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A comparison of a selection of force theoretic frameworks

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Abstract
This review paper compares three models seeking to account for force dynamicity encapsulated within language. A basic introduction to force representation in language will firstly be given. The three models under consideration, by Talmy (1988), Wolff (2007) and Copley and Harley (2015), will then be objectively explained and discussed briefly. Finally, by means of considering three aspects of each model, the models will be compared. The three aspects that will be discussed are the following. Firstly, the definition of the notion of *force* that is being handled in the models will be elaborated on. Secondly, the empirical coverage of each model will be under investigation. Finally, the models will be compared in terms of the degree to which they succeed in mapping their semantics onto the syntax the meaning arises from. It will be concluded that the models by Wolff and Copley and Harley come out best when the three models are compared with respect to the three aspects: Wolff's model is able to model a great variety of dynamic events with different numbers of involved forces and the model by Copley and Harley is very successful considering compositionality.

1. Introduction

Until the end of the twentieth century, the semantic subfield of force dynamics was only marginally explored. This is remarkable, given its prominence and comprehensiveness: conceptual forces, as they are generally understood within force theory, underlie a broad range of dynamic situations. Several frameworks have been proposed which seek to provide an account of forces represented within linguistic material and the way the relevant involved entities behave with respect to those forces. In the present paper, three such models are firstly described and secondly compared to each other with respect to three aspects of force dynamic models.

Before turning to the discussion of the three models, the diversity of events which involve forces will be illustrated shortly. The most evident example of a situation involving a force is one involving a physical force. Consider the sentence in (1):

(1) The wind made the boat float away.

Among other forces, the event denoted by the sentence in (1) involves a force exerted by the wind on a boat, resulting in an event of the boat floating away. The notion of dynamicity, however, not only applies to events in which this dynamicity is directly visible, as is usually the case with physical forces, but also to situations in which dyna-

micity is more abstract. Consider, for example, situations such as the ones denoted by the sentences in (2):

(2) a. John obliged Hannah to stop running.
b. Brenda wants to fly very badly.

These situations do not only involve physical forces. Sentence (2) a can be viewed as involving a *social* force, brought forth by John, which is meant to stop Hannah from running. In the sentence in (2)b, Brenda generates a psychological force consisting of a wish of flying.

In general, the properties of the relevant entities and forces result in specific situations, which language allows its speakers to denote by means of all words, phrases and constructions our linguistic machinery has to offer. What force theoretic models aim to do is to capture the apparent universality of force within their framework, and by doing so, to build a bridge between language and reality with respect to force.

The present paper is structured as follows. Firstly, in section 2, the three models which are under consideration in this paper – the one by Talmy (1988), the one by Wolff (2007) and the one by Copley and Harley (2015) – will be introduced and explained one by one and will be compared to each other on a general level. Secondly, in section 3, based on three aspects of force dynamic frameworks, the three models will be compared in more detail. Those three aspects are 1) the definition of force that is assumed in the three models, 2) the empirical coverage of the models and 3) their validity with respect to compositionality. Those three aspects are assumed to constitute a great deal of the relevant properties of force dynamic models. Moreover, these aspects are the most interesting ones to study, since the three models differ greatly in these respects. Finally, based on the findings from section 3, it will be followed up which model(s) can be said to be the most adequate of the three models.

2. Three accounts of force dynamicity

2.1 A first attempt in modelling force dynamics: Talmy's model

One of the first force dynamic models was proposed by Leonard Talmy (1988). What was groundbreaking about his work at the time was that he abstracted away from causation as a primitive, holistic notion by further decomposing it and by placing it within a broader framework on the basis of which more dynamic notions could be modelled. Talmy analyzed all dynamic events as involving two entities, which he called the Agonist and the Antagonist, which exert opposing forces. He took those forces to fall in two categories: forces arising from a tendency toward action and forces arising from a tendency toward rest. The two forces exerted by the Agonist and by the Antagonist yield a resultant force, which has the same direction as the force of the stronger entity, thus resulting in an event of either action or rest (Talmy, 1988, p. 53-56). Talmy shows his framework to account not only for physical, but also for psychological, social and argumentative force interactions, which causes this framework to allow a broad range of linguistic material to be displayed using a very minimal set of aspects: the two entities, the direction and relative strength of their forces and the outcome of the interaction.

