

Book Review

Interpreting Motion: Grounded Representations for Spatial Language

Inderjeet Mani* and James Pustejovsky[‡]

(*Children's Organization of Southeast Asia and [‡]Brandeis University)

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Reviewed by

Thora Tenbrink

Bangor University, Wales

Inderjeet Mani and James Pustejovsky present a documentation of the state of the art with respect to the formal and computational representation of motion concepts expressed in language (mostly English). Starting from the conceptual properties represented in the linguistic repertory of motion, they provide an overview of existing formalisms and annotation approaches, ultimately moving towards automatic approaches and computational applications. The book is timely in its representation of the current understanding of motion concepts in language, and will therefore be of great interest in the computational and cognitive linguistics communities.

Why, one may ask, do we need a better understanding of motion? It might seem that motion is just one of many human concepts expressed by a number of linguistic terms, which are adequately described by their lexical entries in anybody's dictionary. Mani and Pustejovsky's analysis of the linguistic representation of motion suggests a very different idea, however. Far from representing just one marginal aspect of human language, the conceptualization and verbalization of motion turns out to be central to human life—and, as a consequence, central to communication. Motion combines the two fundamental human concepts of space and time. Space without time is, for humans, as meaningless as time without space. Both are inextricably linked—and this link is most notably and systematically represented in language via expressions of motion. Motion is represented whenever aspects of life are described, reflecting its deep relevance for human thinking. Any computational approach towards interpreting natural language representation will, sooner or later, need to deal with motion concepts. Interpreting motion, therefore, turns out to be one of the most fundamental research issues for a variety of purposes both in basic (or cognitive) and applied (or computational) research.

Strangely, so far, research on the human representation of these fundamental conceptual domains is characteristically divided into two fairly distinct communities dealing with either space or time in language and cognition. The combination of both, adding dynamic aspects, appears to pose too many challenges, adding too many complexities to the already puzzling diversity with respect to human representations of space and time. With their book *Interpreting Motion*, Mani and Pustejovsky are at the forefront of research that aims to bridge this gap by systematically bringing together findings and formalisms from both directions. The effort, as such, is laudable. The formal detail provided to explicate the representational patterns considerably adds to the value of this book. Formalization serves computational purposes just as well

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as providing a more precise conceptual grasp of the identified linguistic phenomena. Nevertheless, it is noted that more elaborate explanations and consistent informal glosses might have supported the general audience of the Oxford University Press “Language and Space” series. Some readers may be more interested in the identified concepts than in the abundance of formalizations, which may be felt to hamper readability.

Against the background of the current state of research, it becomes clear why readers may, at particular points, feel slightly less than satisfied with the mechanisms provided for dealing with motion in language. The book is unusually clear and honest in highlighting limitations in the current understanding of crucially relevant concepts, including existing formalization techniques. Consequently, the book is not only a valuable summary of the currently available tools for interpreting motion, but also a useful starting point for further research that aims to fill various gaps identified by Mani and Pustejovsky’s exploration of the field.

One major gap that pervades much of the book concerns the mapping of non-linguistic formalisms such as ontologies or calculi to linguistic expressions. Such a mapping is essential, because language reflects how humans naturally represent just those concepts that formalisms attempt to capture. The lack of systematic mapping mechanisms between linguistic structures and widely used formalization categories is by no means the authors’ fault, but reflects a longstanding research desideratum well-known in the relevant research communities—with scattered attempts to provide solutions here and there, several of which are represented in this book. Mani and Pustejovsky contribute to this urgently needed research by laying out the available tools in an accessible way and in many cases going several steps further ahead, suggesting mapping solutions wherever and to the extent possible.

