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Autonomous strict motion in French: elements of semantic modelling

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Abstract

Based on previous analyses and studies, this report makes an inventory of the main meaning components that underlie the expression of eventualities of autonomous strict motion in French. The spatio-temporal structure of strict motion eventualities is first set out together with the key concepts on which this structure relies. Additional properties are then introduced, which are likely to complement the basic spatio-temporal schemata of the verbs and constructions addressed. Then, a set of tools is devised in order to capture the different meaning components highlighted, both formally and graphically. The last part of the report aims at illustrating the way the spatio-temporal schemata and the additional semantic features interact for generating a full representation of the verbs and constructions' semantic content.

1 INTRODUCTION

Motion verbs gave rise to many studies and commentaries in the linguistic literature. In some of these studies, they were considered within the general framework of the syntax-semantics interface, in possible relation with specific phenomena arising at that level (unaccusativity/unergativity, aspect...) (Jackendoff 1983, 1990, 1996; Krifka 1992, 1995; Levin & Rappaport Hovav 1992, 1995; Tenny 1995; Tenny & Pustejovsky 1999). Other works, however, directly focused on the expression of motion in language and examined, among others, the behaviour of “dynamic” spatial predicates and PPs, be it in particular languages (e.g. for French: Asher & Sablayrolles 1995; Boons 1987; Boons et al. 1976; Borillo 1998; Guillet & Leclère 1992; Lamiroy 1983; Laur 1991; Sarda 1999; Stosic 2007, 2009b) or in a more crosslinguistic and typological perspective (e.g., Bowerman et al. 1995; Creissels 2006; Grinevald 2011; Hickmann 2006; Kopecka 2006; Slobin 2003, 2004; Stosic 2002, 2009a; Talmy 1985, 2000).

Pursuing this line of research, I came back, in a series of papers, to the semantic analysis of intransitive (including “indirect” transitive) verbs of French denoting an autonomous motion (i.e., a non-explicitly caused motion) (Aurnague 2008, 2011a, 2011b, 2012, 2019, 2022). Which spatio-temporal notions are best suited for defining a motion eventuality in the strict sense (as opposed to an eventuality denoting manner of motion)? How these notions combine together in the verbs' semantics and how aspectual properties

(inner/lexical aspect, Aktionsart) derive from them? To which extent are the “polarity” of the locative PPs associated with the verbs and the possible implicature of these PPs conditioned by the verbs’ spatio-temporal structure? How some meaning features contribute to explain fine-grained differences between specific verbs and constructions (e.g., intransitive *partir* ‘to go (away), to leave’ vs. transitive *quitter* ‘to leave’)? This is only a sample of the questions I tried to tackle in these different papers.

The present report is, in no way, a mere synthesis of these previous pieces of work. Rather, it tries to take advantage of the observations accumulated through these analyses in order to identify the main meaning “ingredients” underlying eventualities or situations of (autonomous) motion in the strict sense. More exactly, it aims at laying the basis of a full-fledged semantics of strict motion eventualities in French –possibly applicable to other “verb-framed” languages (Talmy 1985, 2000)– by singling out and justifying their various meaning components and by proposing the outline of a formal (and graphical) representation of these eventualities. The resulting “toolbox” is, at least, expected to account for the various combinations of meaning components as showing up in French motion verbs and constructions. Obviously, this framework is not definitive and is supposed to evolve when further relevant data will be made available in French or in other languages. For the moment, anyway, I believe that this proposal fills a gap in the literature as no study has systematically tried to highlight and model the semantic features/constraints that govern the lexemes and constructions denoting an eventuality of motion in the strict sense. Some of the meaning properties listed in the following sections have been already evoked in previous works and papers –e.g., intention/purpose, speed, direction, difficulty/effort: Caballero 2009; Lestrade & Reshöft 2012; Matlock 2004; Özçaliskan & Slobin 1999; Pourcel 2004; Sablayrolles 1995; Slobin 1996; Vulchanova & Martinez 2013; Zlatev & Yangklang 2004– but without these properties being part of a comprehensive and theorized decomposition of strict motion predicates’ semantics (in fact, several of the works mentioned focus on manner of motion rather than on motion strictly speaking and/or are mainly concerned with the typological opposition between “verb-framed” vs. “satellite-framed” languages).

The following section (2) introduces the concepts I use in order to grasp the spatio-temporal structure of motion eventualities in the strict sense. In Section 3, other notions will be listed and defined, which, I believe, often have to be added to the spatio-temporal structure if one wants to get a more complete picture of the motion event. Then (Section 4 and Appendix 1), the bases of a formal representation will be outlined and commented on. Before concluding, several illustrations of the combinations to which the meaning components previously highlighted can give rise will be shown (Section 5 and Appendix 2).

2 THE SPATIO-TEMPORAL STRUCTURE OF STRICT MOTION EVENTUALITIES

A fundamental task of my research on dynamic space consisted in proving that notions like “change of location/place” or “inherently directed motion” are not able to correctly delimit the class of verbs of motion in the strict sense (e.g., *arriver* ‘to arrive’, *partir* ‘to go (away), to leave’, *se rendre* ‘to go to’, *sortir* ‘to go out’) as opposed to verbs referring to manner of motion (e.g., *marcher* ‘to walk’, *patiner* ‘to skate’, *patrouiller* ‘to patrol’, *zigzaguer* ‘to zigzag along’) (Aurnague 2011a). Concerning the former notion, for instance (change of location/place), previous work on the ontology of static space in French (e.g., Aurnague 1996, 2004) allowed me to show that the verbs denoting a strict motion eventuality can involve “locations/places” as well as “objects”, as landmarks –or reference/ground entities– of the situation they refer to (e.g., *Le chat est entré dans le grenier/seau* ‘The cat went into the attic/bucket’).¹ Thus, changes of location/place do not accurately grasp this kind of eventuality. Indeed, in many studies where it is involved, this notion is never defined and people seems to simply use it for indicating that some change occurs with respect to the **landmark** (be it a location or an object). In other studies, however, the concept of location/place –and, consequently, that of change of location/place– is given a more precise definition (see, in particular, Jackendoff 1983, 1990) but this definition entails a systematic reduction of the preposition’s semantics to a relation of geometrical inclusion in a region or space portion, leaving aside all the important functional parameters governing the meaning of locative markers (Vandeloise 1986, 2001; for a criticism of regional and geometrical approaches of spatial adpositions, see (Aurnague & Vieu 2013, 2015)).

In order to characterize strict motion eventualities, I followed Boons (1987) and took up the concept of “change of basic locative relation” as used by this author. The spatial change conveyed by a verb is a change of basic locative relation –with respect to a landmark entity– if the relation underlying this change can be expressed by a simple or complex/compound (static) **adposition** of the language under consideration (a preposition in the case of French).² In

¹ (Aurnague 1996, 2004) state that a location/place is a material entity determining a space portion, which is fixed in a given frame of reference. In French, the static locating use of the preposition *à* ‘at’ (Vandeloise 1988) seems to select for landmarks characterized as “specified locations” and it constitutes a good test for distinguishing locations from objects: *Le chat est au grenier* ‘The cat is in (literally ‘at’) the attic’ vs. *Le chat est ??*au seau* ‘The cat is in (literally ‘at’) the bucket’. Contrary to *à* (locating use), *dans* ‘in’ is not sensitive to the opposition object vs. location –its semantic content rather relies on the functional notion of containment (Vandeloise 1986, 2001; Vieu 1991)– and the previous sentences are both fine with this preposition: *Le chat est dans le grenier/seau* ‘The cat is in the attic/bucket’.

² According to Boons, a verb like *enfourner* ‘to put in the oven/kiln’ denotes a real motion or displacement because the successive negation and assertion of the basic locative relation *être dans* ‘to be in’ underlies

my approach, this concept has been associated with that of “change of placement” –akin to notions such as “translocation” (Zlatev et al. 2010) or “translational motion” (Talmy 1985, 2000)– whose assessment brings into play the (encompassing) terrestrial/earth’s frame of reference, possibly represented by some immediate contextual element(s): a change of placement occurs when the position of a target (or located) entity within the terrestrial framework evolves. Thus, a strict motion eventuality is supposed to associate these two kinds of changes as well as the distinct “referents” they involve (Aurnague 2011a): the terrestrial frame of reference (**implicitly**) used in assessing the change of placement of the target and the landmark with respect to which the change of basic locative relation occurs. Together with this theoretical definition, a concrete test is also available to isolate motion verbs in the strict sense in French. It was brought out in previous analyses of the preposition *par* ‘by’ (Aurnague & Stosic 2002; Stosic 2002, 2007) and relies on the observation that strict motion events can be modified by a *par*-headed PP with this preposition giving rise to a “path” interpretation (1) (as opposed to an “imprecise localization” use of *par*: 2):

- (1) Max est sorti/arrivé par la rue St François
‘Max went out/arrived by the rue St François’
- (2) (?)Max a déambulé/erré par (toute) la ville/les rues piétonnes
‘Max strolled/wandered through the city/the pedestrianized streets’

Although I am only interested in eventualities associating a change of basic locative relation with a change of placement (“**change of relation and placement**”), let me stress that three more basic categories of verbs and eventualities of motion/movement can be defined from these properties. Simple **changes of placement** (i.e., not associated with a compulsory change of relation) include many verbs which are usually considered as denoting manner of motion: *errer* ‘to wander’, *marcher* ‘to walk’, *nager* ‘to swim’, *patrouiller* ‘to patrol’, *zigzaguer* ‘to zigzag along’... The modification of these predicates by a *par*-headed PP is most often interpreted through the “imprecise localization” use of this preposition (cf. (2) above). Other eventualities seem to bring into play a **change of basic locative relation** without a change of placement being involved, as illustrated by the verbs based on the relation of support/contact –that can hardly be modified by the preposition *par* with its path interpretation: *L’oiseau est entré dans/??s’est posé sur la maison par le jardin* ‘The bird went into/landed on the house through the garden’ (the

its semantics. On the other hand, the meaning of *adosser* ‘to stand/lean (back) against’ does not consist of the negation and subsequent assertion of a basic locative relation like *être contre* ‘to be against’ as one can put the back of a target entity (e.g., a cupboard) against a landmark (e.g., a wall) with which the former was already in contact (the surface initially in contact with the landmark was not the target’s back). The negated and then asserted relation is a complex one –not reducible to the category of adpositions: *être adossé à* ‘to stand (back) against’ – and therefore *adosser* does not refer to a real or strict motion.

imprecise interpretation of *par* is ruled out too). Finally, some predicate **neither** involve **a change of basic locative relation nor a change of placement**. This category mainly coincides with that of dynamic verbs describing a change of posture/structure or disposition (several linguistic tests are available for distinguishing postural verbs and predicates of change of placement; cf. Aurnague 2011a): *s'accroupir* 'to crouch', *s'asseoir* 'to sit down', *se recroqueviller* 'to curl up'...

Changes of basic locative relation and changes of placement combine together in the semantics of verbs and constructions denoting a strict motion and determine their spatio-temporal structure. The “polarity” of a change of basic locative relation depends on the way it is shaped: it is initial ($r \cdots \blacktriangleright \neg r$; ‘ $\cdots \blacktriangleright$ ’ indicates a transition between states) when the relation is first asserted and then negated (e.g., *sortir* ‘to go out’, basic locative relation *être dans* ‘to be in’, *être-dans* $\cdots \blacktriangleright \neg \text{être-dans}$) and final ($\neg r \cdots \blacktriangleright r$) when the “positive information” follows the negative one (e.g., *entrer* ‘to go into, to enter’, $\neg \text{être-dans} \cdots \blacktriangleright \text{être-dans}$). Medial polarity will characterize changes of relation consisting of a positive information (assertion of a relation) preceded and followed by the negation of the underlying relation ($\neg r \cdots \blacktriangleright r \cdots \blacktriangleright \neg r$). Very few intransitive motion verbs of French seem to introduce a medial change of relation (e.g., *couper par* ‘to cut across’, *passer par* ‘to go through’ and *transiter* ‘to pass in transit’). “Bipolar” predicates and constructions involving double changes of relation (and placement; initial and final) being set apart – e.g., *déménager* ‘to move (house)’, *émigrer* ‘to emigrate’, *s'exiler* ‘to go into exile’, *immigrer* ‘to immigrate’–, the strict motion descriptions I have studied give rise to four different spatio-temporal structures. Type 1 eventualities are made up of an initial change of basic locative relation with a concomitant change of placement (e.g., *partir* ‘to go (away), to leave’, *s'échapper* ‘to escape’, *sortir* ‘to go out’). Type 1' corresponds to the reverse situation (final change of relation with a concomitant change of placement: e.g., *entrer* ‘to go into, to enter’, *pénétrer* ‘to enter, to penetrate’). In Type 2 structure, a change of placement precedes a final change of basic locative relation (with a possible concomitant change of placement). The verbs and constructions coming under this schema are the most numerous in French: e.g., *aller à* ‘to go to’³, *se rendre* ‘to go to’, *venir* ‘to come’, *accourir* ‘to run/rush up to’. Finally, a fourth spatio-temporal configuration can be distinguished (Type 3). It again consists of a

³ *Aller* appears with a preposition because, besides its use denoting a simple change of placement (e.g., *Elle était allée par tout le village, de chemin en chemin...* ‘She had gone throughout the village, from street to street...’ (M. Van der Meersch, *Invasion 14*, 1935)), it very often combines with static spatial prepositions (in particular with *à* ‘at’) with which it tends to form **verbal locutions** that introduce a change of relation and placement with final polarity. Simultaneously, unlike verbs of change of placement whose meaning includes the notion of “tendency” (see Section 3.4 and Footnote 5), the use of *aller* denoting a simple change of placement –illustrated above– is mostly literary and not very common in current French.

final change of relation (and a concomitant change of placement) preceded by a change of placement but, instead of being directly denoted, the latter (previous change of placement) is only presupposed by the semantic content. *Arriver* ‘to arrive’, *aboutir* ‘to end up’ or *parvenir* ‘to reach, to get to’, which refer to a final change of relation and placement while presupposing a previous change of placement, are examples of predicates that involve a Type 3 structure.

3 OTHER SIGNIFICANT CONCEPTS

Besides the notions of (autonomous) target, landmark, change of relation and change of placement, the analysis of intransitive verbs and constructions of autonomous strict motion in French led me to isolate other important concepts of the verbal content which impact, among others, the selectional restrictions and the kind of constructions or interpretations the verbs give rise to. This section sets out these additional concepts and also briefly reviews other possible meaning properties that are likely to play a role in the semantics of the verbs, although not integrated in the present formalization.