One of the most disputed aspects of Talmy's model is that it assumes the forces exerted by the Agonist and by the Antagonist to be opposing (Talmy, 1988, p. 54). This assumption raises problems in modelling linguistic structures denoting dynamic events with entities exerting forces in the same direction. This is the case with a verb like *to help*, which seems to denote situations in which the two interacting entities are working toward a shared goal. Talmy accounts for this problem by posing that, for a verb like *to help*, the Agonist is trying to accomplish a certain goal and the Antagonist is constituted by an abstract entity preventing the intended goal from being accomplished. The helper, in this case, is an external entity abating this Antagonist and by doing this the helper facilitates accomplishing the goal (Talmy, 1988, p. 64). This way of accounting for the problem might be judged to be cumbersome and in the next section the second model will be discussed, which provides a more elegant solution to this problem.

2.2 Rejecting necessarily opposing forces: Wolff's model

The problem posited by situations involving non-opposing forces forms the basis of one of the most outstanding differences between Talmy's model and the second model discussed in this paper, which was proposed by Wolff (2007). Wolff reformulates the elements in Talmy's model into three binary questions to determine the nature of the dynamic predicate: whether the patient (corresponding to the Agonist in Talmy's model) and the affector (corresponding to the Antagonist) are in concordance or not, whether the patient has a tendency toward the end state or not and whether the end state is approached or not (Wolff, 2007, p. 6). Wolff's model therefore roughly agrees with Talmy's model regarding the way of approaching dynamicity, but it allows the forces exerted by the interacting entities to be in concordance. What is more, Wolff leaves open the possibility of the resultant force to be a product of more forces than just those exerted by the two main entities, as will be seen in section 3.2.

Talmy and Wolff both argue purely from the semantics of dynamic predicates – they decompose and analyze the reference of linguistic representations of dynamic events. In the next section, a third model will be discussed, in which quite a different starting point is taken.

2.3 The syntax-semantics interface as a starting point: Copley and Harley's model

A different starting point in analyzing dynamicity than adapted by Talmy and Wolff was taken by Copley and Harley in their 2015 paper. In this paper, Copley and Harley develop a new framework on force dynamics, which reasons from the syntax-semantics interface and will be our third model under consideration. Their main purpose is to account for so-called non-culminating events, which are situations in which the telos associated with parts of the linguistic product is not reached due to the presence of intervening forces. They do this by adapting a definition of the notion of force in which the presence of a force does not directly imply the occurrence of its associated effect: forces can interact with and thus be nullified by other forces. The authors suggest that dynamic verbs refer to forces rather than to endpoint situations, so that non-culmination is taken to be the default rather than the exception (Copley & Harley, 2015, p. 104). In favor of this standpoint they also deliver cross-linguistic evidence.

Also, Copley and Harley particularize away from the idea of one broad causative function by presuming that every dynamic verb refers to a unique force with a unique result (Copley & Harley, p. 116 & 119). More specifically, they analyze the semantics of dynamic verbs to be twofold: on the one hand, they refer to a force, exerted by an entity, and on the other hand, they refer to the unique final situation aimed to reach by means of exerting that force (Copley & Harley, 2015, p. 123-124). The authors are successful in applying this dual analysis of dynamic predicates onto the different syntactic projections present within the linguistic material, as will be further elaborated on in section 3.3.

3. Comparative analysis of the three models

Now that the main characteristics of the three force dynamic models concerned have been outlined, the main differences between the three models will be elaborated on by considering three aspects of each model. Firstly, the differences in what the models take to be the characteristics of the notion of force will be laid out (section 3.1). Secondly, their applicability and power of expression is discussed (section 3.2). Finally, the models will be reviewed considering compositionality (section 3.3).

3.1 Interpretation of the notion of force

Firstly, it will be discussed how the definitions of the notion of *force* differ in the three models. Talmy and Wolff take force in all dynamic events to be inherently equal: what gives rise to the meaning of different dynamic predicates is the way the interacting entities are oriented toward one another and the direction and relative magnitude of the relevant forces, rather than the nature of the forces itself. Copley and Harley, however, take each force to be of a different kind: when two forces are associated with different starting or endpoint situations, they are different forces (Copley and Harley, 2015, p. 112). This difference in the definition of force can also be understood as a difference in the temporal interval within the overall causal chain of events which is referred to by force.

