

Reviews

Review of Kelly S. Mix, Linda B. Smith and Michael Gasser (eds.). *The spatial foundations of language and cognition*. Oxford: Oxford University Press, 2010, xviii + 307 pp., ISBN 978-0-19-955324-2.

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The edited volume *Spatial foundations of language and cognition* collects eleven chapters from scholars across a wide range of disciplines, including psychologists, linguists, and computer scientists. As is emphasised in the foreword, the chapters deal with different facets of the following questions: how do we think about space and how do we use space as a tool for thinking about other things that are not strictly speaking spatial in nature? And what is the interrelationship between thinking about space, using space to guide thinking, and language? Although these contributions are written from different theoretical perspectives and focus on a variety of topics, what unites them is that the research they discuss lends strong support to the idea of embodiment in cognition. As noted by the editors, this can be seen as one of the main contributions of the present volume.

The book is divided into three sections: “Thinking through space,” “From embodiment to abstract thought,” and “Using space to ground language.” Each section begins with an introduction by the editors, who sum up the main points of the chapters, highlight convergences and divergences, and outline implications and further questions that arise. Unfortunately, references that are only cited in the introductions but not in other chapters are not listed in the bibliography, with the result that thirteen references are missing.

Section I, “Thinking through space” contains four chapters which argue that there are many domains in which we recruit the concrete domain of space when thinking about other, more abstract domains. In addition, they all stress that it is not only cognition in general, but especially language that is tightly coupled with space.

In the first chapter, Andy Clark investigates how spatiality might impact cognition from a philosophical perspective. Following Kirsh (1995), Clark argues that space can be used by humans as a prime resource for embodied reasoning in what he calls the ‘cognitive niche construction.’ Clark defines this term as “the process by which human inventions and interventions sculpt the social, symbolic, and physical environment in ways that simplify or productively transform our abilities to think, reason, and problem-solve” (p. 10). Expert bartenders, for example, use space as a resource to keep in mind multiple drink orders. They pick and array glasses of distinct shapes, which then serve as memory cues for recalling the drinks that have been ordered. Language, Clark argues, also functions as a way of reducing the descriptive and perceptual complexity of the world by introducing higher-order tags and labels that can serve as unifying representations for problem-solving and thinking. It thus works in a way analogous to how we use space as a resource for reasoning. As language and space can be argued to interact and mutually reinforce each other, both can be seen as an integrated cognitive resource used for complexity reduction by highlighting and restructuring sensory patterns.

Spivey, Richardson and Zedink (Chapter 2) also focus on the embodied nature of language, claiming that it “is spatial, not special” (p. 16). Their position is that the ‘Symbolic approximation hypothesis’ of early cognitive science, which used exclusively rule-based algorithmic operations on abstract logical symbols to describe cognition, has outlived its usefulness. Instead, they present a wealth of empirical evidence which strongly supports the idea that cognitive processes should be conceived of in embodied, spatial formats of representation grounded in perceiving the world and acting in it. The studies they review span the domains of mental models, verbal recall, visual imagery, and spoken verb comprehension, showing convincingly that representations in these domains co-opt spatial locations and spatial information. As the authors note, this is a stance very much in line with the theoretical commitments of Cognitive Linguistics, especially with work on the image schematic and metaphoric dimension of language, as spelled out by Lakoff (1987) and Langacker (1987). Indeed, the experiments on image schemas in metalinguistic judgements, perception and memory discussed by Spivey et al. present a range of relevant data cognitive linguists can and should integrate into their theoretical work to refine their linguistic analyses.

