex SP headed by of, while the SPs denote the two coexisting (alternative, in (18)) spatial relations holding between Mario and chair. Thus, these three syntactic patterns are attested when SPPs and SPs occur as arguments and heads, respectively.

Although the combination of these senses seems unproblematic when the conjoined/disjoined relations between figure and ground have a spatial/literal reading, metaphoric readings present a more complex set of possible readings. Consider (19)-(24):
(19) Marco is in love and at peace with himself
(20) Marco is in love or at peace with himself
(21) Marco has easily gone through excellent periods and terrible situations unscathed
(22) Marco has easily gone through excellent periods or terrible situations unscathed
(23) #Marco is meditating over and in his problems
(24) #Marco is meditating over or in his problems

Consider (19)-(20), which display the first Boolean pattern and its interaction with metaphorical readings. A well-known fact is that SPs are restricted in their distribution with DPs, when metaphorical readings are involved (e.g. Deignan, 2003; Steen, 2007; Evans, 2009). Thus, love is a state that Mario can be “in” but not “at”; peace is a state that he can be “at” but not “in”. A similar reasoning applies to the state of being “through” excellent periods and/or terrible situations, as (21)-(22) show. Thus, metaphorical readings are compatible with the first two Boolean patterns, although with specific restrictions on the SPPs that trigger them.

Consider now (23)-(24). These examples include two SPPs as conjuncts of a Boolean phrase in the specifier of the SP head of (third pattern). The restrictions of SPPs with respect to metaphorical roles seem to play an important role, in this case. For instance, over usually combines with verbs and DPs denoting mental states that last several intervals of time (here, meditate and his problems: Lakoff, 1993; Evans & Tyler, 2004b). Instead, in combines with states that may lack such “internal” distinctions (e.g. being in love) (Evans & Tyler, 2004b; Evans, 2009; Vandeloise, 2010). Since these SPs combine and are related to the same DP (i.e. his problems), their restrictions on distribution render (23)-(24) uninterpretable.

Overall, (19)-(24) suggest that metaphorical readings in SPPs have a more restricted syntactic and semantic distribution than literal ones, when occurring in Boolean phrases. Nevertheless, both readings can co-exist in Boolean phrases, as (25)-(28) show:

(25) Fio has gone out of the hut and towards her freedom
(26) Fio has meditated near the table or over her problems
(27) Fio has walked over the bridge and her fears, yesterday
(28) Fio has walked over the bridge or her fears, yesterday

These examples extend the paradigm introduced in (1)-(4). In (25), the SPPs out of the hut and towards her freedom describe a scenario involving Fio’s exiting of the hut, and her fictive movement towards freedom. Instead, (26) can describe a scenario in which Fio may have meditated near the table, or over the problems, or both. Similarly, (27) describes a scenario in which Fio overcomes her fears by walking over a bridge, the day before the sentence is uttered. Also (28) can describe a scenario in which either condition holds for Fio, or both.

We offer this interpretation of the examples because most of our speakers preferred
inclusive readings for (26) and (28), over exclusive readings (mean value F=2.8 and F=2.7 respectively). That is, they preferred readings in which either one but also both relations denoted by a Boolean phrase would be considered true (inclusive), rather than either one (exclusive). Informants observed that, since inclusive readings do not seem to contrapose different types of readings for the SPPs (i.e. literal vs. metaphoric), they render the sentences easier to understand. For instance, for our informants, understanding that in (26) Fio only meditated near the table but not over her problems (or vice versa) was a problematic reading. One relation seemed to forcefully exclude the other, even if they could both be true. A similar picture holds for other combinations of SPPs that we tested, and which we do not report here for reasons of space. For the most part, informants preferred inclusive readings, in context.

Overall, these facts suggest that an inclusive analysis of these phrases and the (compositional) semantics of their constituting elements represents a necessary choice for our theoretical account. In order to offer an account of these data, we need to treat and and or as denoting connectives that can combine literal and metaphoric readings into inclusive readings. Consequently, we need to address the questions of if and how these “mixed” readings can be accounted for. In the next section, we evaluate previous and partial answers to this question.

2.3 Theoretical questions and previous approaches

The vast literature on SPs seems not to include discussions regarding how literal and metaphoric readings can co-exist in sentences. We discuss below the reasons for this theoretical vacuum, which ultimately lie in the underlying philosophies of these approaches.

Classical and Contemporary Metaphor Theory (henceforth: CMT) contend that metaphors are mappings between conceptual (semantic) domains that may share only in part their content (Lakoff & Johnson, 1980; Lakoff, 1987, 1993; Gibbs & Steen, 1999; Gibbs, 2008; Steen, 2007, 2011). One domain is understood via the structure of a second domain, and the mapping that is established between the two domains. The domain that provides this logical structure is known as the source domain; the interpreted domain is known as the target domain. For SPs, this entails that the conceptual domain of a “ground” DP (e.g. her freedom in (25)) can render the interpretation of an SP(P) as non-spatial or metaphorical, viz. towards her freedom. Although different in their constituting assumptions, related frameworks such as conceptual blending theory (Fauconnier & Turner, 2000, 2008) and Lexical Cognitive Conceptual Model theory (Evans, 2006, 2009, 2010a, b) propose similar analyses of metaphoric readings. For this reason, we do not discuss them here in detail.

A different perspective can be found in formal analyses. Two very similar examples are the Generative Lexicon (henceforth GL) (Pustejovsky, 1995; Asher & Pustejovsky, 2013) and Type Logical Composition (TLC) (Asher, 2011) treatments of metaphoric senses. In GL, lexical items are associated to layered sense structures based on sense
types, and known as qualia structures or just qualia. A common noun such as hammer, for instance, can include the types physical_object’ (physical property), wood’ (constituency), and building_tool’ (telos). Metaphoric readings emerge when the qualia of two lexical items are merged, and coerced into a reduced structure. Simplifying formal matters considerably, we can treat the quale structure of fox as including the properties λx.¬human’(x)∧cunning’(x), and the quale structure of Tarma coinciding with the constant t. In the sentence Tarma is a fox, the two qualia structures are merged. Thus, the property of being cunning is ascribed to Tarma (i.e. we have cunning’(t) via λ-conversion), and the resulting structure is coerced to a simpler type (here, constituency for cunning’). Therefore, metaphoric readings emerge when restricted and possibly abstract qualia structures are obtained via composition. TLC offers an analysis along very similar lines; hence, we can consider it equivalent to GL’s analysis.

Notably, Chung (2011) is a work within GL that offers an analysis of SPs. The qualia structures making up an SP sense involve types for “location”, “arrangement” and “state” properties (e.g. λx.loc’(x)∧arr’(x)∧state’(x)). An SP that combines with a non-spatial DP has its “location” type changed (or coerced) into a “state” type. Simplifying matters again, the qualia structure of in love can be represented as state’(l) (l being the constant that love denotes), with the “spatial” types of properties loc’ and arr’ being excluded from this quale structure. Thus, metaphoric readings for SP(P)s also involve coercion and restriction of their types. TLC lacks an account of SPPs and their readings, but would lend itself to a similar analysis.