The diagrams in Figures 1 and 2 display the part of the event chain which the models under consideration interpret as force. Both diagrams show two events, of which e_0 is the starting situation and of which e_1 is the endpoint situation. The two events are chained together by a force transforming e_0 into e_1. The arrow underneath the force and the two events is a schematization of the time: the transformation of e_0 into e_1 happens over time. The bold line underneath the time axis displays the demarcation of the event chain which the models take to constitute the definition of *force*.[1] As can be seen, Talmy and Wolff, on the one hand, interpret force purely as what causes e_0 to transform into e_1 (as is shown in Figure 1), whereas Copley and Harley, on the other hand, take a force to be the entire transformation of the specific event e_0 into the specific event e_1 (as is shown in Figure 2).

1 Note that in the analysis given in Figures 1 and 2, e_0 and e_1 can take place at the same time, so that the time it takes for e_0 to transform into e_1 is zero. This is the case with verbs of activity such as *to dance*, where the dancing happens simultaneously with the force causing the dancing to happen being exerted.

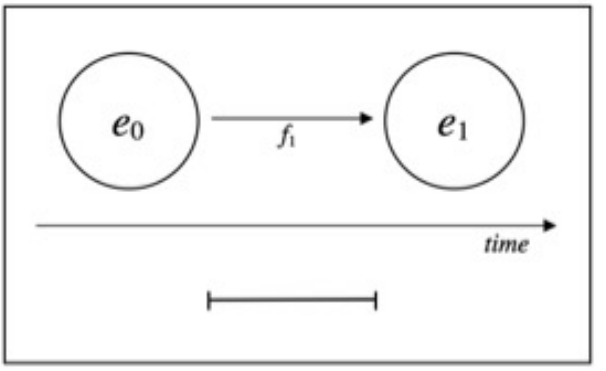

Figure 1. Force according to Talmy and Wolff.

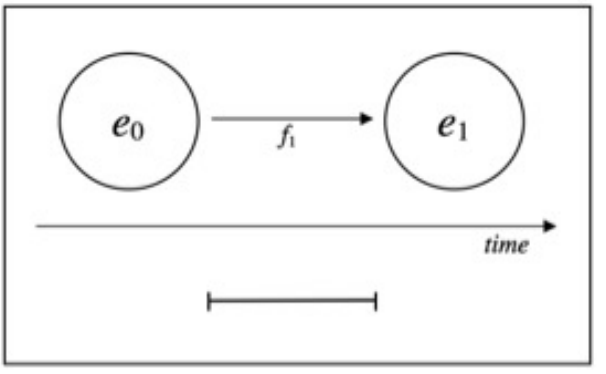

Figure 2. Force according to Copley and Harley.

From this distinction it necessarily follows that under the definition used by Talmy and Wolff, all forces are the same in nature, whereas under the definition used by Copley and Harley, no two forces are the same unless they are associated with the same e_0 as well as the same e_1.

While the models by Talmy and Wolff on the one hand and the model by Copley and Harley on the other hand clearly differ with respect to the way the notion of **force** is interpreted, neither of the two approaches seems to be notably more adequate or powerful than the other. Therefore, in this respect, none of the three models under consideration is deemed to deserve our preference over the other two. In contrast, the next section, in which the expressional power of the three models will be discussed, shows that one of the three models stands out compared to the others.

3.2 Empirical coverage

In this section, it is aimed to get insight into the degree to which the two models correspond with respect to power of expression. This will be done in two parts. In section 3.2.1, the models' applicability to different domains in which forces appear to play a role will be under discussion. In section 3.2.2, it will be investigated to what degree the models stand ground in modelling situations in which different amounts of forces are involved.

3.2.1 Applicability to different domains

In his original paper from 1988, Talmy elaborately discusses the way in which his framework can be extended to different domains. An example of how his framework can be extended to another domain than that of physical force dynamicity is given. Consider the sentence in (3):

(3) Peter restrains himself from eating.