The third chapter, by Kelly S. Mix, describes the possible ways that the use of concrete spatial models in mathematics instruction might help children acquire an understanding of mathematical language and its underlying concepts. Since mathematical entities are often mental constructions, teaching and illustrating how symbolic procedures relate to children’s intuitive mathematical understanding of concrete spatial models and concrete spatial experience can significantly improve mathematical thought. Specifically, Mix reviews four

mechanisms that might be engaged by using concrete materials in mathematical instruction. First, concrete models might give children objects to act upon and opportunity for movement—something which has been shown to be crucial for category development. Second, they generate conceptual metaphors rooted in concrete experience, which have been shown by Lakoff and Núñez (2000) to underlie higher-order mathematics on all levels. Third, these models help children to offload some of the cognitive burden to the environment and in this way scaffold mathematical thinking. Lastly, they might also help in focusing attention on relevant aspects of the mathematical task at hand.

The last chapter of Section I by Ramskar, Matlock and Boroditsky makes a case for the view that people's understanding of the abstract domain of time is based on concrete spatial experience with and knowledge about objects. They summarize a number of ingenious experiments which show that thinking about motion (e.g. when departing or arriving at an airport, waiting for or being on a train, betting on a horse at a racetrack or thinking about how to move an office chair from A to B) can significantly influence people's conception of time. Specifically, thinking about motion can influence whether people think of themselves as moving through time or think of time as coming towards them. Although this view is clearly consonant with the notion of embodiment, Ramskar et al. stress that in contrast to very strong embodiment positions, the studies discussed in their chapter suggest that it is the representation of experience, i.e. thinking about time, that influences temporal cognition and not the physical experience of motion itself. This is especially evident in studies which show that reading sentences that include, so-called, fictive motion (e.g. *the bike path runs alongside the creek*) influences subjects' conception of time, while sentences describing the same scene without a motion component (e.g. *the bike path is next to the creek*) do not.

As the relation between internal representation and the idea of embodiment in its various guises is a controversial issue, it is addressed in several of the chapters. This makes this a valuable book for cognitive linguists as it gives an important overview of current positions on embodiment in the domain of space and its relation to language and internal representations. As commitments to both embodiment and mental representations belong to the core assumptions of Cognitive Linguistics (e.g. Johnson 1987; Langacker 1987), it is evidently important for them to be aware of the current theoretical status regarding the interrelationship of these two concepts. The chapters in Section I convincingly demonstrate that spatiality is related to thinking in important ways. The precise nature of how space is connected to mental representations, however, still needs to be spelled out in more detail.

Section II, entitled "From embodiment to abstract thought" confronts this issue directly, with all four chapters of this section presenting different approaches to the relationship of embodiment and abstract internal representation.

In the first chapter of this section Huttenlocher, Lourenco and Vasilyeva describe recent work on the development of spatial cognition in infants and young children. As this research indicates, children are sensitive to the geometrical features of their environment from very early on. This means that they do not always code the location of objects from an egocentric perspective, as suggested, for example, by Piaget (Piaget and Inhelder 1956). On the contrary, from the work they review Huttenlocher et al. conclude that young children code location in relation to their spatial environment. Moreover, they learn quite early to integrate landmark information and geometrical cues in their spatial representations, as shown in studies where children are disoriented after having been shown the location of a hidden object. The results discussed in this chapter are highly relevant for theories of cognitive perspective, a notion that plays a crucial role in cognitive linguistics (see e.g. Verhagen 2007). Huttenlocher et al. demonstrate that children show two types of perspective coding, depending on the task and situation. If children remain stationary it might only be necessary to represent viewer perspective relative to a particular object or portion of space. However, they also develop the ability to incorporate viewer perspective and position relative to the entire space into their spatial representations in situations that require them to be mobile. These data might also be relevant in investigating the foundations of other perspective-related cognitive behaviours in the social (e.g. Moll and Meltzoff 2011) and in the linguistic (e.g. Clark 1997) domains.