3.1 Animacy

The animate character of the target entity –denoted by a grammatical subject– can sometimes be required when resorting to specific predicates and constructions. This occurs when a predicate or construction refers to an intentional motion (see below) but not only in this case. *Dérocher* and *dévisser* ‘to fall off’, for instance, denote the non-intentional motion of an animate target falling from a rock face she/he was climbing. Animacy and intentionality have thus to be explicitly distinguished when dealing with French autonomous motion predicates.

3.2 Intentionality

Contrary to what could be expected, the autonomous motion of a target does not imply this motion to be intentional. The intentional involvement of an animate target is, indeed, only necessary for a reduced number of verbs and constructions. This is clearly the case of the verb *se rendre* ‘to go to’ and of *courir* ‘to run’ associated with a final PP (see the property of speed below), at least when the latter construction does not give rise to a stative and/or metaphorical reading. Other properties listed in this work –opposition to a force and (un)blocking– seem to bring into play, to some degree, the concept of intentionality. But intention also shows itself through the expression of non-intentionality of a strict motion, specifically with “carrying along by a force” as described in Section 3.6.

3.3 Perspective point

A perspective point can be placed on a landmark entity so that the motion is described as being considered from this particular point of view. Without going into details, let me stress that the nature of this perspective point and the constraints it implies are submitted to significant variations among languages and, even, within the same language (Fillmore 1975): speaker or interlocutor situated near the landmark –that is, at the perspective point– at speech time or at event time (spatial deixis constraint properly speaking), specific link between the speaker or interlocutor and the landmark (e.g., home or workplace) or, simply, discourse attention directed towards the landmark. Contrary to what is sometimes maintained, French only encodes **final** perspective point in the semantics of (some) autonomous motion verbs. *Venir* ‘to come’, *accourir* ‘to run/rush up to’, as well as the more colloquial predicates *s’abouler* or *s’amener* ‘to come along’, are good examples of verbs of change of relation and placement integrating a final perspective point in their meaning.⁴ As pointed out by Cappelli (2013), despite not systematically integrating deixis in their semantic content, some motion verbs based on a relation of inclusion/containment with respect to an initial landmark (e.g., *déboucher* ‘to emerge, to come out’, *jaillir* ‘to gush forth, to leap out’, *surgir* ‘to appear suddenly’, *sourdre* ‘to rise, to spring out’) also give rise to uses in which a (final) perspective point is positioned outside the landmark, in its immediate proximity.

3.4 Speed

Speed is another important property possibly conveyed by the meaning of strict motion verbs and constructions. In previous work (Aurnague 2011a), I showed that the presence of this feature in the semantic content of verbs (initially) denoting a mere change of placement (e.g., *courir* ‘to run’, *filer* ‘to dash (by)’, *foncer* ‘to tear along’, *galoper* ‘to gallop, to hare’, *trotter* ‘to trot along’) allow them to refer to a change of relation and placement, provided they are combined with an “appropriate” (static) spatial preposition/PP. For instance, sentence (3) is opened to two interpretations, one in which the running event takes place within the corridor (mere change of placement) and another one where this

⁴ Beyond French data, it can be claimed that only final displacements naturally give rise to the encoding of a (final) perspective point by some dedicated markers (here verbs; Wilkins & Hill 1995). Furthermore, so called initial deixis or perspective point markers often involve a remote or global view/description of the motion event (rather than a true initial perspective), at least in their original semantics. Except languages with compulsory deictic marking (which are supposed to have markers that semantically encode initial deixis), initial perspective meaning arises, most of the time, from a pragmatic contrast with the semantic content of final perspective markers.

event starts outside the corridor and ends up in it (change of relation and placement).

- (3) Max a couru dans le couloir
'Max ran in(to) the corridor'

Thus, speed has a clear grammatical role because, like other properties mentioned in the following sections (direction, carrying along by a force, opposition to an internal force), it conditions the possibility, for a predicate of change of placement, to go into a construction interpretable as a change of relation and placement.⁵ Yet, it is also encoded by verbs that refer, on their own, to strict motion eventualities such as *accourir* 'to run/rush up to', *dévisser* 'to fall off', *s'échapper* 'to escape' or *s'engouffrer* 'to rush/dive into'. Sometimes speed co-occurs with other constraints like, for example, carrying along by a force or (un)blocking (see further).

3.5 Direction, linear oriented motion

Being directed is a prominent characteristic of some dynamic spatial eventualities. *Avancer* 'to advance, to move forward', *reculer* 'to (move) back', *monter* 'to go up' or *descendre* 'to go down' are good examples of verbs which involve a direction and thus describe a "linear oriented motion".⁶ Unlike what many studies state, I maintain that referring to a direction/orientation does not necessarily imply that the corresponding motion is accompanied by a change of basic locative relation –with respect to a landmark entity (for a similar assumption, see (Sarda 1999)). Rather, the above-mentioned verbs basically denote simple changes of placement (a sentence like *L'expédition a avancé à travers la forêt (pendant des semaines)* 'The expedition advanced through the forest (for weeks)' does not introduce any change of relation with respect to the forest). However, in a way similar to speed, the presence of a direction or linear oriented constraint in the semantics of a verb of change of placement allows it to describe a change of relation and placement when combined with a suitable spatial PP (e.g., *Max a avancé dans le couloir* 'Max advanced in(to) the corridor' in one of its two readings).

⁵ (Aurnague 2011a, submitted) suggests that these four properties make up a family resemblance underlying the notion of "tendentiality" (potentiality, for a target, to "tend" towards a landmark or goal). A verb of mere change of placement like *marcher* 'to walk' which does not involve any of these four features is unable to give rise to a change of relation and placement reading in a sentence with a static spatial PP similar to (3).

⁶ Note that linearity is not rectilinearity. It is possible that languages vary along the degree of rectilinearity some of their directional markers (in particular verbs) impose to motion eventualities. Moreover, there is a difference in nature between frontal dynamic direction (related to the target) and vertical dynamic direction (related to gravitation) when defining the orientation of a motion (see Section 4.2.5 and Appendix 1).

3.6 Carrying along by a force

Several French verbs of change of placement indicate that the target's motion is not intentional but rather results from the action of one or more forces carrying along this entity (e.g., *couler* 'to flow', *dégouliner* 'to trickle, to drip', *déraper* 'to slip, to skide', *glisser* 'to slide'). Usually these forces originate in external factors (e.g., effect of gravity, impact/impetus or obstacle possibly destabilizing the static or mobile target) but they can also combine with internal properties (e.g., momentum) and, together, lead to a displacement which is not controlled by the target. The internal structure of this entity (consistency: malleable substance, form...) is also likely to condition the way external forces will act on it. As other semantic properties previously listed (speed, direction), carrying along by a force –which entails uncontrolled motion– allows a predicate of change of placement to refer to a change of relation and placement, provided it appears in a construction with an appropriate spatial preposition/PP. However, this property can underlie the meaning of dynamic verbs whose semantic content directly combine these two notions (change of relation and change of placement), such as *dérocher* or *dévisser* 'to fall off'. Finally, let me stress that carrying along by a force sometimes implies some kind of speed/rapidity for the motion it causes (in particular when gravitation is involved).

3.7 Difficulty of motion

Difficulty of motion constitutes a significant semantic parameter of various strict motion predicates and constructions. This parameter shows itself in two different variants which are not necessarily incompatible. Difficulty can be thus "internal" to the target entity ("target-related") or it can be viewed and expressed in relation with the landmark ("landmark-related"). I now tackle these two variants of difficulty of motion.

3.7.1 Opposition to an internal force (target-related difficulty)

The first kind of difficulty is "internal" because it usually stems from the target entity itself or from its immediate environment. Such a difficulty arises when the target's motion is made harder by the way its structure and parts function under given circumstances (e.g., relative strength of driving parts compared to more passive ones) and by possible connected factors (e.g., frictions with supporting surfaces, effect of gravity in the target's configuration with a landmark). The target must thus oppose internal forces in order to move around. Examples of verbs conveying this property include non-canonical or unusual displacements (specifically of human beings: e.g., *ramper* 'to crawl', *se traîner* 'to drag o.s.') and upward motion eventualities in which the role of gravity is

underlined (e.g., *grimper* ‘to climb’ or *se hisser* ‘to heave o.s. up’).⁷ An important characteristic of a difficulty of this nature relies on the fact that the force opposed to the target’s motion operates **throughout the change of placement** this entity is involved in (**and outside any change of relation**; e.g., *Max s’est traîné dans l’appartement toute la journée* ‘Max dragged himself in the flat the whole day’). In other words, and like the notion of change of placement with which it closely interacts, opposition to an internal force firstly relates to the target entity, regardless of any change of relation with respect to a landmark that may occur (hence the term “target-related difficulty”).

However, we are faced, here again, with a property of changes of placement which, like other features previously mentioned (speed, direction, carrying along by a force), allows a verb that encodes it to be complemented with a change of (basic locative) relation in presence of an associated PP (e.g., *Max s’est traîné au salon* ‘Max dragged himself in(to) the lounge’ in one of its two readings). In such a case, internal (target-related) difficulty can be apprehended through the final change of relation possibly expressed by the verb and the spatial PP and, therefore, takes on a more “external” coloration (as it is also considered in terms of its consequences on the achievement of the final change of relation; see the following section). Note that, most of the time, the opposition to an internal force is intentional and, even in presence of non-animate targets, I claim that intentionality is potentially activated as a background element, through a form of “animation” of the target (the intention ascribed to the target can, for instance, be considered as being preprogrammed or consubstantial with this entity).

3.7.2 Landmark-related obstacle/difficulty

This second category gathers cases where the difficulty of motion is contemplated **in relation with a landmark** (e.g., *s’extraire* ‘to get out of, to extricate o.s.’, *se dégager* ‘to extricate o.s.’, *accéder* ‘to reach, to get to’, *parvenir* ‘to reach, to get to’, *s’infiltrer* ‘to infiltrate’). Landmark-related obstacle/difficulty regularly derives from elements that are strictly unrelated to the moving target (e.g., material external obstacle) –contrary to what occurs with target-related difficulty. This kind of difficulty may, as well, not affect continuously the target’s change of placement and only concentrate on a part of it (in other words, the obstacle/difficulty may be temporally limited to a sub-part of the whole event, at least for extended events). Indeed, the key criterion is that a difficulty is likely to occur during the dynamic eventuality (of strict motion) so that the **change of relation** it includes **may be hard to achieve or**

⁷ Note that many upward motion situations where an animate entity (in particular a human being) must oppose the effect of gravity also result in non-canonical displacements for the corresponding targets.

may not be achieved at all. The extended vs. limited spatio-temporal dimension of the obstacle/difficulty is not taken into account and a sentence like *Max est parvenu au salon* ‘Max reached the lounge’ may cover cases of continuous effort (*Max s’est traîné au salon* ‘Max dragged himself in(to) the lounge’; see previous section) as well as situations where a more punctual obstacle/difficulty arises on the way to the landmark.⁸

Landmark-related obstacle/difficulty often goes with the target’s intention to achieve the change of relation with respect to a landmark that underlies the dynamic eventuality. Yet, here I prefer to handle these two aspects separately, intention (see Section 3.2) being possibly introduced at a different level of the verb’s semantics.

3.8 Control

The control of a spatial entity over other one has been the subject of many observations and studies, specifically within Vandeloise’s work on the expression of static location (1986, 2001). Control arises when the spatial configuration denoted by a marker implies that one or more forces are exerted on a component of this configuration (e.g., a landmark controlling a target via a relation of containment or support). As Talmy (1988, 2000) showed, forces are involved in the meaning of a variety of linguistic markers (not only pure spatial ones) and, according to Vandeloise (2001), their presence in the semantics of spatial static prepositions (or adpositions) endow them with a true “dynamic” status (thus, in Vandeloise’s theoretical framework, static prepositions can be “dynamic”; this author applies the term “kinetic” to prepositions and verbs of motion).

Several properties already listed led me to mention the impact of forces on motion events (carrying along by a force; difficulty: opposition to an internal force, landmark-related obstacle/difficulty) and thus to indirectly tackle the notion of control. These different situations share certain characteristics as forces occur in the course of motion and in direct relation with the possibility vs. impossibility of its realization (by causing it vs. making it more difficult or obstructing it). The properties of control I consider in the following sections are more independent of motion proper, either because they operate before/outside it (blocking, Section 3.8.1) or because they are limited to accompany it (without necessarily causing or obstructing it: guidance, Section 3.8.2). While static

⁸ The different situations to which the sentence *Max est parvenu au salon* may apply also suggest that landmark-related obstacle/difficulty can lie on less material elements than concrete external obstacles, such as distance to the landmark. The same example shows that landmark-related difficulty may be external to the target but may as well stem from it. Whatever the origin of the difficulty, it is viewed through its consequences on the achievement of the displacement with respect to the landmark.

control exerted by a surrounding landmark (containment) is typical of blocking, guidance emphasizes the effect of horizontal/lateral forces and frontiers (real or virtual) on a moving target. These two properties are, thus, somewhat related.

3.8.1 Blocking

The blocking contemplated here is a spatial configuration in which a target is controlled by a landmark in every direction (vertical, frontal and lateral control). In other words, the target's motions get impeded or, at least, restricted by the landmark's physical boundaries and action. The containment relation (deeply analysed by Vandeloise (1986, 2001) and Vieu (1991)) is the one which better represents this kind of control but situations involving attachment to a landmark (or even of being in the latter's range of action) come under this category of control too. In French, the property at issue shows itself in the semantics of motion verbs denoting an initial change of relation and placement (e.g., *s'échapper* 'to escape', *s'enfuir* 'to run away' or *se sauver* 'to run away') where a configuration of theoretical blocking is overcome by the target which manages to leave the landmark.