The sentence in (3) contains the psychological verb *to restrain*. To be able to model psychological verbs like *to restrain*, Talmy assumes a so-called divided self: the forces being exerted arise from different 'parts' of the self (Talmy, 1988, p. 69). In the sentence in (3), the Agonist is a part of Peter with a tendency toward action (or, more specifically, toward *eating*), but this force is overcome by the force exerted by a stronger Antagonist, which is taken to be a different part of Peter, with a tendency toward rest. In similar ways, Talmy also shows his framework to be able to account for not only physical and psychological but also for social and argumentative force interactions. For a more precise description of how he does this exactly, I would like to refer to Talmy (1988).

Wolff proves his model to be applicable to physical, psychological and social force interactions. He does this by carrying out a series of experiments in each of which it is tested to what degree the predictions made by his model about situations in a domain in which forces play a role agree with the way participants described those situations. The way the participants described the situations were mostly in accordance with the predictions made by his model, indicating that for all the different domains that his model was tested with, namely physical, psychological and social force interactions, the model is adequate.

Copley and Harley do not explicitly describe the way their model can be extended to different domains. However, they assume that when forces are taken to be inherently abstract, a model for physical forces can easily be generalized to account for other domains as well (Copley & Harley, 2015, p. 113). By stating this, the authors assume to have accounted for the applicability of their model to different domains, too.

Intuitively, neither of the three models seems to greatly stand out concerning its applicability to other force dynamic domains. The papers in which the models are proposed, however, differ in the explicitness with which this applicability is laid out. What is relevant for the present discussion is that Talmy is the most explicit in this respect and that Wolff has shown empirically that his model is extensionally adequate. These models will therefore be preferred here. Also, further research is required to demonstrate explicitly the applicability of the other model by Copley and Harley to the domains the model has not yet been empirically tested for.

3.2.2 Modelling different numbers of forces

As has been shown in the previous section, the applicability in the different domains does not seem to constitute a problem for either of the three models directly. In this section, we

will see to what degree the models are successful in describing situations involving differing numbers of forces.

Firstly, modelling linguistic structures which on the surface do not denote more than one force will be considered. This is something in which the model proposed by Copley and Harley comes out best: Talmy and Wolff assume that there are always two forces. This does not seem to be the case with the verbs in the sentences in (4):

(4) a. Mary dances in the bathroom.
b. Manny bakes a cake.

The model by Copley and Harley is able to account for the dynamicity of these verbs as follows. Recall that Copley and Harley decompose the meaning of dynamic predicates into a part selecting for agentivity and a part denoting the final situation of the dynamic event. In the case of the sentences in (4), the agentivity is denoted by the exertion of a force causing the dancing in the case of *to dance* or the baking in the case of *to bake* and the final results are the taking place of the dancing and the existence of a cake. So, whereas Copley and Harley easily model these verbs, it is hard to imagine how Talmy and Wolff would, since they both assume more than one force per force interaction.

Copley and Harley's model, therefore, comes out best as far as modelling one-force-events is concerned. However, while their main purpose is to account for non-culminating events, they are unclear as to how to model the involvement of more than one force: they propose a way of integrating non-culmination into their framework by suggesting that the presence of a force itself does not imply the occurrence of its associated final situation, but they do not show how this non-culmination comes about in the presence of intervening forces. That is what the models proposed by Talmy and Wolff do best: they can model two forces and they use the aspect of relative force strength to account for the outcome of the interaction. In this way, the models proposed by Talmy and Wolff also seem to neatly account for non-culminating events: the exerted force of one entity, which has an intended result, might not be able to bring about this result because of a stronger force exerted by another entity.

Having noted that Copley and Harley seem to be able to only model one force, the framework proposed by Wolff is the only one able to model more than two forces: Talmy assumes two entities which both exert one force, whereas Wolff also takes into account the resultant force of the other forces present in the interaction (besides those exerted by the two relevant entities) (Wolff, 2007, p. 7).

It seems as if the model by Wolff is able to model a wider range of force interactions concerning the number of involved forces than the models by Copley and Harley and Talmy are. Also, in section 3.2.1, it has been concluded that the models by Talmy and Wolff are the most explicit in accounting for their applicability to different domains. This section will therefore be concluded by mentioning that Wolff's model can be preferred with respect to empirical coverage.