A third, intermediate position is found in Conceptual Semantics (CS) (Jackendoff, 1983, 1990). CS is based on the assumption that lexical items denote Lexical Conceptual Structures (LCSs), which involve the principled combination of universal semantic categories (e.g. PLACE, PATH, THING, SITUATION). The LCS of a sentence is based on the combination of the LCSs of its constituents, which define the semantic relations among the different categories. Furthermore, CS proposes the thematic relation hypothesis: relational elements denote LCSs that can take different types of LCSs as their arguments, but assign the same roles to these arguments. Thus, the SPPs in love and in the room involve two DPs with the same role (love and the room as grounds). However, literal or metaphoric readings arise as a consequence of each DP denoting different “sub-concepts” of the THING concept: LOCATION for room, STATE for love.

As our concise overview suggests, these three different semantic strands take a similar stance on how metaphoric readings can arise. However, each strand lacks the syntactic tools to analyse any constructions beyond copular constructions. For instance, CMT, GL and TLC lack a supporting syntactic apparatus. Even Chung (2011), which also studies in detail Boolean phrases with DPs as arguments, does not address Boolean phrases involving SPPs. A similar problem arises in CS, since this theory only deals with the morpho-syntactic structure of single SPs. Since our data suggest that metaphoric readings emerge at the phrasal level in Boolean phrases and sentences alike, they also highlight the need for a proper syntactic and semantic analysis of these data. We offer our analysis in
sections 3 and 4.

3. The Proposal: Syntactic Assumptions and Analyses

The goal of this section is to first discuss generative syntactic analyses of SPs (section 3.1), then present our Type Logical Syntax apparatus (TLS: section 3.2) and analysis (section 3.3).

3.1 A structure for SPs and their sentences

Traditional generative analyses of SPs suggest that this category includes two morphosyntactic heads (Jackendoff, 1983, 1990; Kracht, 2002). Common labels are “Path” and “Place”, or “Dir(ectional)” and “Loc(ative)”, iconic labels that capture the content of each head. There are, however, three different proposals on their hierarchical relation. The classical analysis suggests that Path takes PlaceP as an argument (i.e. a Place head with a DP complement). The second analysis, mostly based on data from fusive/agglutinative languages (e.g. German, Hungarian) suggests that Place is a morphological segment of Path (Emonds, 1985, 2000; van Riemsdijk, 1998; van Riemsdijk & Huybregts, 2007). The third analysis, known as the “P-within-P” hypothesis, suggests that the Place head, or an SP with similar properties, sits in the specifier position of another SP head (Hale & Keyser, 2002).

The structures that these analyses suggest for English SPs are shown in (29)-(31):

(29) [PathP from [PlaceP under [DP the sofa]]]
(30) [PathP [Path [Place in-to] [the room]]]
(31) [SP [SP ahead] of [DP the car]]

The structure in (29) presents the classical analysis, based on the syntactically complex SP from under the sofa, as an SP including two distinct lexical items (cf. Jackendoff, 1983). The structure in (30) presents the second analysis, which can account for the structure of morphologically complex SPs (here, in-to). The structure in (31) presents the “P-within-P” analysis, which can account for SPs involving complex SPs headed by of, viz. ahead, in front.

Although each of these analyses has its merits, the P-within-P hypothesis has two advantages that identify it as a better analysis for our purposes. First, it permits a slightly more general account of SPs, with the proviso that any SP (e.g. from in (29)), or morphological part thereof (e.g. in, ahead in (30)-(31)) sit in the specifier position of another SP head (e.g. of in (31)). Second, it allows us to analyse Boolean phrases as sub-types of prepositional (coordinative) phrases (cf. Emonds, 1985, 2000; Hale & Keyser, 2002; Camacho, 2003). However, differently from SPs, Boolean connectives are syncagorematic: they take arguments belonging to the same category, here SPs or DPs (e.g. Emonds, 1985; Winter, 2001; Camacho, 2003; among others). The simple and yet precise account of the Boolean phrases and SPPs it can offer is offered in (32)-(34):
The structures in (32)-(34) show that Boolean phrases and SPs share similar underlying structures, in the sense that a main head (e.g. the SP of, or the silent SP “(P)”, and and or) takes two arguments to form a phrase. For both SPs and Boolean phrases, these arguments can be DPs or SPPs, although in slightly different combinations. SPs take another SP(P) and a DP as arguments, while Boolean connectives take two arguments of the same type (e.g. DPs). Furthermore, (34) shows that Boolean phrases in specifier position act as “complex” phrasal arguments of a head, but arguments nonetheless.

Although descriptively adequate, these structures should nevertheless be seen as the result of syntactic processes that combine distinct lexical items and phrases into larger units. We need this “dynamic” perspective, since we need to make precise “when” and how the structural differences in our three patterns license literal, metaphoric or even uninterpretable readings, as discussed via (1)-(28). Without this derivational perspective and an apparatus to represent it, these differences would become hard if not impossible to capture, as it will become via the discussion of our data. We thus outline our apparatus and analysis in the following sections.

3.2 A TLS fragment

In this section we present Type-Logical Syntax (TLS) (Moortgat, 2010; Morrill, 2011), in order to present our analysis of the syntactic processes underpinning our examples. We employ a TLS formalism for two key reasons. First, TLS permits us to assign homogenous types to distinct phrases (e.g. SPs and Boolean SPs), and connect the emergence of metaphoric readings to the syntactic contexts that license them. Second, TLS calculi permit to define a transparent mapping from syntactic structures to semantic interpretations, literal and metaphoric alike.

In TLS calculi, all lexical items are assigned types. Types can be seen and represented as being either complete or output types, or incomplete or input types. Complete types represent derivational units that can stand as independent items, for instance phrases (e.g. np for the girl). Incomplete types are assigned to units that must combine with other items, to form a complete type (e.g. s\np for the verb dines). Since the girl and the verb dines match in input type (np), the sentence the girl dines can be derived, and be assigned type s.

In our analysis, we follow these basic rules of type assignment. However, we take a perhaps less naïve view of lexical categories than the standard view found in TLS. We base this view on the current analysis of these categories in current generative theories. According to this analysis, all lexical items, be they nouns, verbs or other categories, are formed via the merge of category-less roots and category-assigning morphemes (e.g. little v: Hale & Keyser, 2002; Acquaviva & Panagioditis, 2009; Acquaviva, 2012).
Their precise status as nouns, verbs or other categories depends on the features that these category-assigning morphemes carry. As a result, the phrases that these items can form mostly share their underlying distributional properties. Hence, we use only one basic “universal” type \( p \), mnemonic for “phrase”, to represent any phrase, and to recursively represent complex types assigned to e.g. heads.

