

Spatial entities and their categorization in language and cognition. From linguistic properties and their formalization to processing by adults and children

Scientific head: Michel AURNAGUE

Michel AURNAGUE

ERSS, Maison de la Recherche
Université de Toulouse-Le Mirail
5 allées Antonio Machado
31058 Toulouse Cedex 1
Tel: 0561503602

Sub-topics related with the project:

The representation of space and its development
The linguistic description of space and its development
Body, motion, objects perception in space, handicaps
Space, vision, images
Space, hearing, sounds

Other participating groups:

Institut de Recherche en Informatique de Toulouse (IRIT, UMR 5505, CNRS & Université de Toulouse 3)
Laboratoire Cognition et Développement (UMR 8605, CNRS & Université de Paris 5)
Laboratoire Jacques Lordat (EA 1941, Université de Toulouse-Le Mirail; INSERM U455)

Abstract

While previous linguistic and psycholinguistic research on space has mainly focused on spatial relations (e.g., prepositions, postpositions, verbs), the aim of this project is to study how language categorizes spatial entities. This question is examined from three different and complementary perspectives: descriptive and psycholinguistic; formal and computational; and developmental. Descriptive and psycholinguistic studies were concerned with various categories of markers (nouns, prepositions, postpositions, verbs, etc.) and examined the description of static and dynamic space in several languages (French as well as Basque, Korean, Serbo-Croatian...). The result is a first linguistic classification of entities that seems to be general enough to hold across languages. This classification was compared to the categories that have been proposed in the philosophy of language, particularly in formal ontology or in artificial intelligence. Some theoretical elements aiming at formally defining these categories while fulfilling some general principles of ontological coherence were proposed. In order to test these propositions, part-whole relations were modeled by formalizing different kinds of dependences (between entities). Lastly, developmental research showed that, despite general cognitive factors determining how children talk about space, language-specific properties have a clear impact on their spatial representations. Moreover, studies on children with motor impairment indicate that motor development is neither determining for (objects) search tasks nor for the production and comprehension of spatial markers.

Key-words: linguistic expression of space – ontology – lexical semantics – crosslinguistic comparisons – knowledge representation – axiomatic theories – formal semantics – children development – categorization – perception – motor handicap

Participants : 5 researchers, 1 engineer, 5 teachers-cum-researchers, 4 Ph.D. students

Man-months: 60 months-man

Reminder of the stakes and goals set down at the beginning of the project

The initial project aimed at uncovering the categories of spatial entities that language seems to distinguish, following three complementary approaches: descriptive and psycholinguistic, formal and developmental. It consisted in:

a) finding out –through the analysis of linguistic data– the relevant distinctions between spatial entities that are available in language and the concepts on which these distinctions are based;

b) establishing –by means of crosslinguistic comparisons– how general these categories are across languages;

c) comparing this categorization with ontological classifications proposed in other domains (formal linguistics, AI, philosophy, etc.);

d) defining formal tools intended to model these categories and the concepts they call for (possible consequences for lexical semantics and AI);

e) determining the best way to integrate these formal definitions within a general semantic theory (possible problems for a theory of reference);

f) determining the psycholinguistic reality/validity of these categories and concepts by means of chronometric experiments (adult subjects), as well as production and comprehension experiments (children from 3 years on);

g) testing the developmental dimension of these spatial concepts through the comparative experimental study of normal and motorically handicapped children, the longitudinal study of emerging speech, and experimentation on early comprehension skills with infants;

h) pathing the way for further interdisciplinary research aiming at determining whether the categorization of spatial entities revealed by this work is specifically linguistic or is also involved in more general cognitive processes.

In the original schedule, the following steps were foreseen:

January 2000 – December 2000: linguistic and formal analysis of spatial categorization; collection of spontaneous productions with handicapped children.

July 2000 – December 2001: psycholinguistic experiments with adults and with 3- to 6-year-old children; testing with young children (30 months, 9 months).

January 2000 – December 2001: analysis of the longitudinal corpora.

Summary of results actually obtained

Descriptive and psycholinguistic research examined spatial descriptions in a large range of data: in addition to differences related to the syntactic category of the relevant markers (e.g., nouns, prepositions, postpositions, cases, verbs) and to their semantic properties (e.g., static space, dynamic space), several languages were also taken into account (French, Basque, Korean, Serbo-Croatian). These various analyses all indicate that distinctions among spatial entities underlie linguistic descriptions of space, distinctions which appear to be quite stable across static and dynamic descriptions, as well as across languages. The classification emerging from these descriptive and psycholinguistic studies constitute, without doubt, a novelty in the panorama of research on space in language. If further results complete partially explored research fields (“forces”, “dependences” between spatial entities, “paths”...), other observations allow us to delimit ontological notions (“space portions”, “locations”, “objects”, “buildings”/“mixed entities”, “roads”, “pipes”...) that are in great need of precise definitions, despite the fact that they are recurrent in the linguistic literature on space.

From the point of view of formal analyses, it is important to note that the distinctions highlighted by descriptive studies concern spatial concrete entities (or *continuants*) that have to be distinguished from temporal concrete entities (or *occurrents*). The first task of these

analyses consisted in establishing a state of the art by examining the various proposals that may explain and found the linguistic categorization, whether they stem from formal ontology (metaphysic branch of analytic philosophy), semantics (philosophy of language and formal linguistics) or AI. This state of the art was extended by a set of theoretical propositions including a coherent selection of results described in the literature and completed by original propositions of our own, particularly in relation to categorization differences which can be explained by the temporal properties of the predicates applied to concrete entities. The second task was to test these proposals by formalizing part-whole relations. Since the previous descriptive work has shown the importance of dependence relations (dependences between categories, functional dependences between material objects), a significant part consisted in defining and characterizing the inferential properties of these relations.

Finally, developmental studies were devoted to two main questions: 1) the modular or interactive character of the various components (perceptual, motor, cognitive, linguistic) of spatial cognition among children; 2) the universal or variable character of the capacities involved during their development. They included four series of analyses carried out among French-speaking subjects. First, experimental work examining the expression of spatial relations with children from 3 years on show the joint impact of two types of factors that are related to the properties of languages, on the one hand, and to cognitive development, on the other hand. Furthermore, two studies in progress test the assumption according to which language has an impact on children's early spatial representations: the study of comprehension and categorization of spatial relations among infants during the prelinguistic period (9 to 15 month) and the longitudinal analysis of spontaneous speech from the emergence of language onwards (18 months on). Finally, some studies indicate that young children with motor impairment (SMA II, 30 months) do not present any delay in development, neither in situations involving the search of hidden objects, nor during the production or comprehension of spatial relations markers.

Publications from the project