Three additional peculiarities of blocking situations have to be mentioned. First, blocking regularly involves "typical" cases of control, that is to say landmarks which are **functionally devised** to exert a control (on specific targets), associated with the corresponding category of target (animate or not). Second, it is quite usual for (animate) targets to intentionally overcome the control of the landmark but this feature can vary from verb to verb and I thus prefer not to encode it systematically (as an element correlated with unblocking).⁹ Third, although the initial change of relation and placement is, very often, a rapid/fast motion event (speed property), I also take this feature apart (cf. Section 3.4) and process it at another level of the verb's semantics.¹⁰

3.8.2 Guidance

Unlike blocking, guidance does not preclude a co-occurring displacement. Its main effect is to "channel" or direct the motion by essentially controlling the lateral displacements of the target (that is to say, the displacements which are

⁹ In relation to intention, note that opposition to a force and, more broadly, difficulty of motion seem not to be underlined by the verbs under examination (contrary to the verbs discussed in Section 3.7). Rather, it is the **rupture of the functional relation of control** which is significant here, independently of the possible difficulty of the motion eventuality.

¹⁰ Like other properties listed, the notion of blocking associated with speed has grammatical outcomes – more precisely aspectual outcomes – as it allows a verb of initial change of relation and placement to identify a motion eventuality subsequent to the transition/culmination it contains (Aurnague 2011a).

perpendicular to the direction along which the target is supposed to progress). Guided motions (e.g., *aboutir* ‘to end up’) are, most of the time, the consequence of a landmark’s action but they can also result from other elements of the situational context acting on the target. One can easily see that the elements at the basis of a guided motion are not necessarily responsible for that very motion or change of placement, this dimension of the eventuality (cause of the motion) being independent of the concept of guidance.

Guidance was already put forward in previous work on the semantics of the French preposition *à travers* ‘through’ (Stosic 2002, 2007, 2009a; Aurnague 2000). Though it is an important concept, it was little noticed in the literature about the expression of dynamic space in language. The target’s displacement being guided, it is not unusual for the possible (final) change of relation following the change of placement to be non-intentional, in the sense that it was not foreseen or pre-programmed by the (animate) target –during the previous change of placement. But this is not systematic and, rather, indirectly ensues from the verb’s semantics integrating the notion of guidance.

3.9 Complements

Up to this point, ten semantic properties have been listed which, together with the four basic features previously mentioned (target, landmark, change of relation, change of placement), underlie the meaning of French verbs and constructions referring to a strict motion: animacy, intentionality, perspective point, speed, direction or linear oriented motion, carrying along by a force, opposition to an internal force (target-related difficulty), landmark-related obstacle/difficulty, blocking and guidance.

I now review seven other properties which, although not taken into account in the theoretical and formal approach, also seem to play a role in the semantics of verbs and constructions of strict motion (change of relation and placement). At least some of them would be worth incorporating into the formal system if it were to be extended.

The discreet or furtive nature of a motion eventuality (Stosic 2009b, 2019) is the first of these properties. **Discreetness** shows itself in the meaning of verbs such as *s’éclipser* ‘to slip away/out’, *se glisser* ‘to slip somewhere’ and *s’insinuer* ‘to insinuate o.s. into, to creep into’, or at least in some of their uses. It is quite often coupled with the properties of landmark-related obstacle/difficulty (independently of the verb’s polarity), speed (verbs of initial polarity) or immixion (see further; verbs of final polarity) and it commonly applies to animate targets.

Partomotion (also called “motor pattern” or “body motion pattern”: Stosic 2009b, 2019) is another meaning element that sometimes occurs in the

expression of strict motion. The term “partomotion” refers to the specific way the different parts of a target are activated in relation to each other in a dynamic spatial context. Because the relative motion of body parts is not alien to the immediate surroundings in which the target operates, partomotion often incorporates information relating to the **medium or environment** of the motion eventuality (for instance, *marcher* ‘to walk’ and *courir* ‘to run’ need a supporting surface and *nager* ‘to swim’ involves water). In the case of strict motion, the partomotion constraint is mainly conveyed by verbs of change of placement which, together with an appropriate (static) spatial preposition/PP, can introduce a change of relation and placement (e.g., *courir* + PP ‘to run + PP’, *ramper* + PP ‘to crawl + PP’). Although partomotion is not responsible for the strict motion interpretation of these constructions, a full representation of their meaning should include this parameter.

Verbs like *jaillir* ‘to gush forth, to leap out’ or *s’engouffrer* ‘to rush/dive into’ suggest that a force of a certain intensity is involved in the motion event. When it underlies verbs and constructions of strict motion (see also *déferler* ‘to break, to roll in’), the corresponding property of **strength of a force** (or “power of the force”: Stosic 2009b, 2019) usually goes with that of fast speed –which allows *déferler*, combined with a PP, to denote a final change of relation and placement. Moreover, it appears that strength of a force sometimes applies to targets with a specific **internal structure** (Aurnague 2011a; “configuration of the target” in Stosic 2019) and, more precisely here, to liquid targets (e.g., *jaillir* in some of its uses, *déferler*). For verbs of final polarity, it should be emphasized that while strength of a force gives rise to strict motion situations when coupled with an inclusion/containment configuration (*s’engouffrer*), it is confined to situations of simple change of basic locative relation when a support/contact configuration is involved (e.g., *s’abattre* ‘to fall down on’, *heurter*, *percuter* ‘to strick, to collide with’; see Aurnague 2011a). The latter verbs do not therefore belong to the category of strict motion.

Among the features of manner of motion highlighted by Stosic (2019), **immixion** or interference is another meaning property that is likely to arise in the semantics of strict motion verbs. Because immixion consists of the undue presence/intrusion of a target in(to) a landmark, the verbs that convey this feature –in one or several of their uses– are supposed to have a final polarity: e.g., *s’infiltrer* ‘to infiltrate’, *s’insinuer* ‘to insinuate o.s. into, to creep into’, *s’introduire* ‘to enter, to penetrate’. As suggested previously, it is not uncommon for this property to act with those of discreetness and landmark-related obstacle/difficulty. Once again, the target is most often an animate entity.

A last complementary property that may operate in the semantic content of strict motion verbs and constructions is the **affectedness** of the target and/or the landmark in a dynamic spatial event. The presence of affectedness is important

as it may condition to some extent certain grammatical behaviours of verbs of strict motion, such as direct infinitival constructions or the possibility of implicating the landmark of a strict motion eventuality (Aurnague 2011a, 2019, 2022). However, the emergence of this property seems to be highly dependent on other semantic features already listed (e.g., speed, difficulty of motion, control, discreteness, strength of a force, immixion) and further observations would be necessary to better understand its functioning in the domain of strict motion.

4 EXPRESSING STRICT MOTION: TOWARDS A FORMAL REPRESENTATION

This section (together with Appendix 1) sets down some formal bases for representing the semantic content of the motion verbs and constructions studied. Quite naturally, this formalization will both rely on the four spatio-temporal structures or schemata brought out in Section 2 and on the additional concepts retained in Sections 3.1-3.8.

4.1 The spatio-temporal “skeleton” of eventualities

As we saw, the spatio-temporal structures characterizing (autonomous) strict motion eventualities are obtained by associating the notions of change of basic locative relation and change of placement. The polarity of changes of basic locative relation, the way changes of relation and changes of placement are combined –with respect to temporal ordering: concomitance, succession...– and their status in the verb’s semantic –e.g., regular part of the meaning, presupposed element– distinguish the various structures or schemata obtained. Additional concepts possibly integrated in the verb’s meaning are then articulated with these structures that provide, so to speak, the spatio-temporal “skeleton” of motion eventualities.

The formal definitions set out below in order to capture the main spatio-temporal structures of strict motion verbs and constructions in French each introduce a change of basic locative relation (with its corresponding target¹¹ and landmark) and a change of placement (with its corresponding target), the target of the two eventualities being the same –the terrestrial/earth’s frame of reference used to assess the change of placement remains implicit at this level and does not appear as an argument of the predicate Ch-plmt.¹² These two

¹¹ Since we deal with autonomous motion eventualities, and even if it is not made explicit, the function **target** in the formulas is meant to provide the **autonomous** target of an eventuality, that is to say a target whose motion is not attributable or overtly imputed to the action of another element.

¹² Although the predicates Ch-rel “change of (basic locative) relation” and Ch-plmt “change of placement” are handled as primitives here, I believe that some formal definitions could be provided for them. The

eventualities are summed into a “bigger” one which is supposed to represent the whole eventuality of strict motion, referred to by the lexical item or expression “v”.¹³ As recalled above, the four definitions also show the spatio-temporal relations between the two sub-eventualities (of change of relation and change of placement) making up the whole eventuality and, specifically, their concomitance or succession.

Several temporal operators are necessary to state the relations between the events involved in a strict motion eventuality (here and in the following sections and appendices). All of them have already been used, to various extents, in the literature (e.g., Asher 1993; Asher et al. 1995; Kamp & Reyle 1993). The relations \subseteq_t , \equiv_t and \supset_c between two eventualities indicate respectively temporal inclusion, temporal equivalence/identity and immediate precedence (“abutment”). The function *init* (cf. Appendix 1) applies to an eventuality and yields its “initial time” –a function *end* is also available although not used in the current modelling. *Prestate* and *poststate* functions take an event as argument and return the state which precedes (previous state) or follows (result state) it. Finally, Part_t (cf. Section 5 and Appendices 1 and 2) signals a temporal part-whole relation between two events while \oplus is a two-argument function which, applied to events, retrieves their sum. Following (Vieu 1991; Aurnague & Vieu 1993) and (Muller 1998, 1999, 2007), I also consider that every spatial entity can be associated with its “spatio-temporal referent”, that is to say the (usually four-dimensional) space-time portion or history it defines throughout its “life”. Spatio-temporal referents are thus abstract constructs that can be viewed as defining equivalence classes between entities. The function *stref* appearing in the formulas (cf. Section 5 and Appendices 1 and 2) retrieves the spatio-temporal referent of an entity *x* either in its globality (*stref(x)*), either restricted to a specific temporal span (identified through a time *t* or event *e*: *stref(x,t)*, *stref(x,e)*).

Besides temporal relations between sub-eventualities, the four schemata set out below also display the causal links between them. The integration of causality or causation in this formal framework differs in two main respects

definition of a change of relation would, in particular, have to ensure that the spatial relation *r* underlying this kind of change belongs to the set of static locative relations of the language. A minimal change of placement should be characterized by the fact that the spatio-temporal referent (see further) of the target before (previous state) and after (result state) the change determines “positions” which are neighbouring but not equivalent with respect to the terrestrial frame of reference. A (non necessarily minimal) change of placement could then include one or more minimal changes of placement which, beyond their spatio-temporal relations, may be also structured by causal links in terms of enablement (see further). A change of placement is basically a “continuous” eventuality but, as we can see, its formal account requires some kind of “discretization”.

¹³ When the verb alone is likely to denote a simple change of placement, the strict motion eventuality (change of **relation and placement**) is designated by a complex expression “v” associating the verb and a preposition (e.g., *aller à* ‘to go to’, *courir dans* ‘run into’).

from the way causality is usually handled at the lexical or grammatical level. First, although here no causal link seems to manifest itself directly at the structural (lexical or grammatical) level of language –we are dealing with autonomous, non-caused, motion–, I argue that specific causal relations between sub-eventualities are nevertheless involved, which constitute an important contribution to the functional (i.e., not only geometrical) dimension of autonomous motion expression. Second, unlike many accounts of lexical or grammatical causation that rely on a single causal link (but see Talmy 1976, 2000), two causal relations are distinguished in the current framework, following what has been proposed in some studies of plans/actions and intentions in philosophy and AI (Goldman 1970; Pollack 1990; Korta 1994). The relation $\text{Gen}(e1,e2)$ –‘Generate’– indicates that the completion of event $e1$ entails that of $e2$ whereas the relation $\text{Enab}(e1,e2)$ –‘Enable’– means that $e1$ ’s occurrence opens the way for the achievement of $e2$, but without entailing it.¹⁴ These causal relations are, however, independent of intentionality itself –i.e., they can hold for non-intentional events–, which is addressed separately (see Section 4.2.2).

I am now in a position to introduce the formal definitions of the four types of (autonomous) strict motion eventualities distinguished in Section 2 on the basis of their spatio-temporal structure (each definition mentions, between brackets, the type of eventuality it is intended to capture; see Section 2). I will only comment on the formalizations proposed for Types 1 (Def1) and 2 (Def3). Def1 indicates that the strict motion eventuality e , designated by the lexeme or expression “ v ” in language, consists of the sum of a change of relation $e1$ with a target x and a landmark y , and a change of placement $e2$ whose target is also x , these two sub-events being temporally concomitant.¹⁵ Moreover, the state previous to $e1$ consists of the assertion of a spatial relation r between x and y whereas the result/posterior state is characterized by the negation of this relation (R_r stands for the semantic definition of the spatial relation spelled out as “ r ” in language). Finally, the two sub-events are causally linked by a relation of generation (two-way or symmetrical causation).¹⁶ Def3 mostly differs from

¹⁴ Note that many formalisms in AI make also apparent the applicability conditions associated with causally related events. Moreover, two kinds of enablement should possibly have to be distinguished according to whether an event $e1$ “directly” enables an event $e2$ or not (“indirect” enablement) in a causal chain or structure. Direct enablement between $e1$ and $e2$ could be defined by stating that no event $e3$ (distinct from both $e1$ and $e2$) exists in the chain, which is enabled by $e1$ and enables $e2$ (obviously, an event $e3$ **generating** $e2$ can occur). Most of the enablement relations present in the formulas of this work may be given this “direct” interpretation (at least at a level of representation involving changes of relation and changes of placement).

¹⁵ The different predicates Ch-rel-plmt (in the left part of the four definitions) can equally take, as their first argument, an expression of the form $v(e)$ or directly the event e they are supposed to characterize.

¹⁶ While the choice was made to relate a change of relation and a change of placement occurring concomitantly by a two-way causal link (of the generation-type), the possibility of a one-way causal link

Def1 in the following aspects: the change of relation e1 and the change of placement e2 making up e stand in a specific relation of precedence (abutment; they are not temporally concomitant); the spatial relation between the target x and the landmark y that underlies the change of relation is first negated (previous state) and then asserted (result state); the causal link between the two sub-events is weaker as the change of placement e2 only enables the completion of the change of relation e1 (the former does not automatically generate or entail the latter).