We turn to a definitions of the operations and connectives that regulate how words, qua combinations of types, are combined into phrases and sentences. The connectives “/” and “•” respectively represent the right division and product operations (Moortgat, 2010, §2; Morrill, 2011, ch. 1). Division is an idempotent, binary, associative operation, while product is also a non-commutative operation: product types are taken as ordered pairs of types. While (right) division can increase the complexity of our structures, product defines whether two units can be combined in a principled way. We leave aside other connectives (e.g. left division ‘\( \backslash \)’) (Morrill, 2011), as we do not deem them necessary in our analysis. We can now define our (recursive) set of types via the rules in (35):

\[
(35) \begin{align*}
1. \text{Given a Lexicon } L, & \ p \text{ is a morphological type} & \quad \text{(Lexical type)} \\
2. \text{If } x & \text{ is a type and } y \text{ is a type, then } x/y \text{ is a type} & \quad \text{(Type formation: Division)} \\
3. \text{If } x/y & \text{ is a type and } y \text{ is a type, then } (x/y)\cdot y \vdash x, y\cdot(x/y)\vdash x & \quad \text{(Merge: forward app.)} \\
4. \text{Nothing else is a type} & & \quad \text{(Closure rule)}
\end{align*}
\]

Rule 1 defines \( p \) as the basic type from which complex types are built. Rule 2 defines how complex types representing heads or complex morphemes (e.g. affixes) are formed. Rule 3, forward application, roughly corresponds to the merge operation in generative (minimalist) frameworks (cf. Hale & Keyser, 2002; Harbour, 2007). This rule defines how lexical items are combined to form more complex structures (e.g. phrases, sentences). The rule says that adjacent and matching types are cancelled out. If two types do not match (e.g. we merge \( x \) and \( y \)), a derivation is said to diverge or crash. The three-place connective ‘\( \vdash \)’ says that, if we take two inputs of a certain type, then we can prove that their result is an output of a certain type. Rule 4, the closure rule, says that no other methods to derive types are possible, in our system. Via this set of assumptions, we can generate the minimal set type \( \text{TYPE}=\{p, p/p, p/p/p\} \). More complex types can be defined and employed for our analysis (cf. Ursini, 2013, 2014a, b, 2015a, b; Ursini & Akagi, 2013a, b). However, for our goals this simple type set will suffice to account for the syntactic aspect of our data.

In order to capture the cyclical and sequential nature of our derivations, we define a simple pre-order as the pair of an interval set \( I \), and an addition operation ‘\( + \)’, i.e. \( <I,+> \). We implement two labels, Lexical selection (LS) and Merge Introduction (MI), to explicitly represent the selection of a lexical item and the merge of two elements. A basic derivation is shown in (36), with each consecutive step showing the involved operation on the right side:

\[
(36) \text{a. Mario loves Peach}
\]
This simplified derivation reads as follows. A phrasal element, the DP Mario, is merged with the transitive verb loves. Since the first element is assigned type p and the second type p/p/p, the merge of these elements is assigned type p/p/p, as a result of this derivational process. The further merge of Peach allows the full sentence Mario loves Peach to be formed, an object of type p. This VP can be seen as minimal clausal structure that the three constituents form, via the merge operation. A more accurate analysis of sentence structure could be offered but, for our purposes, this simplified view will suffice to account for the data. With these basic definitions in place, we turn to the analysis of our data.

3.3 Analysis of the data

We start our analysis by first motivating the type assignment to lexical items (DPs, SPs, verbs, Boolean heads) that we employ for our analysis. First, we assign type p, the type of phrases, to ground and figure DPs (e.g. the car, her freedom, danger), thus leaving aside an analysis of their internal structure. We also assign type p to “internal” SPs such as in front (viz. in front of). These are simplifications that we can afford, since the internal structure of these phrases does not play a role in our discussion. Second, we assign type p/p/p to heads, including SPs of and “(P)”, the silent head, Boolean connective and or, and verbs (e.g. copula is, other verbs such as has gone). This type assignment is summarized in (37):

(37) a. p:= {Marco. at, in, in front, the beach, love, at the beach, in front of the desk, in love,...}  
   b. p/p/p:= {(P), of, is, has gone, and, or,...} 

This type assignment appears coarse-grained, since it only captures the basic valence and distributional properties of each lexical item and category. For instance, it captures the fact that simple SPs (e.g. in, in front) and SP phrases (e.g. in love) can act as arguments of other heads (e.g. of), including Boolean and or. It also indirectly shows that, when a type p is derived, then the corresponding phrase may or may not have a metaphoric reading (viz. in front of the desk and the derivations to follow). However, since our crucial concern is to show how (and “when”) the structures in (32)-(34) come about, this coarse-grained approach seems precise enough.

We can now move to the analysis. We start by offering a complete derivation of (8), repeated here as (38a), to outline how our system works:

(38) a. Tarma has gone in front of the desk
The derivation in (38b) shows that a sentence (here, a VP) is derived when a verb is merged with a figure DP and an SPP including a ground DP (steps $t$ to $t+8$). This SPP, in turn, is derived when an SP(P) and a ground DP are merged, in this order (steps $t+5$ to $t+8$). When these phrases are derived, their corresponding interpretation can license a literal reading, at the final step (i.e. $t+8$). Therefore, at a syntactic level we can identify the derivational intervals at which phrases are formed, and “when” the computation of literal or metaphoric readings emerges.

A consequence of this analysis is that sentences receiving metaphoric readings are predicted to have parallel derivations, since they involve the merge of the same lexical items and corresponding types. This is shown via (39), which repeats (10) as (39a):

(39) a. Marco was at the mercy of Morden’s troops

b. $t$. [ Marco$_p$] (LS)
   $t+1$. [ was$_{ppp}$] (MI)
   $t+2$. [ Marco$_p$][ was$_{ppp}$]$(\cdot)$[ Marco$_p$] was$_{ppp}$] (MI)
   $t+3$. [ at$_p$ ] (MI)
   $t+4$. [ Marco$_p$] was$_{ppp}$]$(\cdot)$[ at$_p$ ][ Marco$_p$] was$_{ppp}$] (MI)
   $t+5$. [ (P)$_{ppp}$] (MI)
   $t+6$. [ Marco$_p$] was$_{ppp}$]$(\cdot)$[ at$_p$ ][ Marco$_p$] was$_{ppp}$] (MI)
   $t+7$. [ the mercy of Morden’s troops$_p$] (MI)
   $t+8$. [ Marco$_p$] was$_{ppp}$]$(\cdot)$[ at$_p$ ](P)$_{ppp}$)[ the mercy of Morden’s troops$_p$] (MI)

The key step in (39b) is the final step, which involves the merge of the DP the mercy of Morden’s troops, and the computation of the metaphoric reading for SPP and sentence. Once this DP merges with a silent P and forms an SPP, a metaphoric reading can arise at a phrasal and sentential level, again at step $t+8$. Hence, as the derivations in (38b) and (39b) show, our account can make precise the steps “when” metaphoric and literal readings are computed, at least in sentences not involving SPPs in Boolean phrases.
The next step in our analysis consists in deriving sentences including Boolean phrases. For reasons of space, we only present the steps that derive the Boolean phrases, thus offering partial derivations in which we merge fully derived SPPs. We start from the first pattern: SSPs acting as arguments of and or. We repeat (15) as (39a) and offer its derivation in (40b):

