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Learning, Reasoning, and Talking about Space

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Preface

This is the sixth volume in a series of books dedicated to basic research in spatial cognition. Spatial cognition research investigates relations between the physical spatial world, on the one hand, and the mental world of humans, animals, and artificial agents, on the other hand. Cognitive agents – natural or artificial – make use of spatial and temporal information about their environment and about their relation to the environment to move around, to behave intelligently, and to make adaptive decisions in the pursuit of their goals. More specifically, cognitive agents process various kinds of spatial knowledge for learning, reasoning, and talking about space.

From a cognitive point of view, a central question is how our brains represent and process spatial information. When designing spatial representation systems, usability will be increased if the external and internal forms of representation are aligned as much as possible. A particularly interesting feature is that much of the internal representations of the meanings of words seem to have a spatial structure. This also holds when we are not talking about space as such. The spatiality of natural semantics will impose further requirements on the design of information systems. An elementary example is that "more" of something is often imagined as "higher" on a vertical dimension: consequently, a graphical information system that associates "more" with "down" will easily be misunderstood. Another example concerns similarity relations: features that are judged to be similar in meaning are best represented as spatially close in a graphical information system.

In addition to the question of how this information is represented and used – which was the focus of the previous Spatial Cognition volumes – an important question is whether spatial abilities are innate ("hard wired") or whether these abilities can be learned and trained. The hypothesis that spatial cognition is malleable, and hence that spatial learning can be fostered by effective technology and education, is based on recent evidence from multiple sources. Developmental research now indicates that cognitive growth is not simply the unfolding of a maturational program but instead involves considerable learning; new neuroscience research indicates substantial developmental plasticity; and cognitive and educational research has shown us significant effects of experience on spatial skill.

Because an informed citizen in the 21st century must be fluent at processing spatial abstractions including graphs, diagrams, and other visualizations, research that reveals how to increase the level of spatial functioning in the population is vital. In addition, such research could lead to the reduction of gender and socioeconomic status differences in spatial functioning and thus have an important impact on social equity. We need to understand spatial learning and to use this knowledge to develop programs and technologies that will support the

capability of all children and adolescents to develop the skills required to compete in an increasingly complex world. To answer these questions, we need to understand structures and mechanisms of abstraction and we must develop and test models that instantiate our insights into the cognitive mechanisms studied.

Today, spatial cognition is an established research area that investigates a multitude of phenomena in a variety of domains on many different levels of abstraction involving a palette of disciplines with their specific methodologies. One of today's challenges is to connect and relate these different research areas. In pursuit of this goal, the Transregional Collaborative Research Center SFB/TR 8 Spatial Cognition (Bremen and Freiburg) and the Spatial Intelligence and Learning Center (Philadelphia and Chicago) co-organized Spatial Cognition 2008 in the series of the biannual international Spatial Cognition conferences. This conference brought together researchers from both centers and from other spatial cognition research labs, from all over the world. This proceedings volume contains 27 papers that were selected for oral presentation at the conference in a thorough peer-review process to which 54 papers had been submitted; each paper was reviewed and commented on by at least three Program Committee members. Many high-quality contributions could not be accepted due to space limitations in the single-track conference program.

The Program Chairs invited three prominent scientists to deliver keynote lectures at the Spatial Cognition 2008 conference: Heinrich H. Bülthoff spoke on "Virtual Reality as a Valuable Research Tool for Investigating Different Aspects of Spatial Cognition", Laura Carlson's talk was about "On the 'Whats' and 'Hows' of 'Where': The Role of Salience in Spatial Descriptions", and Dedre Gentner addressed the topic "Learning about space". Abstracts of the keynote presentations are also printed in this volume.

Spatial Cognition 2008 took place at Schloss Reinach near Freiburg (Germany) in September 2008. Besides the papers for oral presentation, more than 30 poster contributions were selected for presenting work in progress. The conference program also featured various tutorials, workshops, and a doctoral colloquium to promote an exchange of research experience of young scientists and knowledge transfer at an early stage of project development. Immediately before the conference, a workshop sponsored by the American National Science Foundation (NSF) was organized by the SILC consortium in cooperation with the SFB/TR 8 at the University of Freiburg. This workshop included lab visits at the Freiburg site of the SFB/TR 8.

Many people contributed to the success of the Spatial Cognition 2008 conference. First of all, we thank the authors for preparing excellent contributions. This volume presents contributions by 61 authors on a large spectrum of interdisciplinary work on descriptions of space, on spatial mental models and maps, on spatio-temporal representation and reasoning, on route directions, wayfinding in natural and virtual environments, and spatial behavior, and on robot mapping and piloting. Our special thanks go to the members of the Program Committee for carefully reviewing and commenting on these contributions. Thorough reviews by peers are one of the most important sources of feedback to the authors

that connects them to still-unknown territory and that helps them to improve their work and to secure a high-quality scientific publication.

We thank Thomas F. Shipley for organizing, and Kenneth D. Forbus, Alexander Klippel, Marco Ragni, and Niels Krabisch for offering tutorials. For organizing workshops we owe thanks to Kenny Coventry and Jan M. Wiener as well as Alexander Klippel, Stephen Hirtle, Marco Ragni, Holger Schultheis, Thomas Barkowsky, Ronan O'Ceallaigh, and Wolfgang Stürzl. Further thanks go to Christoph Hölscher for organizing the poster session, and Sven Bertel and Marco Ragni, who were responsible for organizing the doctoral colloquium and for allocating travel grants to PhD students.

We thank the members of our support staff, namely, Ingrid Schulz, Dagmar Sonntag, Roswitha Hilden, Susanne Bourjaillat, and Ulrich Jakob for professionally arranging many details. Special thanks go to Thomas Barkowsky, Eva Räthe, Lutz Frommberger, and Matthias Westphal for the close cooperation on both sites of the SFB/TR 8.

We thank Wolfgang Bay and the SICK AG for the generous sponsorship for this conference and the continuous support of scientific activities in and around Freiburg. We thank Daniel Schober and the ESRI Geoinformatik GmbH for sponsoring the travel grants to PhD students participating in the doctoral colloquium.

We thank the Deutsche Forschungsgemeinschaft and the National Science Foundation and their program directors Bettina Zirpel, Gerit Sonntag, and Soo-Siang Lim for continued support of our research and for encouragement and enhancing our international research cooperations.

For the review process and for the preparation of the conference proceedings we used the EasyChair conference management system, which we found convenient to use.

Finally, we thank Alfred Hofmann and his staff at Springer for their continuing support of our book series as well as for sponsoring the *Spatial Cognition 2008 Best Paper Award*.

September 2008

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Related Book Publications

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