Lipinksi, Spencer and Samuelson, in the next chapter, argue for a process model of spatial memory and spatial language use. According to them, work on spatial representation has mostly been conceptual and has been concerned too much with static representations. Instead, Lipinksi et al. propose that a theory of spatial cognition that can be properly constrained by empirical findings must emphasize the processes that give rise to representational states on a second-to-second basis. They present a computationally implemented formal model of spatial working memory, called Dynamic Field Theory. This model, they argue, explains what is currently known about real-time spatial cognition and its relation to spatial language in a theoretically satisfying manner. In addition, it can and has been tested empirically. What is especially interesting about this model is the fact that spatial memory and spatial language can be modelled in a way that shows that both make use of the same frames of reference. This process-based model, then, is able to specify quite precisely how non-linguistic, sensorimotor systems and linguistic systems are tightly interlinked in the domain of space.

The relation of internal representations and embodiment is taken up again in Chapter three of this section. Landau, O'Hearn and Hoffman discuss their recent work on spatial representation in subjects with Williams Syndrome (WS), which, among other cognitive deficits, leads to severe deficits in spatio-

cognitive functioning. The language capacities of people with WS, however, are relatively intact. Embodied models of spatial cognition, such as Ballard et al. (1997), propose that embodied methods of anchoring thinking and acting to the environment (e.g. indexing through eye fixation) play a crucial role in our interactions with the spatial world. However, the experiments reviewed by Landau et al. show that the problems these subjects have with behavioural and linguistic spatial tasks cannot be explained by deficits in these embodied mechanisms. As the mechanisms themselves seem to be relatively intact, what seems to be responsible for these problems is very likely to lie at the level of the ability to form higher-level abstract internal representations. This, in turn, suggests that human spatial cognition might be aided and supported by embodied tracking and anchoring mechanisms, but that mental representations of space are still essential in all domains of spatial thinking and acting. The exact nature of these representations, however, is still not well understood.

Laura A. Carlson, in the concluding chapter of Section II, examines experimental work on how space is encoded in language. She shows that spatial parameters like the distance between objects “are encoded and mapped onto representations used in the processing of spatial language” (p. 167). Importantly for theories of the relationship between language and conceptual representation, the distance parameter seems to be involved not only in spatial terms explicitly conveying distance (*near*, for example). On the contrary, distance seems to be a crucial component of all linguistic spatial terms. The specific aspects that are encoded within a frame of reference used for spatial processing and language use, however, seem also to be task- and context-dependent. For example, when we hear or read sentences about smaller objects (e.g. *The neighbour has parked a snow-blower in front of his mailbox*) we estimate the distance between the two objects to be smaller than when we hear or read sentences about larger objects (e.g. *The neighbour has parked his snowplough in front of his house*). In general, research on how space is mapped onto language and how language and cognition are tightly tied to our experience lends support to the idea of embodiment, especially the immersed experiencer model of conceptualization (Zwaan 2004; see also Winter and Bergen 2012). The chapters in this section demonstrate that there has been significant progress in tackling the question of how embodiment and internal representations are related. However, they also show that there is still much work to be done, both empirically and theoretically, in order to fully address this controversial issue.

Whereas the chapters in Sections I and II dealt with thinking and space, spatial cognition, and their connection to language, the last section of this volume focuses more directly and explicitly on the ways in which space is important for language. Specifically, the chapters in Section III, “Using space to ground language,” examine different facets of the ways in which interacting in and perceiving spatial settings are fundamental to acquiring and using

language. Like many other chapters of this volume, they are thus concerned with the relationship of language and other cognitive and sensorimotor systems, a topic that is also very much at the centre of Cognitive Linguistics. The first two chapters deal with issues of language acquisition, while the last chapter of this section discusses the relationship of spatial representations and verb meanings.

Smith and Samuelson stress the importance of the body in infants' and young children's sensorimotor and linguistic development. They present a computational model of a perseverative reaching error (the A-not-B error) that occurs in infants of around 8 to 10 months of age. The model used to describe the motor plan responsible for this error and how it can be overcome is directly linked to the body's position and a motor plan to act in space. As Smith and Samuelson show, the model can also be used to model 18- to 24-month-old children's early word learning in which a word and a spatial location are linked through association (cf. Baldwin 1993). What is more, the authors point out that the tight link between the body's spatial position in both sensorimotor tasks and in word learning has been demonstrated successfully in a number of experiments. In children's development, these sensorimotor representations, which are directly tied to the physical world through the body, turn into more abstract representations over time. These are, in turn, freed from direct connection to sensorimotor processes, but are still grounded in the body's physical interaction in space.

