

## A two-vector model of events

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When we talk about events, we clearly imply a relational structure. For example, linguists resort to a thematic role structure where the basic roles are agent and patient. When we think about physical phenomena, we conceive of events as relations between causes and effects. When we make plans, we think of actions and their consequences. These perspectives reveal different aspects of the same underlying structure, which is an asymmetric relation between two entities.

This common structure of events in language, physical thinking and planning can be naturally interpreted in geometric terms. The structure can be modeled as a mapping between vector spaces (Gärdenfors and Warglien 2012). The action and the result components of the event is represented as vectors in the two spaces. The action space is conceived as a space of forces (or force patterns) acting upon some target entity. The result component of the event represents changes in the properties of the target, and therefore the result space is modelled as a vector space. The changes are typically changes of location or changes of object properties.

The two-vector representation of events will be applied to two areas:

### 1. Causal thinking

The event model captures a basic sense of *causation*: the action causes the result. Most accounts of causation analyze the relation between the action and the effect as a relation between two events. In contrast, our model views causation as a relation *within* an event by introducing a distinction between forces and changes of states. Unlike many other theories, our model does not treat causes and effects as symmetrical entities: they belong to different domains – causes to the force domain and results to change in location (in the case of movements) or in some property (color, size, weight, temperature, etc).

### 2. Events as a basis for semantics

Gärdenfors (2014, p. 177) proposes that a construal of an event contains at least one vector (force or result) and one object (patient or agent). This leads to a general proposal concerning the semantics of sentences: A declarative sentence typically expresses a construal of an event. A construal of an event can be a complex structure that not only involves the two vectors, but also a patient and an agent with their properties, as well as counter-forces, instruments, recipients, intentions, etc.

Linguists often distinguish between *manner verbs* that specify as part of their meaning how an action is performed, and *result verbs* that specify the resulting state. Result verbs group together verbs describing motion with verbs that describe property changes. The distinction is supposed to be exhaustive: Any particular use of a verb is either a manner verb or a result verb. On the proposed event model the distinction comes out very naturally: Manner verbs refer to force vectors of events while result verbs refer to result vectors. Another way of expressing this is to say that the manner/result distinction is basically a cause/effect distinction.

## References

- Gärdenfors, P. (2014). *Geometry of Meaning: Conceptual Spaces as a Basis for Semantics*. Cambridge, MA: MIT Press.
- Gärdenfors, P. and Warglien, M. (2012). Using conceptual spaces to model actions and events, *Journal of Semantics*, 29, 487-519.