Def1 (Type 1: e.g., *partir* ‘to go (away), to leave’, *s’échapper* ‘to escape’, *sortir* ‘to go out’)

$$\text{Ch-rel-plmt1}(v(e),x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge v(e) \wedge \text{prestate}(e1)=R_r(x,y) \wedge \text{poststate}(e1)=\neg R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1)$$

Def2 (Type 1’: e.g., *entrer* ‘to go into, to enter’, *pénétrer* ‘to enter, to penetrate’)

$$\text{Ch-rel-plmt1}'(v(e),x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge v(e) \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1)$$

Def3 (Type 2: e.g., *aller à* ‘to go to’, *se rendre* ‘to go to’, *venir* ‘to come’, *accourir* ‘to run/rush up to’)

$$\text{Ch-rel-plmt2}(v(e),x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e2 \supset c e1 \wedge e=e1 \oplus e2 \wedge v(e) \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge e2 \subseteq_t \text{prestate}(e1) \wedge \text{Enab}(e2,e1)$$

Def4 (Type 3: e.g., *arriver* ‘to arrive’, *aboutir* ‘to end up’, *parvenir* ‘to reach, to get to’)

$$\text{Ch-rel-plmt3}(v(e),x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge v(e) \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1) \wedge \exists e3 (\text{Ch-plmt}(e3) \wedge \text{target}(e3)=x \wedge (\Phi \rightarrow (e3 \supset c e \wedge e3 \subseteq_t \text{prestate}(e1) \wedge \text{Enab}(e3,e1))))^{17}$$

could also be considered, for reasons of formal economy/parsimony among others. In this case, it would be wiser to maintain the causal link from the change of placement to the change of relation, in particular due to the change of position in the terrestrial/earth’s frame of reference that the former (but not the latter) implies and the degree of spatial dynamicity that this constraint alone guarantees.

¹⁷ \exists is a presuppositional operator. Φ reproduces the first, non-presuppositional, part of the definition without existential quantifiers: $\text{Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge v(e) \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1)$.

4.2 Introducing additional concepts

The integration of additional concepts within the four spatio-temporal structures just set out is achieved by using “introduction rules” in which the elements “modified” (by these additional concepts) operate as constraints waiting for unification.¹⁸ These rules are fully sketched out in Appendix 1 and I try, in this section, to give some further information about the way the formalization was worked out. The remarks will follow the order in which the concepts retained in Section 3.1-3.8 were listed.

4.2.1 Animacy: $Anim(x)$

The predicate *Anim* applies to the target of some motion events (Appendix 1, *Intr1*). Animacy is obviously required when the motion event is intentional but, in French, this constraint on the target can also be needed for non-intentional displacements (e.g., *dérocher*, *dévisser* ‘to fall off’; see Section 3.1). That is why animacy has to be explicitly distinguished from intention.

4.2.2 Intentionality: $Int(ei,x,II,t)$

Although not always encoded in the verb semantics, intentionality vs. non-intentionality is an important property of some displacements (as just emphasized, intentional motion involves an animate target). Following Searle (1983), I believe that at least three notions have to be distinguished in a theory of intentionality: intentions prior to action, intentions “in action” –ensuing or not from prior intentions– and the bodily movements resulting from these intentions. Moreover, and in accordance with Korta (1994) and Pollack (1990), I consider that intentions group together to form “plans” –containing prior intentions and/or intentions in action–¹⁹ but I distinguish the eventualities making up these plans (noted *ei*) from their “concrete” realization through bodily movements (noted *e*). An important reason to do so is the following one: in a model theoretic approach, only the second kind of eventualities is directly

A more accurate presuppositional account needs the following expression to be added (to the presuppositional part): $\wedge \diamond (\exists e1, e2, R_r \Phi \wedge e3 \supset c_e \wedge e3 \subseteq_{\text{I}} \text{prestate}(e1) \wedge \text{Enab}(e3, e1))$.

¹⁸ Indeed, this functioning could be paralleled with that of modification in formal syntax and semantics. **However**, most of the time the integration of additional material is not governed, here, by a pre-existing structure (like that provided by syntactic units). Rather, the semantic content of expressions (e.g., intransitive verbs) denoting an autonomous strict motion has to be viewed as the result of the interaction between a complex spatio-temporal structure (offering various points of articulation/attraction) and some additional concepts that may attach to it. Languages vary along the final complexity of the semantic combinations arising in expressions of strict motion eventualities.

¹⁹ The intentions included in a plan are related by the causal relations *Gen* and *Enab*. When *Gen* is the only relation involved, the plan is said to be simple. If the relation *Enab* occurs, the plan is a complex one (Korta 1994; Pollack 1990).

mapped to events in the real world. In the formalization, the relation $\text{Int}(ei,x,\Pi,t)$ indicates that the eventuality ei is part of x 's plan Π at time t . A second relation, $\text{Real}(ei,e)$, captures the fact that an eventuality ei –object of an intention, whose further properties appear in a relation Int – translates into e in the concrete world. Although it is not reflected in most formulas, the “arguments” of the eventuality ei , as well as its properties in terms of change of relation and/or change of placement, are supposed to be the same as those displayed by e . Because this work is not specifically about intentions, I limit myself to these two relations and do not go deeper in formalizing the foundations of intentionality.

The two relations just commented on allow to formulate several introduction rules intended to capture the constraints on intentionality (or non-intentionality) possibly present in the semantics of some French motion predicates (see Appendix 1). These rules operate a distinction among intentional properties according to whether they apply to **changes of placement** (usually in the course of the change of placement: rules $\text{Intr}2$ and $\text{Intr}3$) or to **changes of relation** (during the change of relation or before it takes place: rules $\text{Intr}4$, $\text{Intr}5$, $\text{Intr}6$, $\text{Intr}7$). Two axioms are also integrated in the formal system in order to control the coherence of intentional constraints applying to concomitant changes of relation and placement as well as the possible “propagation” of these constraints between the two changes (Appendix 1, $\text{Ax}1$, $\text{Ax}2$).

4.2.3 Perspective point: $\text{Persp}(P,y,e')$

The relation $\text{Persp}(P,y,e')$ encodes the fact that a perspective point P is placed at a landmark y , the motion eventuality e' being seen from this specific viewpoint. The formal modelling distinguishes two cases according to whether P is situated on the landmark y ($\text{Intr}8$; e.g., *venir* ‘to come’, *accourir* ‘to run/rush up to’) or outside it but in its immediate proximity ($\text{Intr}9$; this introduction rule is concerned with some uses of verbs like *déboucher* ‘to emerge, to come out’, *jaillir* ‘to gush forth, to leap out’ or *surgir* ‘to appear suddenly’). The remainder of the formulas states that the eventuality e' , considered from the perspective point P , is a change of placement combined with a change of relation e and makes explicit their common argument as well as their temporal relationships. Because of the constraints they involve –spatio-temporal constraint compatible with Type 2 schema in $\text{Intr}8$ and explicit constraint in $\text{Intr}9$ –, the two introduction rules can only apply to changes of

relation and placement viewed from a final or external perspective (this is in line with data from French; cf. Section 3.3).²⁰

4.2.4 Speed: *Rapid(e)*

In the formal system, the predicate *Rapid* takes as argument an eventuality *e* which is a change of placement (Intr10). According to the four spatio-temporal schemata (see Section 4.1), a change of placement integrated in a strict motion event precedes a change of relation or coincides with it. In the latter case (concomitant changes of relation and placement), the property of speed can, so to speak, indirectly involve the simultaneous change of relation and thus propagate from the change of placement to the change of relation.

4.2.5 Direction, linear oriented motion: *Orient-mot^o... (D,x,e)*

Upward (*haut*), downward (*bas*), frontward (*avant*) and backward (*arrière*), are the four dynamic directions addressed in the formalization, in which they primarily characterize eventualities of **change of placement** (see Section 3.5).²¹ Intr11 and Intr12 introduction rules (Appendix 1), for instance, illustrate the way upward and frontward motions are captured (formalizations for downward and backward changes of placement are parallel to Intr11 and Intr12 respectively). These rules state that, for each minimal change of placement *e'* included in an encompassing change of placement *e*, the spatio-temporal referent of the target *x* after *e'* is situated further ahead in the direction *D* than *x*'s spatio-temporal referent before the minimal change occurs. Vertical direction (*haut*, *bas*; cf. Intr11) is usually provided by gravitation whereas frontal direction (*avant*, *arrière*; cf. Intr12) relies on two constraints, a global one –minimal changes of placement “follow” the target’s direction as fixed at the beginning of the encompassing motion– and a local one –the target does not turn round while progressing in the direction expected (i.e., it does not go backward). These introduction rules reflect a well-known observation about static location (e.g., Piérart 1979) that seems to remain valid for dynamic

²⁰ For languages including a **clear** initial perspective marking (lexical and/or grammatical), the first rule (Intr8), for instance, could be easily widened by licensing a different spatio-temporal relationship between the eventualities *e* and *e'*.

²¹ In (Aurnague et al. 1997: 85), we proposed to distinguish three kinds of directions: abstract vectorial directions (e.g., gravitation), static material directions (e.g., alignment of static entities) and dynamic material ones (e.g., linearity of motion perceived through retinal persistence). Although the first and third categories of directions are involved in the motion eventualities studied here, I do not go deeper into these distinctions.

eventualities, namely the fact that the linguistic and cognitive calculus of frontal orientation is more complex than that of vertical orientation.²²

The relation providing the intrinsic frontal direction/orientation of an entity at a particular point in time that appears in Intr12 (e.g., *Orient-avant(D,x,prestate(e))*) is inspired by (Aurnague 1995, 2004). The change in position of an entity with respect to a given direction D –in particular, the fact that x’s position at t’ is ahead from x’s position at t in that direction– is expressed through the relation $\succ_d(\text{stref}(x,t'),\text{stref}(x,t),D)$ that ensues from an extension (to spatial directions and projections of spatio-temporal referents) of Allen’s (1984) temporal interval calculus also proposed in (Aurnague 1995, 2004). Finally, let me indicate that the directional content (in italics) of the introduction rules is sometimes subsumed into a relation of the form *Orient-motion-...(D,x,e)* (*Orient-motion-haut(D,x,e)* for the italicized part of Intr11), whereas the notation *Lin-orient-motion(D,x,e)* is used to express that the change of placement e of x is a linear oriented motion in the direction D (it is thus defined as a disjunction of the four directional displacements previously commented on).

4.2.6 Carrying along by a force: *Carr-along(y,F,x,e)*

Like other constraints involving forces, carrying along by a force is formalized by means of the relation *Act^o-force(y,f,x,e’)* indicating that an element y –be it an entity or a general force “provider” like gravitation– exerts an action on x consisting of a force f (possible sum of distributed forces), the whole situation giving rise to an event e’.²³ In the specific case of carrying along, the element y has to be different from the entity x (target entity) on which the force is exerted and this action results in a change of placement involving the target. The fact that the target x does not move of its own (non-intentional change of placement) has to be reflected in the introduction rule too. As can be seen in Intr13 (Appendix 1), y’s action on x through the exertion of a force and the

²² Introduction rules for frontward and backward motions (e.g., Intr12) may be simplified by leaving aside the intrinsic frontal orientation of the moving target. Then, every change of placement –at least in the horizontal plane (i.e., motion perpendicular to gravitation)– would be considered as being a “frontward” motion. This kind of formalization corresponds to (very) loose uses of *avancer* ‘to advance, to move forward’ (e.g., *Il avance en reculant* ‘He is advancing by moving back’) in which no more differences exist between frontward and backward displacements.

²³ As pointed out by Reiner et al. (2000: 9-13), in modern physics forces are indirectly tackled through their effects on entities (“process-based conception of forces”). In this work, the formalization of forces is concerned with the “functional” level of representation of space in language (Aurnague & Vieu 1993, Aurnague et al. 1997). Furthermore, we are interested in grasping the commonsense or naive view of physical phenomena as involved in language and cognition, not the theoretical physics’ point of view (Hayes 1985; Reiner et al. 2000: 9-13; Talmy 2000 vol. 1: 456-459; Vandeloise 2001: 134-135). In particular, it is possible, for a force, to be conceived as a (momentary) property or product of an entity that is transferable to another entity through causal interactions.

ensuing (non-intentional) change of placement of x are verified “step by step” through the minimal changes of placement e' making up the whole motion e . Here again, the new information contributed by the introduction rule (in italics) is likely to be represented by the synthetic relation *Carr-along*(y, F, x, e).²⁴

4.2.7 *Opposition to an internal force (target-related difficulty):*

$$Op\text{-}force(x, F, F', e)$$

Opposition to an internal force (target-related difficulty) is also modelled by means of the relation *Act^o-force*. Thus, introduction rule *Intr14* (Appendix 1) specifies that, for each minimal change of placement e' included in a whole motion e , the force f generated by the target x is opposed to a force f' originating in x too. Moreover, the event e'' associated with f leads to the minimal change of placement e' , these two eventualities being part of the target’s intention at the time of the minimal change.²⁵ A more complete formalization would need the additional notion of “normal” change of placement –change of placement occurring in normal/canonical conditions– to be added to the rule (see Appendix 1) in order to ensure that the forces involved in the present situation are stronger than those brought into play by a canonical motion ($>_f$ is an order relation between forces). The relation *Op-force*(x, F, F', e) is supposed to bring together the material added by the introduction rule, with F and F' (in upper case) denoting respectively the sum of successive f and f' forces exerted over e (cf. Footnote 24).²⁶

4.2.8 *Landmark-related obstacle/difficulty: Diff-landm-rtd(e, y)*

The predicate *Diff-landm-rtd* applies to the change of placement and/or the change of basic locative relation of a strict motion eventuality (change of relation and placement). Recall that a difficulty is said to be landmark-related when it occurs at any stage of a strict motion (it does not necessarily last

²⁴ The upper case letter F is intended to denote the sum of the different forces f exerted by x throughout the minimal changes of placement e' making up the encompassing motion eventuality e .

²⁵ Non-intentionality of the force f' opposed to f is not explicitly set in *Intr14* as I assume as a part of commonsense knowledge the fact that two **opposed** forces originating in the same animate entity are not both intentional.