(40) a. Mario walks along the river and near the forest
   b. t+8. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [p along (P) the river]}\) \(\text{(MI)}\)
      t+9. \([\text{ and}_{ppp}\text{]}\) \(\text{(LS)}\)
      t+10. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [p along (P) the river]}\text{ and}_{ppp}\text{]}\)
          \(\text{[}[\text{ Marco}_p]\text{ walks}_{ppp} \text{ [p along (P) the river]}\text{ and}_{ppp}\text{]}\) \(\text{(MI)}\)
      t+11. \([p\text{ near the forest }\text{]}\) \(\text{(LS)}\)
      t+12. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [p along (P) the river]}\text{ and}_{ppp}\text{]}\text{ [p near the forest]}\)
          \(\text{[}[\text{ Marco}_p]\text{ walks}_{ppp} \text{ [p along (P) the river]}\text{ and}_{ppp}\text{[p near the forest]}\text{]}\) \(\text{(MI)}\)

As (40b) shows, the merge of and with an SPP (along the river) licenses the derivation of the Boolean phrase, once the second SPP (near the forest) is also merged (steps t+8 to t+12). Thus, the resulting phrase may involve a combination of literal and metaphorical readings. This “mixed” reading is computed when the full Boolean phrase is derived, at step t+12. A parallel analysis can be applied to Boolean phrases belonging to the second pattern (e.g. behind the table and/or the chair in (15)-(16)). Once the coordinated DPs (i.e. the table, the chair) form a phrase that merges with an SP (i.e. behind), the derived SPP can receive its corresponding reading. Furthermore, the same reasoning applies when the Boolean phrases include mixed readings (e.g. over the bridge and/or her fears, in (27)-(28)). Once a ground DP is merged with an SPP, even if the DP is a Boolean phrase, a given reading is derived accordingly.

The same type of analysis also applies to the third pattern of Boolean phrases. We illustrate this point by repeating (20) as (40a), with its compressed derivation in (40b):

(41) a. Mario walks ahead or to the left of the car
   b. t+8. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [ahead}_p]\) \(\text{(MI)}\)
      t+9. \([\text{ or}_{ppp}\text{]}\) \(\text{(LS)}\)
      t+10. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [ahead}_p\text{]}\text{ or}_{ppp}\text{]}\)
          \(\text{[}[\text{ Marco}_p]\text{ walks}_{ppp} \text{ [p [ahead}_p\text{]}\text{ or}_{ppp}\text{]}\) \(\text{(MI)}\)
      t+11. \([p\text{ to the left }\text{]}\) \(\text{(LS)}\)
      t+12. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [p to the left]}\text{ or}_{ppp}\text{[p to the left]}\)
          \(\text{[}[\text{ Marco}_p]\text{ walks}_{ppp} \text{ [p [to the left]}\text{ or}_{ppp}[p\text{ to the left]}\text{]}\) \(\text{(MI)}\)
      t+13. \([\text{ of}_{ppp}\text{]}\) \(\text{(LS)}\)
      t+14. \([p\text{ [Marco}_p]\text{ walks}_{ppp} \text{ [p to the left]}\text{ or}_{ppp}\text{[p to the left]}\text{ of}_{ppp}\text{]}\)
          \(\text{[}[\text{ Marco}_p]\text{ walks}_{ppp} \text{ [p [to the left]}\text{ or}_{ppp}[p\text{ to the left]}\text{]}\text{ of}_{ppp}\text{]}\) \(\text{(MI)}\)
      t+15. \([\text{ the car}_p\text{]}\) \(\text{(LS)}\)

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Here, the two SPs are first merged with or (steps \( t+8 \) to \( t+12 \)). Then, the resulting Boolean phrase becomes the specifier argument of the SPP (steps \( t+13 \) to \( t+14 \)). Once a Boolean phrase is formed via the merging of a DP (steps \( t+15 \) to \( t+16 \)), its literal or metaphorical reading is determined via the interpretation of its arguments. As in our previous derivations, the resulting interpretation is also percolated at a sentential level, as a result. Thus, the interpretation for this pattern of Boolean phrases is to an extent “delayed” until the ground DP is merged.

We can now discuss how sentences involving “mixed” readings (i.e., one SPP conjunct per literal and metaphorical readings) can be derived. Consider (42a), which repeats (28):

(42) a. Fio has meditated near the table or over her problems

b. \( t+8. \) \([\{ Fio \} \text{meditated}_{ppp} \{ p \text{ near the table } \}] \) (MI)

t+9. \([ \text{or}_{ppp} ] \) (LS)

t+10. \([\{ Fio \} \text{meditated}_{ppp} \{ p \text{ near the table } \}] \cdot [ \text{or}_{ppp} ]\) (MI)

t+11. \([ p \text{ over her problems } ] \) (LS)

t+12. \([\{ Fio \} \text{meditated}_{pp} \{ p \text{ near the table } \} \cdot \text{or}_{ppp} ]\) (MI)

The derivation in (42) shows that a Boolean phrase involving a combination of literal and metaphorical readings for its SPPs is derived via the same principles involved in the other derivations. This entails that these mixed readings are also computed once the Boolean phrase is derived (step \( t+12 \)), as we would expect from our analysis. Overall, the net result is that we now have an account of the syntactic structures underpinning examples (1)-(28). Thus, we have proven that when an SPP and a Boolean phrase are derived, qua phrases, one of the three possible readings emerges (literal, metaphorical, and mixed). This holds for all three patterns of Boolean phrases that we have discussed, as we have shown via the derivations in (38)-(42). We can thus move to the analysis of the semantic data.

4. The Proposal: Semantic Assumptions and Analyses

The goal of this section is to present a situation semantics framework (section 4.1), and give an account of our data that builds on this framework (section 4.2).

4.1 A situation semantics analysis

The literature on the semantics of SPs offers several proposals on the ontological status of their denotations. As partly discussed in section 2.1, formal proposals suggest that SPs denote regions (Nam, 1995; Kracht, 2002), vectors (Zwarts & Winter, 2000), paths
(Jackendoff, 1983, 1990; Zwarts, 2008), eventualities (Landman, 2004), or combinations thereof (Krifka, 1998; Gehrke, 2008). Cognitive linguistics also suggests that, when metaphoric readings are accessed, SPs denote “states” (e.g. Evans, 2009, 2010a), temporal entities, or events (e.g. Lakoff, 1993; Fauconnier & Turner, 2000, 2008). As our data show, the different semantic sub-types of denotata for SPs can co-exist in the semantic space of Boolean phrases. This fact indirectly suggests that metaphoric and literal readings indirectly correspond to interactions amongst these types and their relations, in SPPs and Boolean phrases alike.

For this reason, we assume that all our categories find their denotation in the type of situations, here intended as a universal super-type (Barwise & Perry, 1999; Ginzburg, 2005; Kratzer, 2007). Situations form a Boolean algebra, a set ordered via the part-of or accessibility relation (Barwise & Etchemendy, 1990), which can also represent the “mapping” relation of cognitive approaches (e.g. Fauconnier & Turner, 2000, 2008). This relation is usually represented as “\(a \preceq b\)”, which reads: “\(a\) is part of \(b\)” or “\(a\) is accessible to \(b\)”.

The following properties hold: if \(a\) is part of \(b\), then \((a \cap b) = a\) and \((a \cup b) = b\). In other words, if a situation is part of (accessible to) another situation, then their union will be the super-set situation (here, \(b\)), and their intersection will be the sub-set situation (here, \(a\)).