The book starts with an insightful and fairly detailed introduction section that mainly serves to motivate the complexity involved in interpreting motion, highlighting key insights taken from cognitive linguistic theory as well as earlier psycholinguistic experimentation. Subsequent chapters outline linguistic observations supplemented by non-linguistic calculi, ontologies, and representations, dealing with space and time separately. The main innovative contribution of the book emerges with a proposal for the formal representation of motion in Chapter 4. Here, previous approaches and mechanisms are combined to model the topological changes over time introduced by motion verbs. The remaining two chapters provide annotation specifications and application prospects. Extraction of motion information from natural language descriptions is proposed in terms of manual annotation; computational implementations are currently still very limited. Nevertheless, these chapters set the stage for subsequent machine learning and other automatic approaches, adopting methodologies already successfully established for other formalisms, to which the newly proposed motion formalism is a successor. In general, the described actual applications concern mostly other related work; the book describes the relevance of the current framework to such applications and represents their goals.

Concerning the formal interpretation of motion, the aim in Mani and Pustejovsky’s approach is to capture the spatial implications carried by lexical items in terms of their consequences in the real world. For instance, the verb *to fly* implies a disconnection between the flying figure and the ground below it. Although this is an essential condition for flying, in other cases implications can be context dependent, which is why corpus-based investigation is essential. For instance, to establish the spatial situation conveyed by the verb *to cross* it is necessary to consider what exactly is being crossed. In the case of a field, there is constant contact with the ground, whereas in the case of a river being crossed via a bridge, there is no such contact—in fact, contact with the river will be

avoided. Spatial implications such as these are implicitly understood by humans and need to be made available for computational approaches.

Along these lines, the presented framework scrutinizes lexical denotation in relation to systematic patterns in the spatial domain, rather than making any claims about conceptually prominent aspects of lexical items in a cognitive linguistic (or psychological) sense. In this, the present approach is unique. For example, the linguistic ontology proposed by Bateman et al. (2010) captures the differences in meaning distinguished by the linguistic system, pointing to conceptual patterns reflected in (or made prominent by) language. In contrast, the framework presented in this book aims at identifying the spatial content carried across by the use of lexical items in context.

Altogether, the goal of this book is to provide a clearer and better-defined formal procedure for interpreting the language of motion than has been available before. As a matter of fact, the authors basically reject all previous approaches for being too vague in fundamental respects. I believe that there may be limits to the specificity of linguistic terms, however, due to their phenomenal flexibility. Cognitive linguists generally assume that language serves to trigger associations in people's minds, or build them up on the spot, based on sketchy and flexible semantics along with discourse context. As Talmy (1988, page 165) puts it, "we take a sentence (or other portion of discourse) to evoke in the listener a particular kind of experiential complex, here to be termed a 'cognitive representation.'" In other words, linguistic terms may not in the first place describe or represent meanings as such, but rather serve as triggers for activating concepts of human experience, which are far richer and more flexible than any lexical entry or formalization could possibly represent. These considerations resonate with current efforts to capture more adequately what has been characterized as "embodied cognition" (Anderson 2003). To the extent that human cognition operates in a non-symbolic way, formalizations may ultimately remain inadequate in capturing human understanding of motion.

That said, I do believe that the authors' effort in representing systematic implications that can be gained from the language of motion has led to a considerable step forward in a much-needed direction. It reaches far beyond traditional formal semantics approaches that basically leave the import of conceptual elements altogether untouched. The formal representation of motion is in this book carried further than ever before, combining decades of previous effort ingeniously towards extraction of motion information from natural language descriptions, to the extent possible given the current state of the art—and maybe ultimately limited by the nature of human language.

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Thora Tenbrink is a Lecturer in Cognitive Linguistics at Bangor University (Wales, UK), and a principal investigator in two projects in the Collaborative Research Center SFB/TR 8 Spatial Cognition (Bremen / Freiburg). Her main interest concerns the relationship between cognitive processes and linguistic representations. She is the author of *Space, Time, and the Use of Language* (Mouton de Gruyter, 2007), and has co-edited two books on issues in spatial language and spatial representation. E-mail: t.tenbrink@bangor.ac.uk.