²⁶ An independent axiom is needed for specifying that, in presence of a change of relation with respect to a (final) landmark, opposition to an internal force (target-related difficulty) entails landmark-related difficulties (cf. 3.7.2 and Appendix 2). One could also consider that, in this kind of dynamic configuration (final change of relation following opposition to an internal force), the animate target may have the intention to get to the final landmark from the beginning of the whole motion eventuality (cf. sections 3.7.2, 4.2.2, 5 and Appendix 1 *Intr6*). This is an optional property and its axiomatic introduction should have to resort to a non-monotonic rule.

throughout the whole eventuality) and is apprehended through its possible consequences on the achievement of the change of relation included in the motion (see Section 3.7.2).²⁷ Moreover, this difficulty may be only hypothetical so that it may not occur at all. To be precise, hypotheticality as involved here is not only ascribable to the contingency of the obstacle/difficulty but also ensues from the “relative” character of difficulty which often depends on some kind of norm and on the abilities of the moving target. Three introduction rules are proposed (Appendix 1) according to which part of the strict motion eventuality is concerned with difficulty: the change of placement (Intr15), the change of relation (Intr16) or either (Intr17; this rule is the most general). As can be seen in the formula, the predicate Diff-landm-rtd can be “directly” handled, without giving a formal account of the hypothetical character of difficulty noted above – only the subscript symbol pos points out this modal dimension. Alternatively, this content can be grasped through the use of a more detailed formula including a modal operator.

4.2.9 Blocking: *Blocks(y,x,s)*

Blocking is a state materialized by a static spatial configuration between a target and a landmark (a configuration in which the landmark y controls the target x in every direction; see Section 3.8.1). This state precedes a change of relation and placement involving these two entities (see Intr18 in Appendix 1). Intentionality is sometimes involved in this kind of locative change but this property is tackled independently and introduced case by case, at a different level of specification of the spatio-temporal schema (according to each verb’s semantics). Speed, which often coincides with blocking, is handled apart too.

4.2.10 Guidance: *Guides(y,x,e)*

Guidance results from the action of an element y, usually distinct from the target x, that guides or “channel” x’s motion in the course of a change of placement e, without necessarily causing it (Section 3.8.2). The nature of the guiding element y may possibly be clarified and constrained (see Intr19 in Appendix 1) including, in particular, “roads” or “pipes” (Stosic 2002, 2007),

²⁷ The variable y in the predicate Diff-landm-rtd is intended to reflect the landmark-related character of the difficulty, that is to say the fact that it occurs in the course of an encompassing displacement with respect to a landmark y. The relations between e, y and the encompassing motion eventuality of which e is a part are set out in the introduction rules Intr15-17 (Appendix 1). However, the context of occurrence of Diff-landm-rtd could be further specified through a rule with a modal operator of the following form: Diff-landm-rtd(e,y) $\rightarrow \diamond \exists e',e'',x (Part_i(e,e') \wedge (Ch-rel(e') \wedge target(e')=x \wedge landm(e')=y \wedge Ch-plmt(e'') \wedge target(e'')=x \wedge (e'' \supset c e' \vee e' \equiv e'')) \vee (Ch-rel(e'') \wedge target(e'')=x \wedge landm(e'')=y \wedge Ch-plmt(e') \wedge target(e')=x \wedge (e' \supset c e'' \vee e' \equiv e''))$.

moving entities (other than x) and forces exerted on x (including internal uncontrolled drives). Indeed, these restrictions underlie different sources of guidance that would deserve further examination and modelling in future research.²⁸

The formal system sketched out in this section and in Appendix 1 needs some final remarks to be made. As can be observed, only three notions –deixis or perspective point, landmark-related obstacle/difficulty and blocking– involve a change of basic locative relation (together with a change of placement, concomitant or not). In contrast, five notions –speed, direction/linear oriented motion, carrying along by a force, opposition to an internal force (target-related difficulty) and guidance– apply to changes of placement. Finally, two other properties (animacy and intentionality) are intended to characterize abilities and behaviours of targets without introducing further constraints on the spatio-temporal structures (changes of relation and/or placement) they may combine with. As already hinted, one may wish that the possible propagation among eventualities (belonging to an encompassing strict motion eventuality) of given properties be governed by specific axioms: this may be the case for speed when applied to a change of placement (systematic application to a concomitant change of relation and default application to a following one) and for landmark-related difficulty occurring with the same kind of eventuality (i.e., a change of placement) or with a change of relation (systematic application to a concomitant change of relation vs. change of placement). The compatibility of intentions and the propagation of intentionality between concomitant events of change of relation and change of placement was also commented on (see Section 4.2.2) and translated into the formal system (Appendix 1, Ax1, Ax2). As regards the complementary question of how a strict motion eventuality e can inherit the properties and constraints encoded in the sub- eventualities –change of basic locative relation and change of placement– comprising it, I stick to minimal mechanisms: the eventuality e inherits the target and landmark of the constituent sub- eventualities and, more generally, of the properties verified by each of these sub- eventualities (e.g., intention, speed when that is the case). An exception could be possibly made for landmark-related obstacle/difficulty, by considering that the encompassing motion is “difficult” as soon as one of its sub-parts encodes this specific feature.

²⁸ Further possible sources of guidance are extended material entities other than roads and pipes and immaterial directions. In a more comprehensive modelling, the relationships between some kinds of guidance and the notions of linear oriented motion and carrying along by a force should also be made explicit.

5 ILLUSTRATING SOME POSSIBLE COMBINATIONS

The main semantic ingredients of (autonomous) strict motion eventualities having been reviewed and the basic tools needed for their formalization introduced, I now illustrate some possible combinations these meaning components can give rise to. Going through the four types of spatio-temporal structures previously highlighted (Types 1 and 1', Type 2, Type 3; see sections 2 and 4.1), the following subsections set out the formal definitions proposed for a selection of verbs (and constructions) as well as the graphical representations that synthesize this semantic content. For a more complete survey, Table 1 (Appendix 2) lists about forty-five French verbs and constructions whose main semantic properties –among those discussed up to now– are displayed.

5.1 Type 1 and Type 1' changes of relation and placement

The semantic content of Type 1 changes of relation and placement –as contemplated in this approach– is first illustrated by the formal definition obtained for the verbs *s'échapper* 'to escape' and *s'enfuir* 'to run away' (Def-exp1 for Def-expression1; although only *s'échapper* appears in this definition, it is supposed to also apply to *s'enfuir*). As indicated between square brackets (after the definition), Def-exp1 relies on the spatio-temporal structure detailed in Def1 (Type 1 change of relation and placement) to which have been added speed of motion (Appendix 1, introduction rule Intr10), the property of blocking (Appendix 1, Intr18) and the specification of the (underlying) locative relation usually involved (locating use of *à* 'at').

Def-exp1 $S'échapper(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=R_r(x,y) \wedge \text{poststate}(e1)=\neg R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1) \wedge \text{Rapid}(e2) \wedge \exists s (\text{Blocks}(y,x,s) \wedge s \supset c e1) \wedge (R_r(x,y) \leftrightarrow R_{\hat{a}\text{-loc}}(x,y))$
 [Def1: Ch-rel-plmt1(e,x,y), Intr10, Intr18, $R_{\hat{a}\text{-loc}}$]

The main properties and constraints present in Def-exp1 are summarized in Figure 1 below with the left part of the schema representing the internal structure of the eventuality of change of relation and placement *e*, and the right part showing other important meaning components involved in the eventuality (target, landmark, blocking, kind of locative relation).²⁹

²⁹ The vertical solid line relating the change of relation *e1* and the change of placement *e2* means that these two events are concomitant. They are subsumed in the whole event of change of relation and placement *e*, as expressed by the brace. The symbols between brackets appearing as superscripts of some events specify the type of these events (p: change of placement; rp: change of relation and placement). As regards changes of basic locative relation and their polarity, they are indicated directly after the event concerned.

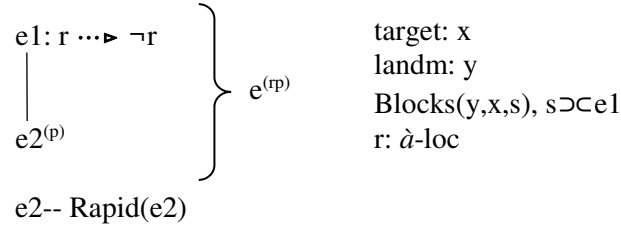


Figure 1: *s'échapper, s'enfuir*

As already noted (Sections 3.8.1 and 4.2.9), the intentional character of the change of relation –and, consequently, of the concomitant change of placement (Appendix 1, Ax2)– together with the animacy of the target (Appendix 1, Intr1, Intr4) could appear as an additional **option** in the formal definition Def-exp1 : $Anim(x) \wedge \exists ei, II (Int(ei, x, II, e1) \wedge Real(ei, e1))$. These pieces of information could be also inserted in the graphical schema with the same optional status (see Figure 2 for the representation of intentionality of a change of relation).

Another example is provided by the definition Def-exp2 applying to the verbs *s'extraire* 'to get out of, to extricate o.s.', *s'exfiltrer* 'to exfiltrate o.s.' and *se dégager* 'to extricate o.s.'. Once again the formal definition is based on the Type 1 spatio-temporal structure (Def1), to which aggregates the intentionality (Appendix 1, Intr4) and difficulty (Appendix 1, Intr16) of the change of relation (of course, intentionality goes with animacy (Appendix 1, Intr1)). Def-exp2, as well as the corresponding graphical representation (Figure 2), also indicate that the underlying locative relation is the relation of inclusion/containment spelled out as *dans* in French.

Def-exp2 $S'extraire(e, x, y) \equiv_{def} \exists e1, e2, R_r \text{ Ch-rel}(e1) \wedge target(e1)=x \wedge landm(e1)=y \wedge \text{Ch-plmt}(e2) \wedge target(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge prestate(e1)=R_r(x, y) \wedge poststate(e1)=\neg R_r(x, y) \wedge Gen(e1, e2) \wedge Gen(e2, e1) \wedge Anim(x) \wedge \exists ei, II (Int(ei, x, II, e1) \wedge Real(ei, e1)) \wedge Diff-landm-rtd_{pos}(e1, y) \wedge (R_r(x, y) \leftrightarrow R_{dans}(x, y))$
 [Def1: Ch-rel-plmt1(e, x, y), Intr1, Intr4, Intr16, R_{dans}]

This kind of graphical representation can be useful for field work and preliminary characterization of verbs' meaning for instance. It also provides a direct (visual) way of comparing strict motion expressions and, with some adaptations, could be used to fill the "condition set" of DRT-like representations of discourse content (Kamp & Reyle 1993).

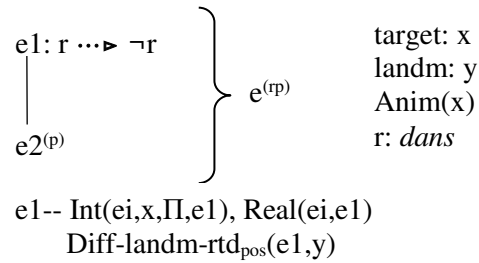


Figure 2: *s'extraire, s'exfiltrer, se dégager*

In the formal and graphical representations just above, landmark-related obstacle/difficulty may be stated with respect to the change of relation $e1$ (as it has been done) or to the change of placement $e2$ (Appendix 1, Intr15) –or even with respect to either of them (Appendix 1, Intr17). However, the two changes being concomitant, the difficulty of achieving $e2$ is likely to ensue from the difficulty of achieving $e1$ (and the reverse if the difficulty was stated in relation with the change of placement $e2$). The very same thing could be said for the intentional character of $e2$ (Appendix 1, Ax2).

Two further illustrations of Type 1 changes of relation and placement as grasped in the theoretical framework are given in Appendix 2 with the formal representation and graphical schema proposed for the verbs *partir* and *s'en aller* ‘to go (away), to leave’ (Appendix 2, Def-exp6, Figure 5) followed by some commentaries on the representation of *sortir* ‘to go out’.

Type 1’ changes of relation and placement are also tackled in Appendix 2 through the formal definition (Appendix 2, Def-exp7) and schema (Appendix 2, Figure 6) corresponding to *entrer* ‘to go into, to enter’. Recall that Type 1’ and Type 1 eventualities only differ by the fact that the former ones negate the underlying locative relation before asserting it so that the change of relation has a final polarity (cf. sections 2 and 4.1).

5.2 Type 2 changes of relation and placement

I now turn to Type 2 changes of relation and placement whose formalization is first illustrated by means of the verb *venir* ‘to come’. As appears in Def-exp3 below, the semantic modelling of this verb combines the spatio-temporal structure set out in Def3 (Section 4.1) with the deictic constraint expressed by the introduction rule Intr8 (Appendix 1; according to this constraint, the motion is viewed from a perspective point situated at the landmark entity). Note that, contrary to initial changes of relation and placement (see Type 1 eventualities in section 5.1), the nature of the basic locative relation is not specified in the definition as it depends on the preposition with which the verb is associated.

Def-exp3 $\text{Venir}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y$
 $\wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e2 \supset e1 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=\neg R_r(x,y)$
 $\wedge \text{poststate}(e1)=R_r(x,y) \wedge e2 \subseteq_t \text{prestate}(e1) \wedge \text{Enab}(e2,e1) \wedge \exists P \text{ Persp}(P,y,e2)$
 [Def3: Ch-rel-plmt2(e,x,y), Intr8]

The graphical representation of this semantic content is similar to that displayed in Figure 3, except for the various constraints on $e2$ (in the lower part of the schema) and the missing property of perspective point or deixis (which would have to be added in the higher part, together with the target and the landmark). As can be observed, graphical representations of Type 2 motion eventualities are made up of a lower/central part (rather than a left part) displaying the internal structure of the eventuality and a higher part (rather than a right part) with further elements and constraints characterizing the situation.³⁰

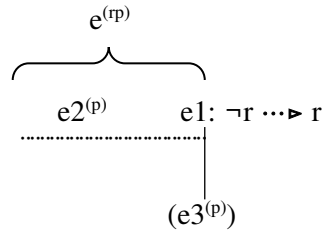
Type 2 autonomous motion predicates are the most numerous in French (see Section 2) because, besides “simple” verbs, they also include constructions combining a verb of change of placement with a static preposition and whose interpretation results (or may result) in a change of relation and placement. Several properties have been identified which, when present in the semantic content of a verb of change of placement, open the way to a construction expressing a strict motion (i.e., a Type 2 change of relation and placement). These properties –speed (see 3.4 and 4.2.4), direction (3.5 and 4.2.5), carrying along by a force (3.6 and 4.2.6), opposition to an internal force (3.7.1 and 4.2.7)– are organized in a family resemblance underlying the notion of “tendentality” (cf. Footnote 5). Def-exp4 below intends to show how the formalisms developed in this work can be used to capture the semantic meaning of complex verbal expressions associating verbs like *dégringoler* ‘to **tumble**/rush down’ or *dévaler* ‘to **tear/tumble** down’ (non-intentional interpretation) with a static spatial preposition. Besides speed (Appendix 1, introduction rule Intr10), Def-exp4 incorporates two further meaning components characterizing the changes of placement denoted by *dégringoler* and *dévaler* –direction (Appendix 1, Intr11/bas), carrying along by a force (Intr13)³¹–, and whose presence enables a Type 2 change of relation and placement to be built (Section 4.1, Def3). The main features of definition Def-exp4 are synthesized in Figure 3 previously commented on.