Via this pair of rules, we can establish the type of the relation they form, \(\preceq\) a distinct object in a model (a situation). Thus, if the relation \(a \preceq b\) holds, then the relation \(\text{type}(a) \leq \text{type}(b)\) holds, too. This latter relation will play a key role in our analysis of the readings that emerge at an SPP and Boolean phrase level. Since we are reasoning with Boolean algebras, we can have an empty situation, represented via the empty set “\(\emptyset\)”. The role of the empty situation will become clear when we will discuss uninterpretable examples.

We then borrow an assumption found in GL and TLC: that types and relations are systematically related (e.g. Pustejovsky & Asher, 2013; Asher, 2011; respectively). Aside from the universal type of situations, more specific sub-types can be defined, and with them relations amongst these types. Thus, our Boolean algebra of situations can be defined as the duple \(S = \langle T = \{L,D,E,\ldots\}, \preceq \rangle\), with \(T\) our set of Types of situations, and ‘\(\leq\)’ doubling as a part-of/accessibility relation defined over types. In this set of types, we identify the sub-type \(L\) of spatial situations (‘Locations’), which can include atomic and sum locations (e.g. we have \(L = \{a, b, \{a,b\}, \ldots\}\)). Other types we employ are the set \(D\) of individuals and the set \(E\) of eventualities. Note that we can talk about situations as objects that our items denote, but also about the super-type of situations. Our discussion will (hopefully) make clear whether we are discussing types or denotations with a certain type.

A consequence of this assumption is that our Boolean algebra includes relations amongst situations that can belong to distinct types. Hence, it also includes relations amongst these types, and relations amongst the senses belonging to these types. Furthermore, since super- and sub-types can be defined, phrases and sentences with different senses can find their senses/readings in these types. We thus reconstruct the notions of “sense network” and polysemy as relations between senses (e.g. Lakoff, 1993; Evans, 2009), and use them to define how readings, \(qua\) phrasal senses, emerge. Before
we explain this matter further, we spell out the rules of type-formation and type-reduction in (43):

(43) 1. Given a set S, s is a semantic type (Lexical type)
2. If a is a type and b is a type, then a→b is a type (Type formation: Function)
3. If a→b is a type and b is a type, then (a→b)×a⊨b (Function application)
4. Nothing else is a type (Closure property)

These rules mirror in the semantic component the syntactic rules we have defined in (35), a point that we explain in more detail in the next few paragraphs. The rules include the (ternary) operator “⊨”, which is the semantic counterpart of “⊢”. While “⊢” represents a proof that two syntactic units can be combined, “⊨” represents a proof that their senses can be composed accordingly. Rule 1 defines the basic semantic type of situations s, which mirrors the syntactic type p, while rule 2 allows the definition of more complex types via function abstraction/formation. Hence, this rule indirectly states that functions, and relations are part of our domain of interpretation (cf. also Szabolcsi, 1997; Harbour, 2007). Rule 3 shows, instead, how these types interact via function application, the semantic counterpart of merge/forward application, represented via the symbol “×” (e.g. Moortgat, 2011, §2.2-2.3). Finally, rule 4 establishes that no other semantic rules are used.

A set of types generated by these definitions is the set TYPE={s,s→s,s→(s→s)}. This set includes the type of referents, functions, and relations, respectively. For interpretive matters, we implement a simple form of λ-calculus to represent our functions (e.g. λx.f(x)) and relations (e.g. λx.λy.R(x,y): Kratzer 2007, among others). The precise details will be clear once we offer our account in the next section. We can now define a mapping between morphological and semantic types, with corresponding standard interpretations. The mapping is shown in (44):

(44) SYNTAX⇒SEMANTICS⇒INTERPRETATION

\[ p \Rightarrow s \quad \Rightarrow s_s; (a \leq b) \]
\[ p/p/p \Rightarrow s \rightarrow (s \rightarrow s) \quad \Rightarrow \lambda x.\lambda y.s_l; (x \leq y) \]

The semantic type s corresponds to syntactic type p. It can denote arguments or saturated relations (e.g. s_l; (a ≤ b)), relations in which argument values have been computed. The subscripts capture the sub-type of a situation: s has the type l of locations (i.e. we have s_l and s_l; (a ≤ b)). Thus, s_l; (a ≤ b) reads: in a situation s_l, a spatial (part-of) relation between a and b holds, as a relation between locations. The semantic type s → (s → s), instead, corresponds to the type p/p/p. As a result, P heads denote part-of relations, represented as \( \lambda x.\lambda y.s_l; (x \leq y) \). When two arguments are inserted in a relation via \( \lambda \)-conversion, a saturated (also structured) situation s_l; (a ≤ b) is derived, accordingly. Crucially, the situations instantiating these relations receive their type via a simple and precise principle of type percolation or accommodation. This principle can be defined as follows.
Consider a structured situation $s$, the situation that is exemplified in a (saturated) relation, or $s:(a \leq b)$. If we have a situation $s:(a_1 \leq b_1)$ as a situation in which two locations are defined as one being accessible to/part of another, then the structured situation $s_1$ will inherit the type $s_1$ from its arguments. Its type $s_1$ is accommodated to the sub-type $l$ of its arguments, since the relation $l \leq s$ holds.

In other words, the type of a saturated relation ultimately depends on that of its arguments, and can in turn determine the reading of the phrase in question.

This principle is assumed, in one form or another, in most of the semantic theories we have discussed so far. In situation semantics this inheritance principle on the type of situations is known as persistence (von Fintel, 1994; Kratzer, 2007). Equivalent accounts can also be obtained via TLS’s monotonicity inference rule (Johnson & Bayer, 1995; Moortgat, 2011), or type accommodation in TLC and GL (Asher, 2011; Asher & Pustejovsky, 2013). This procedure also mirrors the assumption found in blending theory that metaphoric readings emerge when meanings from distinct domains are connected, and domain blending occurs (Fauconnier & Turner, 2000, 2008). Thus, by implementing this procedure in our analysis, we bring together insights from seemingly distinct semantic frameworks. Since all of these principles are ultimately forms of (upward) monotonicity, we adopt the label “monotonicity” to take a theory-neutral stance in our discussion.

We now offer a sample semantic derivation of (37) in (45), in which we directly present the interpreted lexical items, with the labels interpretation (Int) and function application (FA) as semantic matches of LS and MI:

\[(45)\]
\begin{align*}
\text{a. Mario loves Peach} \\
\text{b. t. } & \quad \text{[[ Mario ]]}\models m_1 & \text{(Int)} \\
& \quad [[ \text{loves}_{pp} ]] \models \lambda x. \lambda y. s: \text{love'}(x,y)_{s \rightarrow (s \rightarrow s)} & \text{(Int)} \\
& \quad t+1. [[ \text{loves}_{pp} ]] \models \lambda x. \lambda y. s: \text{love'}(x,y)_{s \rightarrow (s \rightarrow s)}(m) = \lambda y. s: \text{love'}(m,y)_{s \rightarrow s} & \text{(FA)} \\
& \quad t+2. [[ \text{Mario} ]] \times [[ \text{loves}_{pp} ]] \models \lambda x. \lambda y. s: \text{love'}(x,y)_{s \rightarrow (s \rightarrow s)} & \text{(Int)} \\
& \quad t+3. [[ \text{Peach} ]] \models p_1 & \text{(Int)} \\
& \quad t+4. [[ \text{Mario} ]] \times [[ \text{Peach} ]] \models \lambda y. s: \text{love'}(m,y)_{s \rightarrow (s \rightarrow s)}(p) = \lambda y. s: \text{love'}(m,p) & \text{(FA)}$
\end{align*}