The following chapter by Yu and Ballard also focuses on "The role of the body in infant learning." They demonstrate both experimentally and computationally that bodily pointing movements that serve as explicit, intentional cues, such as eye gaze and head movements, play an important role in language learning. These cues seem to be important on higher-cognitive levels, but also at the level of sensory computation. This result seems to hold true both for young and adult learners. Yu and Ballard also apply a formal model of multimodal statistical word learning informed by theories of embodied cognition to elicited production data. Their results suggest that contextual information can be used in identifying sound patterns of individual words. More importantly, their model shows that bodily movements can be used as deictic references to bind words and objects in the physical environment. This in turn enables the building of grounded lexical items. Thus, the use of computational models of embodied word learning in natural contexts also supports a view of language as grounded in sensorimotor experiences with the outside world.

In the last chapter of the volume, Cannon and Cohen look at the abstracted patterns of movement that underlie the semantic representations of verbs. They first review literature on linguistic, cognitive and social development indicating sensitivity to motion patterns in space early in development. The current literature suggests that this sensitivity involves a growing degree of abstrac-

tion. They then go on to interpret this evidence in light of Cohen's 'Maps for verbs' framework, which enables the analysis of the motion elements and their dynamic interactions inherent in verbs (such as *push*, *hit*, *harass*, *bounce*, *chase*, and so on) in great detail. Of course, abstracted motion is not the only important aspect of semantic meaning. In fact, the authors acknowledge the influential role of the perceptual system as a whole and the individual language spoken in determining the final state of the system. As Cannon and Cohen also remark, this psychologically and cognitively motivated work is directly relevant to research in cognitive semantics, especially Talmy's (e.g. 2000) theory of 'force dynamics'.

The present volume is a valuable collection for all scholars interested in the relationship between space, language and cognition. The volume is also of interest for theoretical linguists who wish to inform their analyses with a diverse range of empirical perspectives. This holds especially true for those with an interest in the relationship between embodiment and mental representation, perspective and perspectivation, and spatial language. One might expect that work by theoretical linguists can then feed back into new experimental approaches, fostering a mutually fruitful dialogue between the disciplines involved (cf. Gonzales-Marquez et al. 2007). Moreover, the individual chapters not only present a thorough overview of the present state of research on thinking and space, embodiment and abstract thought, and spatiality and language, they also point to future challenges and open questions for research to come. The editors thus succeed in their aim of assembling chapters that demonstrate the central role space plays *in* and *for* thinking, in that we both think *about* space, and think *through* space, using space as a complex cognitive resource.

In addition, the editors claim that there is much to be gained by also considering "how the state of the art in each literature impacts the other" (p. vii). It could be argued that they may have gone further to explicate exactly how the different strands of research presented relate to each other. Indeed, the question as to what extent the sometimes disparate research on space can actually come together to yield a unified theory of spatial cognition, remains open. Another important concern, addressed in several of the chapters, as well as by the editors, is the influence that a particular language might have on thought (e.g. Boroditsky 2001). Here, more cross-cultural, cross-linguistic, and theoretical work is needed. This is, perhaps, an area where Cognitive Linguistics, with its interest in conceptualization and language, as well as their relation to cultural and bodily situatedness (e.g. Johnson 1987; Lakoff 1987; Langacker 1987) has much to offer. Overall, the present volume successfully shows that regarding the relationship between space, language, and cognition, there is much potential for future interdisciplinary collaboration in the fields of linguistics, psychology, and cognitive science.

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If you have ever felt that a stranger was simply standing too close or have talked about how you and a former friend have 'grown apart', then you will have experienced the strong relation between concrete space and social connectedness. This interrelatedness is apparent when we talk about concepts such