³⁰ The horizontal (dotted) line under the events in Figure 3 is meant to represent temporal succession. As regards the vertical solid line, it indicates temporal concomitance, in a way similar to the schematization of Type 1 eventualities (see Figures 1 and 2 and Footnote 29). However, note that the event of change of placement $e3$ (in Figure 3), concomitant to $e1$, appears between brackets and is given an optional status. Indeed, $e3$ is not included in Def-exp3 (and Def3) as it is not a compulsory part of the spatio-temporal structure.

³¹ The presence of the latter component reflects the non-intentional interpretation of the verbs. Note that only one feature of tendentality is enough to pave the way to an interpretation associating a change of placement and a change of basic locative relation.

Def-exp4 $\text{Dégringoler-prep}_{\text{stc}}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e2 \supset c e1 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge e2 \subseteq_t \text{prestate}(e1) \wedge \text{Enab}(e2,e1) \wedge \text{Rapid}(e2) \wedge \exists D D=-(\text{haut-grav}) \wedge \forall e' ((\text{Ch-plmt}(e') \wedge \text{Part}_t(e',e2) \wedge \neg \exists e'' (\text{Ch-plmt}(e'') \wedge \text{Part}_t(e'',e') \wedge e'' \neq e')) \rightarrow \triangleright_d(\text{Stref}(x,\text{poststate}(e')), \text{Stref}(x,\text{prestate}(e')), D)) \wedge \exists z z \neq x \wedge \forall e' ((\text{Ch-plmt}(e') \wedge \text{Part}_t(e',e2) \wedge \neg \exists e'' (\text{Ch-plmt}(e'') \wedge \text{Part}_t(e'',e') \wedge e'' \neq e')) \rightarrow \exists f, e''' (\text{Act}^\circ\text{-force}(z,f,x,e''') \wedge e''' \equiv_t e' \wedge \text{Gen}(e''',e') \wedge \neg \exists e'i, \Pi (\text{Int}(e'i,x, \Pi, e') \wedge \text{Real}(e'i, e'))))$
 [Def3: Ch-rel-plmt2(e,x,y), Intr10, Intr11/bas, Intr13]

target: x landmark: y



e2-- Rapid(e2)
 Orient-mot^o-bas(D,x,e2)
 Carrying-along(z,F,x,e2)

Figure 3: *dégringoler, dévaler + Prep*

The formal and graphical representations in Def-exp4 and Figure 3 only reflect the strict motion interpretation –involving both a change of placement and a change of basic locative relation– to which *dégringoler* and *dévaler* (in their non-intentional use) give rise when associated to an appropriate spatial preposition and PP. I make the assumption that the **basic** semantic content of the verbs at issue consists of a simple change of placement (without any change of relation) which is complemented by the different features of tendentiality previously pointed out. The presence of tendentiality, through one or several of its underlying properties, results in the integration in the verb's lexical entry of an additional **backgrounded** spatio-temporal structure of Type 2 (Aurnague submitted). This Type 2 schema materializes, so to speak, the consequences of tendentiality, that is to say the possibility for the verb to denote, under given circumstances, a change of placement followed by a final change of relation. Def-exp4 and Figure 3 illustrate the strict motion interpretation of *dégringoler* and *dévaler* arising when this backgrounded spatio-temporal structure is applied. The activation of this reading is likely to be governed by a complex syntactic-semantic rule that, on the one hand, will check the presence of

tendency in the lexical entry of the verb (triggering precondition) and, on the other hand, will verify that the static spatial preposition accompanying it can contribute to the expression of a final change of relation (trigger).³² For a given occurrence of a tendential verb and a spatial preposition/PP, some pragmatic clues related to the context and the situational context are also susceptible to lean towards one and/or the other of the two possible interpretations (simple change of placement or change of relation and placement).

Other examples of formal and graphical representations of Type 2 changes of relation and placement are set out in Appendix 2 through the verbs *aller* + *Prep* ‘to go + Prep’ and *se rendre* ‘to go to’ on the one hand (Def-exp8 and Figure 7) and the verbal constructions *grimper* + *Prep* ‘to climb + Prep’ and *se hisser* + *Prep* ‘to heave o.s. up + Prep’ on the other hand (Def-exp9 and Figure 8).

5.3 Type 3 changes of relation and placement

The case of strict motion expressions coming under Type 3 spatio-temporal structure remains to be tackled. The (formal and graphical) representations obtained for this kind of expressions will be commented on by focusing on the verb *aboutir* ‘to end up’. In spite of their similarity (as a change of placement precedes a final change of relation (and placement)), recall that Type 2 and Type 3 changes of relation and placement differ in an important point (see Section 2): while the change of placement previous to the final change of relation is directly included in the semantic content of Type 2 motion predicates, it only operates as a presupposition in Type 3 predicates’ meaning. This is reflected in Def-exp5 below where *Aboutir* applies to the final change of relation and placement *e* (sum of *e1* and *e2*) whereas the change of placement *e3* preceding *e* is a mere presuppositional constraint on the whole spatio-temporal structure, not a part of the *aboutir* event itself. The presuppositional status of *e3* is also conveyed by the graphical representation, as the corresponding piece of information in Figure 4 appears between slashes together with the symbol \Leftarrow –the right brace indicates that the change of relation and placement *e* consists of the sum of the (concomitant) final eventualities *e1* and *e2*. Besides the spatio-temporal structure contributed by Def4 (Section 4.1), both the formal definition and the graphical representation of *aboutir* state that

³² Moreover, contrary to what happens with the change of placement interpretation of the verb (where a possible spatial PP operates as a modifier (adjunct) of the sentence or the VP), when the minimal conditions for a strict motion reading are met, the syntactic-semantic rule will process the PP headed by the static spatial preposition as a complement of the verb or as a very “low” adjunct, close to the V head (e.g., V’-adjunct).

the change of placement $e3$ preceding the final change of relation (and placement) is a guided motion (Appendix 1, introduction rule Intr19).

Def-exp5 $\text{Aboutir}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1) \wedge \exists e3 (\text{Ch-plmt}(e3) \wedge \text{target}(e3)=x \wedge (\Phi \rightarrow (e3 \supset c e \wedge e3 \subseteq \text{prestate}(e1) \wedge \text{Enab}(e3,e1)))) \wedge \exists z (z \neq x \wedge \text{Guides}(z,x,e3))$
 [Def4: Ch-rel-plmt3(e,x,y), Intr19]

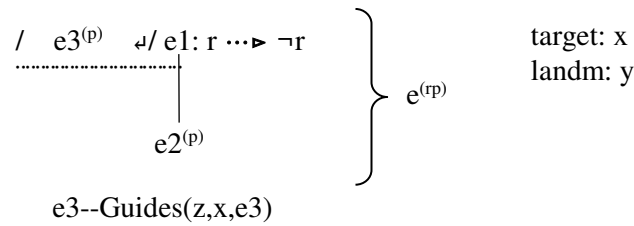


Figure 4: *aboutir*

Like Type 2 strict motion eventualities, the lexical entry of Type 3 motion verbs does not specify the nature of the underlying locative relation, as it depends on the preposition with which the verb combines (even if (most) Type 3 motion verbs appear to be especially related to the preposition *à* ‘at’ in its locating use; cf. Table 1, Appendix 2). Moreover, note that, if needed, the constraint of guiding (Intr19) could be triggered twice, so as to characterize the final change of relation and placement e too (i.e., not only the change of placement leading to this final event).³³

The semantic content of the verb *arriver* ‘to arrive’ is tackled in Appendix 2 (Def-exp10 and Figure 9) as an additional illustration of the representations proposed for strict motion eventualities of Type 3.

6 CONCLUSIONS

Based on previous analyses and studies, this report gave me the opportunity to make an inventory of the main meaning components underlying the expression of (autonomous) strict motion eventualities in French. The notions of target,

³³ The presuppositional status of the change of placement preceding the final change of relation and the requirement that strict motion eventualities both include a change of relation **and** a change of placement make that the (final) change of relation of Type 3 eventualities has to co-occur with a (concomitant) change of placement. This is an interesting contrast between Type 2 and Type 3 predicates (see Footnote 30) which allows to account for sharp differences related to the nature of the prepositions selected by these predicates (and their interpretation; cf. Aurnague 2015).

landmark, change of basic locative relation and change of placement –in combination with several temporal and causal operators– allowed me to characterize the (four) main spatio-temporal schemata involved in the eventualities under examination. Other ingredients proved to play a prominent role in the semantic content of French strict motion verbs and constructions, among others through selectional restrictions and the syntactic constructions (and readings/interpretations) the verbs give rise to. Thus, a total of ten additional concepts –animacy, intentionality, perspective point/deixis, speed, direction/linear oriented motion, carrying along by a force, opposition to an internal force (target-related difficulty), landmark-related obstacle/difficulty, blocking, guidance– are likely to combine with the basic spatio-temporal schemata by means of introduction rules. Although not modelled, other properties were also mentioned in the course of the analysis as possible parts of the verbal meaning (discreteness, partomotion, medium/environment, strength of a force, internal structure, immixion, affectedness).³⁴ On the whole, the amount of parameters taken into account and their detailed (descriptive and formal) examination provided an overview of the semantics of strict motion in French that was not available until now. Obviously, this is not to say that some aspects of the analyses could not be improved, in particular as regards the formal processing of various complex issues (e.g., forces, intentions).

As already underlined, this work relies on previous studies about the expression of static space in French. In particular, it endorses the conceptual and formal model developed in (Aurnague & Vieu 1993; Aurnague et al. 1997) in order to capture the semantics of (static) spatial relations in language – articulation between the static and dynamic sides is carried out by resorting to the notion of change of basic locative relation (among others). Recall that, in this approach, localization is made relationally –no use of an absolute system of coordinates and of a space given beforehand– and operates on “extended entities” as introduced by texts and utterances –no use of the abstract notion of point as in Cartesian geometry. Geometrical properties single out the spatial or spatio-temporal referent of entities (cf. Section 4.1) and combine with the functional constraints also brought into play by spatial relations –the latter constraints apply to the entities themselves, e.g., orientation, support, containment, forces, part-whole relations. (Aurnague & Vieu 2013, 2015) emphasized the usefulness of such a view in comparison with the systems seeking to reduce the meaning of the whole range of (static) spatial relations in language to purely geometrical notions such as inclusion in a region or vectors.

³⁴ Analysing and formalizing autonomous motion/displacement “in general” –i.e., not only strict motion eventualities but also change of placement– would need additional properties to be taken into account. These properties apply to changes of placement and, as other features already evoked, they fall within the domain of manner (Stosic 2009b, 2019). I have specifically in mind the mode or instrument of a motion, its shape and the lack of a goal or purpose.

Other ontological issues integrated into the geometrical-functional approach are likely to challenge purely geometrical formalizations of linguistic space (e.g., the location/place vs. object opposition mentioned in Section 2). With respect to dynamic space more specifically, and as has been highlighted, an important functional component of autonomous strict motion eventualities (and, more generally, of autonomous displacements) has to do with the causal relations between the sub-eventualities that compose them. Beyond causation usually addressed in the analysis of caused motion, these causal links play, I believe, a major role in the functional structuring of strict motion eventualities, by accounting more or less directly for the forces involved in the sub-events and the relationships between the latter in terms of force dynamics. Causal links also make possible to capture the functional continuity of some displacements (over and above the geometrical continuity of space) and interact with the mobility of the target and its autonomy.

Given the above, the modelling of dynamic space outlined in this work differs quite notably from other proposals like the one set up by Mani and Pustejovsky (2012). For instance, it should be noted that, except for the notion of orientation, the authors restrict their spatial model to geometrical concepts and tools, on the “usual” grounds that functional constraints would be difficult to grasp and would come under the field of commonsense knowledge and pragmatic (Mani & Pustejovsky 2012: 27-28). For similar reasons (“heterogeneity” and difficulty to be delimited), manner of motion is not really tackled by the authors who stick to consider as falling within this domain the variations/modifications of any element in the characteristic frame of a motion (event or situation, figure, region or path traversed, distinguished point or region of the path (ground), medium; Mani & Pustejovsky 2012: 48-52, 95-99, 104-106).³⁵ Finally, and despite the steady recourse to the notion of change of relation, the path of a moving target is conceived as a material and extended/stretched element of which particular points or regions can be highlighted (indeed, the (explicit/presupposed or implicit) path of a motion eventuality is handled as an argument of the verbal predicate; Mani & Pustejovsky 2012: 38-43).

Following, among others, Jackendoff’s (1983: 163-169) claims about their “reality”, a quasi-material conception of paths spread out in typological and/or formal work on the linguistic expression of dynamic space. Yet, this view is far from being unproblematic. Besides their materiality, the frequent “bipartite”, or

³⁵ For obvious reasons, such a conception of manner is not able to precisely isolate the lexical properties of French motion verbs which condition some constructions and interpretations (e.g., carrying along by a force, opposition to an internal force (target-related difficulty); see above). More crucially, it extends the notion of manner to meaning aspects which, to my mind, should remain outside it. For instance, as specific modifications of a more general spatio-temporal schema –right-headed path–, the verbs *arrive* and *enter* can be considered as expressing manner of motion (Mani & Pustejovsky 2012: 104-106).

even “tripartite”, structure of paths –with initial, final and, sometimes, medial points or regions– as well as the properties of shape/form and orientation they are inclined to subsume would deserve a serious examination. Corpus analyses carried out by linguists (e.g., Stefanowitsch & Rohde 2004) showed that, even for a satellite-framed language like English –where a same motion event can be located with respect to successive entities–, a path could be perfectly centred on a single landmark (i.e., without this motion including any (additional) backgrounded phase and/or landmark within an encompassing eventuality). From a more formal perspective, Lestrade (2012) stresses the inadequacy of paths conceived as a succession of points or regions when accounting for the distinct location “modes” in languages (static, initial, final...). This author advocates for a capture of dynamic modes (initial or final) that would be based on a single point or region, with respect to which a change of relation takes place.³⁶

Similar observations combined with the ontological considerations previously mentioned –location/place vs. object opposition– led me (from my first studies on dynamic space (Aurnague 2008) onwards) to opt for a semantics of autonomous strict motion based on the concept of change of basic locative relation (following Boons 1987 and, even previously, Lyons 1977). However, the definition of a strict motion –and thus of a true path in my terminology– needs another property to be activated, that of change of placement (known as “translocation” (Zlatev et al. 2010) or “translational motion” (Talmy 1985, 2000) in other works). As we saw, the change of placement component of a strict motion can temporally coincide with the change of basic locative relation or the two elements can follow each other (most of the time, the change of placement comes first). But eventualities of change of placement do not necessarily come with a change of basic locative relation and, associated with complementary properties (several of which have been listed in this work), they delimit the class of (atelic) predicates which are usually considered as falling under the domains of direction/orientation and manner. Conversely, and this is an important outcome of this research, some changes of basic locative relation may not be accompanied by a change of placement (e.g., support/contact, social routines, transitions from partial to total inclusion/containment).