As always, “[[.]]” represents the interpretation function. For the sake of simplicity, we translate loves as $s: \text{love'}(x,y)$: a situation in which two referents stand in a “love” relation. The interpretations of Mario and Peach, the referents $m$ and $p$, become the arguments of the love relation $l$ in this order, via standard function application. For simplicity, in (45) we do not represent the sub-type of the referents $m$ and $p$ (i.e. individuals $d$), and we do not restrict the verb type to represent it as a relation between individuals. In our analysis, however, we will be more precise, as we need to display when the various readings arise. 5

### 4.2 The analysis of the data

We begin our analysis from the interpretation of our argument phrases. We assign the type $l$ of locations to SPs and ground DPs, as our data suggest. We assign the type $s/s/s$ to of and the silent “P” head, as the type of relations that take two situations as arguments and
map them onto a “saturated” situation. The types of the relations that SPPs denote, and the situations they instantiate (i.e. their readings), are computed via monotonicity. We discuss the precise consequences of this result in the remainder of the section.

The corresponding type assignment is offered in (46), whereas the set of interpretations we offer for our lexical items is in (47):

\[(46)\]
\[
\begin{align*}
\text{a. }& s := \{\text{Marco, at, in, in front, the beach, love, at the beach, in front of the desk, in love,...} \} \\
\text{b. } & s/s/s := \{(P), \text{ of, is, and, or,...} \}
\end{align*}
\]

\[(47)\]
\[
\begin{align*}
\text{a. } & [\text{Marco} ] \models m_p, [\text{the car} ] \models c_p, [\text{at } ] \models a_r, [\text{in front } ] \models fr_l, \\
\text{b. } & [P ] \models \lambda x.\lambda y. s_s : (x \leq y), [\text{of } ] \models \lambda x.\lambda y. s_s : (x \leq y), [\text{and } ] \models \lambda x.\lambda y. s_s : (x \cap y), \\
& [\text{or } ] \models \lambda x.\lambda y. s_s : (x \cup y), [\text{has gone } ] \models \lambda x.\lambda y. s_s : go' (x,y), [\text{was } ] \models \lambda x.\lambda y. s_s : is' (x,y)
\end{align*}
\]

In other words, proper names and ground DPs (e.g. Marco, the car) denote distinct referents, acting as figure and ground (viz. (47a)). However, while Marco denotes a referent of type \(d\) (individuals), the car and with it the SPs at and in front, among others, denote locations of type \(l\). Thus, this simplified treatment can capture the intuition that these SPs can denote a set of locations (e.g. general locations for at, frontal locations for in front) defined with respect to a ground. The silent “P” head and of denote a part-of/accessibility relation between various types of entities. Thus, via monotonicity, the resulting phrases can denote situations instantiating relations with a spatial type (a literal type), or a situation type (a metaphoric type). The same reasoning applies to and and or, which respectively denote conjunctions and unions of situations defined (and typed) in this compositional manner.

For the verbs (e.g. the copula, has gone) in our examples, we assume a simplified semantics. We do not translate temporal and aspectual morphology (e.g. the present perfect contribution in verbs such as has gone). Unlike SPs, we consider verbs not to be “deeply” polysemous, although this is certainly a necessary simplification, for our purposes (cf. Pustejovsky, 1995; Asher, 2011). Hence, we directly assign them the type \(e\) of eventualities. Note that in our simple list of interpretations in (47), we do not offer an interpretation of whole phrases, as these are offered in our analysis of the data.

We now discuss the interpretation of our examples. Our crucial concern is to capture the basic interpretation of SP phrases, and show how they can be combined in Boolean phrases. The compositional interpretation of our first example, (38), is offered in (48):

\[(48)\]
\[
\begin{align*}
& t. \quad [\text{Tarma } ] \models t_d \\
& t+1. \quad [\text{has gone } ] \models \lambda x.\lambda y. s_s : go' (x,y) \\
& t+2. \quad [\text{Tarma has gone } ] \times [\text{has gone } ] \models (t_d \times \lambda x.\lambda y. s_s : go' (x,y)) = \lambda y. s_s : go' (t_d,y) \\
& t+3. \quad [\text{in front } ] \models fr_l \\
& t+4. \quad [\text{Tarma has gone } ] \times [\text{in front } ] \models \lambda y. s_s : go' (t_d,y) \times (fr_l) = s_s : go' (t_d,fr_l) \\
& t+5. \quad [\text{of } ] \models \lambda x.\lambda y. s_s : (x \leq y) \\
& t+6. \quad [\text{Tarma has gone in front } ] \times [\text{of } ] \models s_s : go' (t_d,fr_l) \times (\lambda x.\lambda y. s_s : (x \leq y)) =
\end{align*}
\]
In other words, the derivation in (48) says that a sentence such as *Tarma has gone in front of the car* denotes a situation $s$, in which Tarma, an individual, is related to a frontal location defined with respect to a given car. This situation receives the type $e$ of events. This is the case, since it involves an individual and a location that the individual reaches, after moving in the ground’s direction. This is another simplification, but one that is consistent with standard treatments of the semantics of motion verbs (e.g. Landman, 2004; Gehrke, 2008). The situation $s'$, which represents Tarma’s “frontal” location after moving, receives its spatial type $l$ via monotonicity, when both arguments are inserted in the relation (steps $t+5$ to $t+8$). Since *in front* and *the car* are assigned the type $l$ of locations, the SPP *in front of the car* denotes a spatial relation between locations. As a consequence, $s'$ is also of type $l$ as shown in $t+8$. As a result, the literal reading for this SPP emerges via monotonicity.

Via this example, we can make now precise the notion of “reading”, defined as the type that the sense of a phrase (here, an SPP) denotes. Since a phrase that denotes a situation that instantiates a (saturated) relation, its type is its corresponding reading. Furthermore, we can also make precise the notion of “literal” or spatial reading for SPPs as a reading involving a relation between two locations, as arguments of the same type. Note, also, that the verb *has gone* merges with two arguments with matching types, the situation for the whole sentence has a literal reading. However, this reading emerges because the sentence denotes an event in which Tarma goes in front of the desk. We now have the prolegomena for a full account of readings in Boolean phrases.