3.3 Syntax-semantics mapping

Finally, the degree to which the three models are accurate in the light of compositionality will be discussed. The principle of compositionality holds that "the meaning of a [...] whole is a function only of the meanings of its [...] parts together with the manner in which these parts were combined" (Pelletier, 1994, p. 11). This principle is mainly motivated by the creativity aspect of language: we are able to interpret linguistic products we have never heard before (Partee, 1995). This means that in order to attach meaning to sentences, we are able to only rely on information that is present within the sentence, namely the meaning of the individual elements and the underlying sentence structure. The principle thus forms the basis of language comprehension and meaning it is therefore a prerequisite for any semantic model.

Talmy and Wolff both argue purely from the semantic value of dynamic verbs and the syntax is therefore not of utmost priority. Wolff makes no attempt to map the elements in his model onto the syntax. Talmy indicates which elements in his dynamic diagrams correspond to the subject, the object and the verbal phrase by labelling the elements corresponding to those constituents with '1', '2' and 'VP', respectively (Talmy, 1988, p. 61). This works to a certain extent, but it makes his semantics-to-syntax-mapping quite rough and undetailed compared to how Copley and Harley's model performs with respect to compositionality.

Copley and Harley, on the other hand, reason from the syntax-semantics interface, resulting in a model which is relatively successful mapping its semantic analysis onto the syntax. Firstly, they account for the origin of external arguments by stating that they are selected by a *voice phrase* denoting the source of the force. Secondly, concerning the verbal phrase and the internal argument, Copley and Harley analyze dynamic situations as denoting an endpoint situation and the force necessary to reach that endpoint situation. This dichotomy is integrated into the syntax by making use of the notion of *vP*. The vP is an extension of the verbal phrase which decomposes verbs into a part selecting for agentivity and a part consisting of the lexical root, which denotes the endpoint situation of the dynamic verb reference (Carnie, 2013). Copley and Harley map the twofold semantics of dynamic verbs as described above onto the vP on the one hand and its complement, a small clause (SC), on the other hand: the agentive part of the verb, the exertion of the force, is denoted by the vP head and the final situation, which is the endpoint of the dynamic verb reference, is referred to by SC (Copley & Harley, 2015, p. 123). This is shown in Figure 3.

In this example, the force is exerted by the VoiceP head, which is *Mary*. The door being open is the final situation of the vP *open the door*, so that situation is represented in SC. The dynamicity that precedes that final situation, then, is indicated in the vP head. In the realization of this phrase, however, the vP head is silent.

As we have seen, Talmy analyzes the verbal phrase in a sentence without mapping more specific units within the verbal phrase to more specific elements within his framework. Copley and Harley, on the other hand, decompose the verbal phrase and propose a systematic way of mapping specific parts of the verbal phrase on the elements within their model. With respect to compositionality, therefore, the model by Copley and Harley will be preferred here.

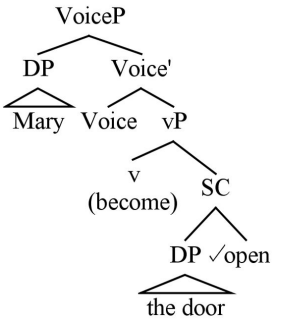

Figure 3. Structural representation of the sentence Mary opens the door (extracted from Copley and Harley, 2015, p.125).

4. CONCLUSION

Now that the three models have been compared, we are in a position to try and look whether one of the three models turns out to be outstandingly more adequate than the other two, overall. Let us summarize the findings that have come forward. In section 3.1, it was concluded that the models clearly differed with respect to the way the notion of *force* was defined, however none of the different approaches seemed more accurate than the other. In section 3.2, Wolff's model was taken to be the most accurate one, for it seemed to have the most expressional power in terms of its applicability to different domains and its ability to model dynamic events with different amounts of forces. Finally, the model by Copley and Harley was preferred in the light of compositionality. All things considered, therefore, the models by Wolff and Copley and Harley can be said to be more accurate than the one by Talmy. Both models are not comprehensive, however: Wolff's model performs poorly with respect to compositionality and Copley and Harley's model is unable to model more than one force.

It seems as if in modelling phenomena in general, we have to do with a trade-off between universality of the phenomenon and comprehensiveness of models aiming to capture that universality. Force dynamics is a very broad and widely applicable topic, which would make accurate models of force dynamics extremely powerful, but which simultaneously hampers the development of such a comprehensive model, precisely because it has so many aspects enforcing demands on those models. Up until now, no solution for this trade-off has been found, but as attested by the models discussed in this paper, the future is looking bright. ■

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