Among the extensions of the theoretical approach set out in this report, let me point out some teaching/didactic experiments carried out in several classrooms of French primary school (Didacdep project, pupils from stages 2 and 3 of primary schools, 8-11 years old) and whose results have been analysed in a series of papers (e.g., Aurnague & Garcia-Debanç 2016a, 2016b). Different

³⁶ Although he mentions the possible “functional” determination of a “region”, Lestrade (2012) seems to tackle the semantics of spatial relations on the basis of the latter entities (i.e., regions in which targets are included) rather than in a direct relational (and functional) way (cf. Aurnague & Vieu 2013, 2015).

activities or tasks were proposed to students, several of which consisted in classifying motion verbs according to their semantic or meaning affinities (semasiological tasks). They were also asked to elicit verbal predicates matching specific properties through an onomasiological task of sentence production (ritualized elicitation repeated with the same instructions). The analysis of these activities shows that relatively “abstract” properties like polarity (initial or final; cf. Section 2) of a strict motion eventuality were identified by children. Other constraints or meaning components, usually associated with eventualities of change of placement (speed, direction/linear oriented motion, carrying along by a force, difficulty...), also underlie students’ classifications (and ritualized elicitations) and seem thus to be cognitively accessible –although this accessibility is partly sensitive to the nature of the activity or task. On the long term, a deeper observation of narrative texts and other “spontaneous” productions may be necessary in order to identify the motion predicates which are the best known and the most widely used by children, in particular when referring to autonomous strict motion. Because of their frequent uses, such predicates could be considered as being part of the most basic elements involved in the expression of dynamic space in French (see the notion of “basic verb” in Viberg’s (2002, 2012) studies for instance).

7 APPENDIX 1

This appendix lists the different “introduction rules” that are likely to apply to the spatio-temporal schemata highlighted in section 4.1 (Def1-4), in order to build the complete semantic content of strict motion verbs.

Operating principle: spatio-temporal schema of the form $F \wedge G$; introduction rule of the form F' (application constraints, standard characters) $\wedge H$ (italics); matching of F' and F (unification of variables in F' with variables in F); the variables that H shares with F' (before unification of F' and F) are substituted in the same way (i.e., substituted for variables in F); possible additional renaming in H , according to G 's content; after substitution and renaming, H is added to $F \wedge G$: $F \wedge G \wedge H$.

• *Animacy*

Intr1 $\text{target}(e)=x \wedge \text{Anim}(x)$

• *Intentionality*

Intr2 $\text{Ch-plmt}(e) \wedge \text{target}(e)=x \wedge \text{Anim}(x) \wedge \forall e' ((\text{Ch-plmt}(e') \wedge \text{Part}_t(e',e) \wedge \neg \exists e'' (\text{Ch-plmt}(e'') \wedge \text{Part}_t(e'',e') \wedge e'' \neq e')) \rightarrow \exists e'i,\Pi (\text{Int}(e'i,x,\Pi,e') \wedge \text{Real}(e'i,e')))$ /A change of placement is intentional if each of the minimal changes of placement composing it is itself intentional at the time it takes place/³⁷

Intr3 $\text{Ch-plmt}(e) \wedge \text{target}(e)=x \wedge \text{Anim}(x) \wedge \forall e' ((\text{Ch-plmt}(e') \wedge \text{Part}_t(e',e) \wedge \neg \exists e'' (\text{Ch-plmt}(e'') \wedge \text{Part}_t(e'',e') \wedge e'' \neq e')) \rightarrow \neg \exists e'i,\Pi (\text{Int}(e'i,x,\Pi,e') \wedge \text{Real}(e'i,e')))$ /Non-intentional change of placement at the time it takes place/

Intr4 $\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Anim}(x) \wedge \exists e'i,\Pi (\text{Int}(e'i,x,\Pi,e) \wedge \text{Real}(e'i,e))$ /Intentional change of relation at the time it takes place/

Intr5 $\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Anim}(x) \wedge \neg \exists e'i,\Pi (\text{Int}(e'i,x,\Pi,e) \wedge \text{Real}(e'i,e))$ /Non-intentional change of relation at the time it takes place/

Intr6 $\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Anim}(x) \wedge \text{Ch-plmt}(e') \wedge \text{target}(e')=x \wedge e' \supset c e \wedge \text{Enab}(e',e) \wedge \exists e'i,e'i,\Pi (\text{Int}(e'i,x,\Pi,\text{init}(e')) \wedge \text{Ch-rel}(e'i) \wedge \text{target}(e'i)=x \wedge \text{landm}(e'i)=y \wedge \text{Int}(e'i,x,\Pi,\text{init}(e')) \wedge \text{Enab}(e'i,e'i) \wedge \text{Real}(e'i,e'))$ /Planned or anticipated change of relation at the beginning of the change of placement which precedes/³⁸

³⁷ Encoding the intentionality of a change of placement in the course of its realization is, most of the time, sufficient for capturing the (intentional) content of the verbs and constructions under examination. The expression of an intention previous to the change of placement is usually not needed (except, perhaps, when the change of placement is associated with an anticipated change of relation; see below). Stating the intention of a global change of placement with parts of it situated (anticipatedly) in well-defined landmarks or sub-landmarks is even less needed.

³⁸ When the intention to achieve a change of placement followed by a change of relation with respect to a landmark exists at the beginning of a change of placement, only the planned or anticipated change of placement is systematically realized in the change of placement actually carried out (which is expressed in language), as the final change of relation with respect to the landmark may occur without the animate

Intr7 $\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Anim}(x) \wedge \text{Ch-plmt}(e') \wedge \text{target}(e')=x$
 $\wedge e' \supset c e \wedge \text{Enab}(e',e) \wedge \neg \exists ei, e', \Pi (\text{Int}(ei, x, \Pi, \text{Init}(e'))) \wedge \text{Ch-rel}(ei) \wedge$
 $\text{target}(ei)=x \wedge \text{landm}(ei)=y \wedge \text{Int}(e'i, x, \Pi, \text{Init}(e')) \wedge \text{Enab}(e'i, ei) \wedge \text{Real}(e'i, e')$
 /Non-planned or anticipated change of relation/³⁹

Propagation/inheritance of intentionality:

Ax1 $\forall e, e', x, y (\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Ch-plmt}(e') \wedge \text{target}(e')=x \wedge$
 $e \equiv e' \wedge \text{Gen}(e, e') \wedge \text{Gen}(e', e) \wedge \neg \exists e'i, \Pi' (\text{Int}(e'i, x, \Pi', e') \wedge \text{Real}(e'i, e')) \rightarrow$
 $\neg \exists ei, \Pi (\text{Int}(ei, x, \Pi, e) \wedge \text{Real}(ei, e))$ /If a change of placement is not intentional at the
 time it takes place neither is the concomitant change of relation of the target/

Ax2 $\forall e, e', x, y (\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Ch-plmt}(e') \wedge \text{target}(e')=x$
 $\wedge e \equiv e' \wedge \text{Gen}(e, e') \wedge \text{Gen}(e', e) \wedge \exists ei, \Pi (\text{Int}(ei, x, \Pi, e) \wedge \text{Real}(ei, e)) \rightarrow \exists e'i, \Pi'$
 $(\text{Int}(e'i, x, \Pi', e') \wedge \text{Real}(e'i, e'))$ /If a change of relation is intentional at the time it takes
 place then the concomitant change of placement of the target is also intentional/

• *Perspective point*

Intr8 $\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Ch-plmt}(e') \wedge \text{target}(e')=x \wedge e' \supset c e \wedge$
 $\text{Enab}(e', e) \wedge \exists P \text{Persp}(P, y, e')$ ⁴⁰

Intr9 $\text{Ch-rel}(e) \wedge \text{target}(e)=x \wedge \text{landm}(e)=y \wedge \text{Ch-plmt}(e') \wedge \text{target}(e')=x \wedge e \equiv e' \wedge$
 $\text{prestate}(e)=R_r(x, y) \wedge \text{poststate}(e)=\neg R_r(x, y) \wedge \text{Gen}(e, e') \wedge \text{Gen}(e', e) \wedge \exists P$
 $\text{Persp}(P, \text{ext}(y), e')$

• *Speed*

Intr10 $\text{Ch-plmt}(e) \wedge \text{Rapid}(e)$

target being aware of it (e.g., *Max a réalisé qu'il était en Espagne une heure après y être parvenu* 'Max realized he was in Spain an hour after he got there'). The rule Intr6 reflects this point.

Fully capturing the semantics of a verb like *parvenir* 'to reach, to get to' and, to a lesser extent, *accéder* 'to reach, to get to' probably needs to introduce a slightly more complex rule in which the previous intention may not concern the landmark explicitly mentioned in the description but the final landmark of an encompassing change of relation and placement (of which the "present" motion would be a part). Another possible case that should also be addressed is when the intention relates to a **direction** that the target is willing to explore until reaching one or more landmarks (final or intermediate) –in that direction.

³⁹ This specific case seems to not be directly involved in the semantics of intransitive or indirect transitive strict motion verbs in French. Rather, it appears as an indirect –partly pragmatic– consequence of some specific verb meaning (*aboutir* 'to end up').

⁴⁰ If needed, the relationships between the perspective point P and the change of placement e' could be made more explicit for certain uses by stating, for instance, that the direction associated with P and that arising from the change of placement (at some stage) are opposite. Moreover, several more "immediate" axioms are supposed to reflect the behaviour of the relation Persp and, in particular, the fact that the spatio-temporal referent of the perspective point P is included in the spatio-temporal referent of the landmark y (or in that of ext(y)) during e'.

• *Direction, linear oriented motion*

Intr11 $Ch-plmt(e) \wedge target(e)=x \wedge \exists D D=haut-grav \wedge \forall e' ((Ch-plmt(e') \wedge Part_i(e',e) \wedge \neg \exists e'' (Ch-plmt(e'') \wedge Part_i(e'',e') \wedge e'' \neq e')) \rightarrow \succ_d(Stref(x,poststate(e')),Stref(x,prestate(e')),D))$ /Vertical upward change of placement; the definition of a vertical downward change of placement is similar, except for $D=-haut-grav$ (or $D=(bas-grav)$)/

Intr12 $Ch-plmt(e) \wedge target(e)=x \wedge \exists D Orient-avant(D,x,prestate(e)) \wedge \forall e' ((Ch-plmt(e') \wedge Part_i(e',e) \wedge \neg \exists e'' (Ch-plmt(e'') \wedge Part_i(e'',e') \wedge e'' \neq e')) \rightarrow \exists D' (Orient-avant(D',x,poststate(e')) \wedge \succ_d(stref(x,poststate(e')),stref(x,prestate(e')),D) \wedge \neg \succ_d(stref(x,prestate(e')),stref(x,poststate(e')),D')))$ /A change of placement e is a frontward motion if, during each minimal change of placement e' comprised in it, the target x goes ahead in the frontal direction D provided by x at the beginning of e (global constraint) and if x does not turn around with respect to its frontal direction at the beginning of the minimal change of placement (local constraint); the definition of a backward change of placement is similar, except for the relations Orient-avant that are substituted by Orient-arrière⁴¹

• *Carrying along by a force*

Intr 13 $Ch-plmt(e) \wedge target(e)=x \wedge \exists y y \neq x \wedge \forall e' ((Ch-plmt(e') \wedge Part_i(e',e) \wedge \neg \exists e'' (Ch-plmt(e'') \wedge Part_i(e'',e') \wedge e'' \neq e')) \rightarrow \exists f,e''' (Act^o-force(y,f,x,e''') \wedge e''' \equiv e' \wedge Gen(e''',e') \wedge \neg \exists e'' i, \Pi (Int(e''i,x,\Pi,e') \wedge Real(e''i,e''')))$ /For each minimal change of placement e' included in e, the force f exerted by the entity y on the target x generates this minimal change of placement which, furthermore, does not result from any intention on the part of x/

• *Opposition to an internal force (target-related difficulty)*

Intr14 $Ch-plmt(e) \wedge target(e)=x \wedge Anim(x) \wedge \forall e' ((Ch-plmt(e') \wedge Part_i(e',e) \wedge \neg \exists e'' (Ch-plmt(e'') \wedge Part_i(e'',e') \wedge e'' \neq e')) \rightarrow \exists f,f',e''',e''''',e''''i,e''i,\Pi (Act^o-force(x,f,x,e''') \wedge Act^o-force(x,f',x,e''''') \wedge Op(f,f') \wedge e'''' \equiv e' \wedge e''''i \equiv e'''' \wedge Gen(e''''',e') \wedge Int(e''''i,x,\Pi,e') \wedge Int(e''i,x,\Pi,e') \wedge Real(e''''i,e''''') \wedge Real(e''i,e'''))$ /For each minimal change of placement e' included in e, the force exerted by the target x – which is opposed to another force f' also originating in x – generates this minimal change of placement, the event corresponding to f and the minimal change of placement being both the outcome of x's intentions/

Additional information, comparison to a normal displacement: $\wedge \forall f',f'',e''''',e''''''',e''''''''',e''''''''i,e''''''''i ((Ch-plmt-norm-min(e''''''')) \wedge$

⁴¹ Ideally, Intr12 would have to be supplemented in order to ensure the orientational stability of the target during the state used to determine a direction (prestate of the whole event, intermediate poststates). Also, note that two other options, at least, are available for characterizing forward/backward motions, one of which is more flexible than Intr12 –forward “local” motion without any constraint on the global direction of the change of placement– while the other one lays down more strict conditions –rectilinear direction, control of frontal and lateral positions.