With this derivation at our disposal, we discuss our example (39) in (49):

(49) $\begin{align*}
& t. \quad [[ \text{ Tarma }]][=t_d] \quad \text{(Int)} \\
& t+1. \quad [[ \text{ was }]] = \lambda x. \lambda y. s_i :is'_{(x,y)} \quad \text{(Int)} \\
& t+2. \quad [[ \text{Tarma}]][[[ \text{ was }]]] = (t_d) \times (\lambda x. \lambda y. s_i :is'_{(x,y)}) = (\lambda y. s_i :is'_{(t_d,y)}) \quad \text{(FA)} \\
& t+3. \quad [[ \text{ at }]] = a_i \quad \text{(Int)} \\
& t+4. \quad [[ \text{Tarma was }]][[[ \text{ at }]]] = (\lambda y. s_i :is'_{(t_d,y)}) \times (a_i) = s_i :is'_{(t_d,a_i)} \quad \text{(FA)} \\
& t+5. \quad [[ \text{ (P) }]] = \lambda x. \lambda y. s_i :is'_{(x,y)} \quad \text{(LS)} \\
& t+6. \quad [[ \text{Tarma was at }]][[[ \text{ (P) }]]] = s_i :is'_{(t_d,a_i)} \times (\lambda x. \lambda y. s_i :is'_{(x,y)}) = s_i :is'_{(t_d,\lambda y. s_i :is'_{(a_i,y)})} \quad \text{(FA)} \\
& t+7. \quad [[ \text{ the mercy of Morden’s troops }]] = d_i \quad \text{(Int)} \\
& t+8. \quad [[ \text{Tarma was at (P) }]][[[ \text{ the mercy of Morden’s...}]]] = s_i :is'_{(t_d,\lambda y. s_i :is'_{(a_i,y)})} \times (d_i) = s_i :is'_{(t_d,a_i :is'_{(a_i,d_i)})} \quad \text{(FA; mon.)}
\end{align*}$

Our derivation in (49) reads as follows. First, *at* is interpreted as denoting a general set
of possible locations for a figure, without specifying which location/state is at stake (cf. Coventry & Garrod, 2004; Feist, 2006; Ursini & Akagi, 2013c). The composition of *at* with a silent P and the partitive DP *the mercy of Morden’s troops* marks the emergence of a metaphoric reading (steps $t+5$ to $t+8$). Since this DP denotes a certain physical-intellectual state (i.e. surviving on someone’s mercy), its sense has a different type from the sense of *at*. Thus, the relation between a set of locations and a mood cannot be a spatial relation: it instantiates a more “abstract” situation.

As a consequence, the type of the SPP *at the mercy of Morden’s troops* is accommodated to the type $s$ of situations, via monotonicity (step $t+8$). A metaphoric reading arises, defined as a reading in which the arguments of a relation belong to different types, and the situation this relation instantiates belongs to their super-type. Consider now the fact that the copula denotes, in its literal sense, a relation between individuals and classes, both of type $d$ (e.g. *Mario is blonde/a man*: Partee & Rooth, 1983; Winter, 2001; Steen, 2007). Since in this sentence the copula denotes a relation between an individual and a state, monotonicity changes the type of this relation and the situation it instantiates, as $t+8$ shows. Therefore, the metaphoric reading of Mario being in a certain “mood” percolates from the SPP to the whole sentence.

Since we now have a more precise account of how literal and metaphoric readings in (5)-(16) can arise, we are ready to tackle the cases involving Boolean phrases. For this purpose, we offer the interpretation of (40) in (50). For practical reasons, we use constants (i.e. $a$, $b$, $c$) for our situation referents, from this point onwards:

\[
(50) \quad t+8. \quad [\text{Marco walks along (P) the river}] \models a_s \cdot \text{walk}^y (m_o, c_l; (al, r_j))
\]

\[
(50) \quad t+9. \quad [\text{and}] \models \lambda x. \lambda y. b_s : (x \cap y)
\]

\[
(50) \quad t+10. \quad [\text{Marco walks along (P) the river }] \times [\text{and }] \models
\]

\[
(a_s \cdot \text{walk}^y (m_o, s_l; (al, r_j)) \times \lambda x. \lambda y. b_s : (x \cap y) = \lambda y. a_s \cdot (\text{walk}^y (m_o, b_s; (c_l; (al, r_j)) \cap y))
\]

\[
(50) \quad t+11. \quad [\text{near the forest}] \models d_s : (nr \leq fs_l)
\]

\[
(50) \quad t+12. \quad [\text{Marco walks along (P) the river and }] \times [\text{near the forest}] \models
\]

\[
\lambda y. a_s \cdot (\text{walk}^y (m_o, b_s; (c_l; (al, r_j)) \cap y) \times d_s : (nr \leq fs_l) =
\]

\[
a_s \cdot (\text{walk}^y (m_o, b_s; (c_l; (al, r_j)) \cap d_s : (nr \leq fs_l))
\]

In other words, the phrase *along the river and near the forest* denotes a situation in which two spatial relations are defined with respect to Mario. These two relations instantiate the structured situations/locations $c_i$ and $d_i$. Thus, the type of this Boolean phrase and the situation it denotes (i.e. $b_i$) is also that of spatial relations, via monotonicity (viz. step $t+8$). Note here that, since the verb *walk* takes two distinct yet coordinated spatial relations as its arguments, the property of *distributivity* applies (Partee & Rooth, 1983; Winter, 2001). In other words, Mario is understood as walking along the river and also walking near the forest, with both relations holding in the situation $b$. Consequently, we can now account for the interpretation of examples involving the first pattern of Boolean SPs. Furthermore, this analysis can be applied to Boolean phrases including two ground
DPs, our second pattern (again, *behind the table and the chair* in (15)-(16)). The minimal difference is that the spatial relations introduced in this example are distributed to two grounds (here, the table and the chair), but co-existing in the same situation.

Consider now the interpretation of (41) in (51), featuring our third Boolean pattern:

(51) \begin{align*}
\text{t+8. } & [[ \text{ Marco walks ahead } ]] \models a; \text{walk'(m}_a \text{,ah}_j) \\
\text{t+9. } & [[ \text{ or } ]] \models \lambda x. \lambda y. b; : (xUy) \quad \text{(Int)} \\
\text{t+10. } & [[ \text{ Marco walks ahead } ] \times [[ \text{ or } ]]] \models a; \text{walk'(m}_a \text{,ah}_j) \times \lambda x. \lambda y. b; : (xUy) = a; \text{walk'}(m_a \text{,ly}_j : (ahUy)) \quad \text{(FA)} \\
\text{t+11. } & [[ \text{ to the left } ]] \models l_f \quad \text{(Int)} \\
\text{t+12. } & [[ \text{ Marco walks ahead or } ]] \times [[ \text{ to the left } ]] \models a; \text{walk'}(m_a \text{,ly}_j : (ahUy)) \times (l_f) = a; \text{walk'}(m_a \text{,ly}_j : (ahUy) \times (l_f)) \quad \text{(FA)} \\
\text{t+13. } & [[ \text{ of } ]] \models \lambda x. \lambda y. d; : (x \leq y) \quad \text{(Int)} \\
\text{t+14. } & [[ \text{ Marco walks ahead or to the left } ]] \times [[ \text{ of } ]] \models a; \text{walk'}(m_a \text{,ly}_j : (ahUy) \times (l_f)) \times (l_f) = a; \text{walk'}(m_a \text{,ly}_j : (ahUy) \times (l_f)) \times (l_f) \quad \text{(FA)} \\
\text{t+15. } & [[ \text{ the car } ]] \models c_l \quad \text{(Int)} \\
\text{t+16. } & [[ \text{ Marco walks ahead or to the left of } ]] \times [[ \text{ the car } ]] \models a; \text{walk'}(m_a \text{,ly}_j : ((ahUy) \times (l_f) \leq c_l)) \quad \text{FA; mon.}
\end{align*}

In other words, the interpretation of the Boolean phrase *ahead or to the left*, sitting in specifier position, corresponds to a union of locations (steps t+8 to t+12). This union of location becomes part of a relation with the ground (here, the car), and instantiates a structured spatial situation (steps t+13 to t+16). Thus, (51) is interpreted as an event in which Mario walks in a certain direction (“ahead” or “to the left”), and perhaps in both directions, with respect to this car. The SPP and sentences receive a literal reading via monotonicity, accordingly.