$target(e''''')=x \wedge Act^{\circ}\text{-force}(x,f'',x,e''''') \wedge Act^{\circ}\text{-force}(x,f''',x,e''''') \wedge Op(f'',f''') \wedge e'''''\equiv e'''''' \wedge e''''''\equiv e''''''' \wedge Gen(e''''''',e''''''') \wedge Int(e''''''',i,x,\Pi,e''''''') \wedge Int(e''''''',i,x,\Pi,e''''''') \wedge Real(e''''''',i,e''''''') \wedge Real(e''''''',i,e''''''') \succ (>_f(f'',f''')) \wedge >_f(f'',f'''))^{42}$

• *Landmark-related obstacle/difficulty*

Intr15 $Ch\text{-rel}(e) \wedge target(e)=x \wedge landm(e)=y \wedge Ch\text{-plmt}(e') \wedge target(e')=x \wedge (e' \supset C e \vee e \equiv e') \wedge Diff\text{-landm}\text{-rtd}_{pos}(e',y)$

or $\diamond \exists e'' (Part_t(e'',e') \wedge Diff\text{-landm}\text{-rtd}(e'',y))$ [in place of $Diff\text{-landm}\text{-rtd}_{pos}(e',y)$]

Intr16 $Ch\text{-rel}(e) \wedge target(e)=x \wedge landm(e)=y \wedge Ch\text{-plmt}(e') \wedge target(e')=x \wedge (e' \supset C e \vee e \equiv e') \wedge Diff\text{-landm}\text{-rtd}_{pos}(e,y)$

or $\diamond \exists e'' (Part_t(e'',e) \wedge Diff\text{-landm}\text{-rtd}(e'',y))$ [in place of $Diff\text{-landm}\text{-rtd}_{pos}(e,y)$]

Intr17 $Ch\text{-rel}(e) \wedge target(e)=x \wedge landm(e)=y \wedge Ch\text{-plmt}(e') \wedge target(e')=x \wedge (e' \supset C e \vee e \equiv e') \wedge (Diff\text{-landm}\text{-rtd}_{pos}(e,y) \vee Diff\text{-landm}\text{-rtd}_{pos}(e',y))$

or $\diamond \exists e'' ((Part_t(e'',e) \vee Part_t(e'',e')) \wedge Diff\text{-landm}\text{-rtd}(e'',y))$ [in place of $(Diff\text{-landm}\text{-rtd}_{pos}(e,y) \vee Diff\text{-landm}\text{-rtd}_{pos}(e',y))$]

• *Blocking*

Intr18 $Ch\text{-rel}(e) \wedge target(e)=x \wedge landm(e)=y \wedge Ch\text{-plmt}(e') \wedge target(e')=x \wedge e \equiv e' \wedge \exists s (Blocks(y,x,s) \wedge s \supset C e)$

• *Guidance*

Intr 19 $Ch\text{-plmt}(e) \wedge target(e)=x \wedge \exists y (y \neq x \wedge Guides(y,x,e))$

Additional information, ontological characterization of y : $\wedge (Road(y) \vee Pipe(y) \vee \exists e' (Ch\text{-plmt}(e') \wedge target(e')=y) \vee Force(y))$

⁴² The non-monotonic operator \succ (Lascarides & Asher 1993) and the notion of (minimal) normal change of placement make possible to capture the fact that we are faced here with general knowledge about the expected “dynamic” behaviour of the target involved in the process. At this point, I prefer not to explicitly resort to a modal or intensional formalization.

8 APPENDIX 2

- Ch-rel-plmt1

- *Partir, s'en aller* ‘to go (away), to leave’

Def-exp6 $\text{Partir}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=R_r(x,y) \wedge \text{poststate}(e1)=\neg R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1) \wedge (R_r(x,y) \leftrightarrow R_{\hat{a}\text{-loc}}(x,y))$
 [Def1: Ch-rel-plmt1(e,x,y), $R_{\hat{a}\text{-loc}}$]

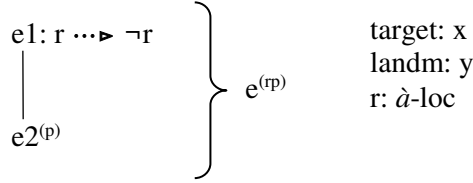


Figure 5: *partir*

- *Sortir* ‘to go out’

Sortir(e,x,y) is formally represented like *Partir*(e,x,y), with the only difference that the relation underlying the initial change of placement is of a distinct nature: $(R_r(x,y) \leftrightarrow R_{\text{dans}}(x,y))$. Likewise, the only difference between the graphical schemata concerns the locative relation: r : *dans*. See, below, the formula and representation set out for the “symmetrical” verb *entrer* ‘to go into, to enter’.

- Ch-rel-plmt1’

- *Entrer* ‘to go into, to enter’

Def-exp7 $\text{Entrer}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1) \wedge (R_r(x,y) \leftrightarrow R_{\text{dans}}(x,y))$
 [Def2: Ch-rel-plmt1’(e,x,y), R_{dans}]

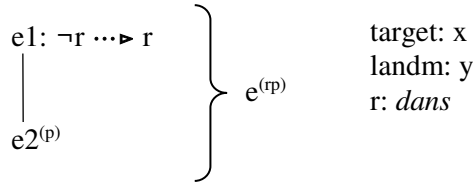


Figure 6: *entrer*

- Ch-rel-plmt2

- *Aller + Prep* ‘to go + Prep’ (e.g., *aller à* ‘to go to’)⁴³, *se rendre* ‘to go to’

⁴³ As indicated in Section 2 (Footnote 3), in current French, the verb *aller* ‘to go’ is mostly used in association with static spatial prepositions, with which it constitutes verbal locutions in order to denote a final change of relation and placement.

Def-exp8 $\text{Aller-prep}_{\text{stc}}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y$
 $\wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e2 \supset_c e1 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge$
 $\text{poststate}(e1)=R_r(x,y) \wedge e2 \subseteq_i \text{prestate}(e1) \wedge \text{Enab}(e2,e1)$
 [Def3: Ch-rel-plmt2(e,x,y)]

The nature of the relation is determined by the preposition.

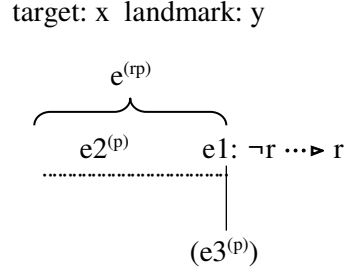


Figure 7: *aller + Prep, se rendre*

• *Grimper, se hisser + Prep* ‘to climb, to heave o.s. up + Prep’

Def-exp9 $\text{Grimper-prep}_{\text{stc}}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge$
 $\text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e2 \supset_c e1 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=$
 $\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge e2 \subseteq_i \text{prestate}(e1) \wedge \text{Enab}(e2,e1) \wedge \text{Anim}(x) \wedge \exists D$
 $D=\text{haut-grav} \wedge \forall e' ((\text{Ch-plmt}(e') \wedge \text{Part}_i(e',e2) \wedge \neg \exists e'' (\text{Ch-plmt}(e'') \wedge$
 $\text{Part}_i(e'',e') \wedge e'' \neq e')) \rightarrow \succ_d(\text{Stref}(x,\text{poststate}(e')), \text{Stref}(x,\text{prestate}(e')), D)) \wedge \forall e'$
 $((\text{Ch-plmt}(e') \wedge \text{Part}_i(e',e2) \wedge \neg \exists e'' (\text{Ch-plmt}(e'') \wedge \text{Part}_i(e'',e') \wedge e'' \neq e')) \rightarrow$
 $\exists f,f',e''',e'''' ,e''''i,e'i,\Pi (\text{Act}^\circ\text{-force}(x,f,x,e''') \wedge \text{Act}^\circ\text{-force}(x,f',x,e'''') \wedge \text{Op}(f,f') \wedge$
 $e'''' \equiv_e e' \wedge e'''' \equiv_e e'''' \wedge \text{Gen}(e'''' ,e') \wedge \text{Int}(e''''i,x,\Pi,e') \wedge \text{Int}(e'i,x,\Pi,e') \wedge$
 $\text{Real}(e''''i,e'''') \wedge \text{Real}(e'i,e')) \wedge \text{Diff-landm-rtd}_{\text{pos}}(e2,y)$
 [Def3: Ch-rel-plmt2(e,x,y), Intr1, Intr11, Intr14, Intr15]

The nature of the relation is determined by the preposition.

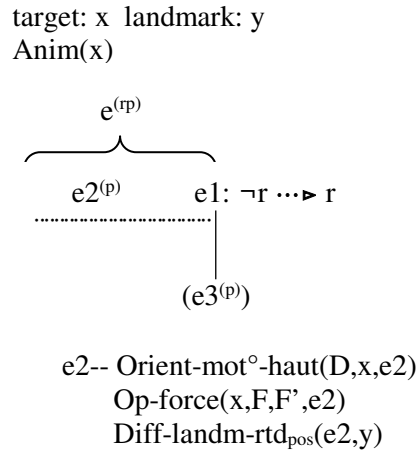


Figure 8: *grimper, se hisser + Prep*

See in Section 5.2 (*dégringoler* ‘to tumble/rush down’, *dévaler* ‘to tear/tumble down’) what is said about the verbs whose meaning incorporates one or more features of “tendentiality” and the possibility, for them, to yield a Type 2 spatio-temporal structure (associated to tendentiality in their semantic content, as a backgrounded spatio-temporal schema) when combined with an appropriate static spatial preposition/PP. With regard to the relationships between opposition to an internal force and landmark-related obstacle/difficulty, an additional axiom may be integrated into the formal framework outlined in Appendix I, indicating that if a change of placement is accompanied by an opposition to an internal force and if this change of placement is followed by a final change of relation, then the property of landmark-related difficulty is active in the course of the change of placement. This rule could possibly extend the property of opposition to an internal force and that of landmark-related difficulty to the final change of relation.

- Ch-rel-plmt3

• *Arriver* ‘to arrive’

Def-exp10 $\text{Arriver}(e,x,y) \equiv_{\text{def}} \exists e1,e2,R_r \text{ Ch-rel}(e1) \wedge \text{target}(e1)=x \wedge \text{landm}(e1)=y \wedge \text{Ch-plmt}(e2) \wedge \text{target}(e2)=x \wedge e1 \equiv e2 \wedge e=e1 \oplus e2 \wedge \text{prestate}(e1)=\neg R_r(x,y) \wedge \text{poststate}(e1)=R_r(x,y) \wedge \text{Gen}(e1,e2) \wedge \text{Gen}(e2,e1) \wedge \exists e3 (\text{Ch-plmt}(e3) \wedge \text{target}(e3)=x \wedge (\Phi \rightarrow (e3 \supset c e \wedge e3 \subseteq \text{prestate}(e1) \wedge \text{Enab}(e3,e1))))$
 [Def4: Ch-rel-plmt3(e,x,y)]

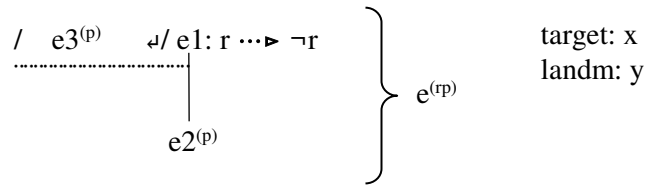


Figure 9: *arriver*

	r	Anim	Int	Persp	Speed	Dir°/Lin- or-mot°	Carr-along	Op-force	Diff- landm-rtd	Blocking	Guidance
Ch-rel- plmt1											
<i>Partir, s'en aller</i>	à-loc										
<i>S'échap- per, s'enfuir</i>	à-loc	(X)	(Int, Ch- rel, Ch- plmt)		X					X	
<i>Déroche- r, dévisser</i>	à-loc	X	¬Int, Ch- rel, Ch- plmt		X		X				
<i>Sortir</i>	dans										
<i>S'exfiltr- er, s'extraire, se dégager</i>	dans	X	Int, Ch- rel, Ch- plmt						X		
<i>Débouch- er1, surgir</i>	dans			(X) (ext land m)	(<i>surgir</i>)						
Ch-rel- plmt1'											
<i>Entrer, pénétrer</i>	dans								(some uses of <i>pénétr- er</i>)		
<i>S'infiltr- er, s'insérer , s'introd- uire</i>	dans	(X)	(Int, Ch- rel, Ch- plmt)						X		
<i>S'engouf- frer</i>	dans				X						
Ch-rel- plmt2											
<i>Aller + Prep, se rendre</i>		(<i>se rendre</i>)	(<i>se rendre</i> : Int, Ch- plmt)								
<i>Venir, accourir</i>		(<i>accou- rir</i>)	(<i>accourir</i> : Int, Ch- plmt, Ch- rel?)	X (land m)	(<i>accou- rir</i>)						
<i>Courir, filer, foncer, + Prep</i>		(<i>courir</i>)	(<i>courir</i> : Int, Ch- plmt)		X						

<i>Avancer, reculer, monter, descendre + Prep</i>						X					
<i>Ramper, se traîner + Prep</i>		X	Int, Ch-plmt					X	X		
<i>Grimper, se hisser + Prep</i>		X	Int, Ch-plmt			X		X	X		
<i>Couler, dérapier, glisser, rouler + Prep</i>			¬Int, Ch-plmt, Ch-rel				X				
<i>Dégringoler, dévaler + Prep</i>		Intentional use: X	Intentional use: Int, Ch-plmt; Non intentional use: ¬Int, Ch-plmt, Ch-rel		X	X	Non intentional use: X				
Ch-rel-plmt3											
<i>Arriver</i>	(à-loc)										
<i>Parvenir, accéder</i>	(à-loc)		For animate targets (at least): Int, Ch-rel, Ch-plmt						X		
<i>Aboutir</i>	(à-loc)		Indirectly: ¬Int, Ch-rel								X
<i>Déboucher2</i>	(dans, init)		Indirectly: ¬Int, Ch-rel	(X) (ext landm)							X

Table 1: Verbs/constructions and semantic properties[†]

[†] The brackets surrounding semantic properties or components indicate that these properties or components only apply to some uses and/or verbs. The coding of intentionality (Int) or non-intentionality (¬Int) specifies whether this relates to a change of relation and/or a change of placement. Finally, a perspective point can be positioned at a landmark (landm) or outside it, in its immediate proximity (ext landm).

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