Thanks to this analysis, we can also explain why (23)-(24) are uninterpretable. Recall that, when metaphoric readings are involved, there is a tighter semantic relation between SP and underlying state (e.g. *over* but not *in his problems*: Deignan, 2003; Tseng, 2004; Evans, 2009). Unless SP and DP can denote a state with well-defined properties, the SPP cannot describe a certain state (e.g. being “in” love). In our framework, this entails that an SPP such as *in his problems* denotes a situation in which the relation between *in* and *problems* can only denote an empty situation $\emptyset$. Hence, the Boolean phrase it is merged also becomes uninterpretable: we cannot establish a situation corresponding to the interpretation of the Boolean phrase(s) *over and/or his problems*. Therefore, we account for why only literal readings can emerge and why metaphoric readings are for the most part blocked, in the third pattern.

The final example we discuss is (42), and its interpretation in (52), which presents an analysis of mixed readings in Boolean phrases:

(52) \begin{align*}
\text{t+8. } & [[ \text{ Fio has meditated near the table } ]] \models (a; \text{med'}(f_\alpha \text{,c}_i : (nr, t_j)))
\end{align*}
The crucial aspect of this derivation is the interpretation that emerges at step $t+12$. The two situations $c_i$ and $d_i$ respectively denote Fio’s position and state of mind. They thus represent distinct types of relations (i.e. a spatial relation, and a state Fio is experiencing), and the literal and metaphoric readings of their respective SPPs. Since we assume that $or$ denotes the union of these two situations and their types, the super-situation $s_s$ is formed. Note that the type of this situation is the super-type $s$, a fact that suggests that Boolean phrases with mixed readings are more accurately described as having metaphoric readings, too. The precise label for these readings is not crucial: what matters is that we can account for how mixed readings in Boolean phrases emerge, in a systematic manner.

Via this analysis we can also account for Boolean phrases belonging to the second pattern, and including metaphoric and literal readings (e.g. over the bridge and/or her fears, in (27)-(28)). Since these phrases denote a relation distributed over two arguments, the emerging relations can have distinct readings. In (27)-(28), the situation of Fio going over the bridge can be considered as involving a literal reading, and that of Fio going over her fears as involving a metaphorical reading, via distributivity. Subsequently, via monotonicity both readings become part of a situation in which both relations, whether they be spatial or metaphorical, involve Fio as the figure. In words, each reading is derived at an SPP level, and then it becomes conjoined/united to the other derived reading, at a Boolean phrase level. The so-called mixed readings can be seen as emerging from the interplay of these simple principles, and the relations defined on the types of relations and the situations they instantiate.

Let us take some stock, before concluding. We can now account for the semantics of SPPs in Boolean phrases, for each pattern we have discussed. Since our semantic analysis accounts for how literal and metaphorical readings can arise, and models the possibility that these distinct readings can co-exist, it aptly captures the meanings of sentences (1)-(28). Furthermore, the analysis captures the fact that speakers prefer the interpretation of $or$ with SPPs as being inclusive, as we discussed in section 2.2. We have employed a Boolean algebra for situations in order to account for the type relations and readings occurring in our examples. We also have used a corresponding Boolean (inclusive) interpretation for $and$ and $or$, and obtained an appropriate account of our examples. Analyses treating $or$ as relating mutually exclusive alternatives would not account for these results (e.g. Alonso-Ovalle, 2006, 2008), even if they would employ equivalent type relations. We now have a formally precise account of literal and metaphorical SPPs in Boolean Phrases; therefore, we have reached our goal.
5. Conclusions

In this paper we have presented an account of how literal and metaphoric readings in SP phrases arise (e.g. *at the beach, in love*), and how they can co-exist in Boolean phrases (e.g. *near the table or over her problems*). The key assumptions underpinning our account are twofold. First, senses and readings (i.e. senses of SPPs) find their types in the domain of situations, which includes various sub-types (locations, states, and so on) and their relations. Second, readings emerge as types of the situations that SPPs can denote, when they combine with their arguments. Since Boolean phrases combine these readings in a recursive fashion, they can involve literal, metaphoric and mixed readings as well. In this way, we have offered an account of a set of fairly understudied data with a relatively slender syntactic and semantic account, which builds on previous formal and cognitive analyses. This is, in our opinion, a welcome result, which could lead to a more thorough analysis of Boolean phrases and their interaction with polysemy and metaphors. However, we leave such analysis for the future.

Notes

1 In recent work in the “Cartography” line of minimalist research, SPs are assumed to involve more than two heads (e.g. Asbury, 2008; Svenonius, 2008, 2010). We leave aside a more fine-grained, but dispensable treatment of SPs.

2 Although the two relations are not equivalent, it is useful for our discussion to consider them as such. See Barwise and Etchemendy (1990) for discussion on this matter.

3 Our system does not employ truth-values, a less standard but not uncommon choice for types (e.g. Ginzburg, 2005; Partee, 2009). This is also consistent with a key assumption found in cognitive linguistics theories: that metaphors do not involve “truths”, but rather conceptual relations about different domains and their types.

4 More precisely, if we have a of type $l$ and b of type $l$, and $s:(a \leq b)$, then s will be of type $l$, i.e. we have $s:(a \leq b)$. The equation $\text{type}(s) = \text{type}(a \leq b)$ holds, since the equations $\text{type}(s) = ((\text{type}(a) \land \text{type}(b) = l) \lor (\text{type}(a) \lor \text{type}(b) = l))$ also hold, and the result is $\text{type}(s) = l$, at least in this case. For other cases, we directly discuss the results rather than going through the details for each case.

5 We also simplify matters a bit by leaving the “structured” situation variable that instantiates a relation, not bound by any operators (e.g. the existential operator, viz. $\exists s(x,y)$). This formal imperfection has two advantages: it renders our discussion of the data simpler, and has no influence on our analysis.

6 More accurately, *problems* seems to denote a type of state involving several sub-states, over which a related entity can place his focus/efforts. For mental states, *in* seems only compatible with DPs denoting “homogenous” states without distinct parts, as in the case of *love* (Evans, 2009). Then, given $i$ an “internal” state, $pr$ some problems, the relation $i \leq pr$ would not hold, since $i \cap pr = \emptyset$: problems lack internal states, hence *in his problems* cannot denote any situation but the empty one, to instantiate a relation between these two states.
References


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Francesco-Alessio Ursini (francesco.ursini@english.su.se) is currently Senior Lecturer in Semantics, Morphology, and Language and Cognition at the English Department of Stockholm University. He holds a PhD in cognitive sciences (linguistics track) from Macquarie University, Sydney. In recent times, he expanded his interests to comic studies, with a focus on cross-cultural research on themes/tropes shared across manga, fumetti and comics.