

Origins of time: New insights into the psychological foundations of time

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Introduction

What are the origins of our ability to perceive and reason about time? The human experience of time is rich and multifaceted: low-level duration perception on the order of seconds; words (e.g. “hour”) and grammatical features (e.g. tense) that encode specific aspects of temporal experience; and high-level reasoning about duration, sequences, and causality. While some of these temporal abilities are present early in development (e.g. duration perception), others do not emerge for many years (e.g. the semantics of temporal words like “hour” or “yesterday”). There is an active debate about the origins of these varied facets of temporal cognition (e.g., Núñez & Cooperrider, 2013; Evans, 2013; Casasanto & Bottini, 2013). For instance, what are their evolutionary and developmental sources? Do certain temporal capacities distinguish us from non-human animals? Is our understanding of time built on a spatial foundation, or do both space and time rely on a shared, domain-general representational system? The time is ripe for an integrated approach to this foundational human capacity.

This symposium brings together researchers whose work has presented varied perspectives on the psychological origins of time, from perception to conceptualization (e.g., Bender & Beller, in press; Casasanto & Bottini, 2013; Santiago et al, 2007; Núñez & Cooperrider, 2013; Boroditsky & Gaby, 2010). The researchers hail from a variety of backgrounds, including anthropology, linguistics, psychology, and cognitive science, and approach the origins of time from the perspective of human development, cross-cultural variability, and cognitive processing. The five talks will discuss recent evidence from development, language, culture, and behavior, followed by a brief moderated discussion.

Bender and Beller adopt a cross-cultural perspective to examine the role of *frames of reference* in the conceptualization of time. **Marghetis, Tillman, Srinivasan, and Barner** explore the development of spatial metaphors for time in children, focusing on spontaneous temporal gestures and their relation to the acquisition of temporal language. **Santiago** discusses the roles of culture and attention in shaping cross-cultural differences in the conceptualization of time. **Walker, Bergen, and Núñez** argue that different conceptual models are used for different kinds of temporal reasoning. Finally, **Casasanto** compares and contrasts existing theories of the origins of interactions between space and time. **Boroditsky** serves as moderator.

Questions on temporal Frames of Reference (FoRs): Principles, preferences, and possible grounding in spatial FoRs (Beller & Bender)

When speaking and reasoning about time, people do not only tend to use vocabulary and concepts borrowed from the domain of space, they also engage in similar cognitive processes. Localizing one object in reference to another, for instance, requires one to adopt a specific perspective or “frame of reference” (FoR). The same holds when localizing one event in reference to another. Yet, while research on *spatial* FoRs has been highly prolific for almost two decades now, research on *temporal* FoRs is still in its infancy, hampered by a lack of consensus even on basic assumptions: Can spatial FoRs be mapped onto time at all? On which principles should such a mapping and/or the resultant taxonomy of temporal FoRs be based? How should findings on temporal references be interpreted? And what does this reveal about the origins of temporal reasoning? In this talk, we critically discuss current problems in conceptualization, but also highlight the potential of a unified taxonomy of spatio-temporal FoRs.

Linking space and time in the child's mind: The case of gesture (Marghetis, Tillman, Srinivasan, & Barner)

In nearly every language, space and time can be expressed in similar language (e.g., “the chalkboard/conference is *behind* me”). When adults talk about time, they also gesture, thus recruiting space to represent duration, temporal sequences, the past, the present, and the future. By contrast, children produce temporal language from an early age (e.g., *minute, yesterday*) but do not exhibit adult-like comprehension until many years later. Here we investigate the role of space in children's early conceptualization of time by examining the development of spontaneous gestures that represent time. We show that many types of temporal gesture—previously documented only in adults—are present in children as young as five, and become increasingly common in older children. We discuss relations between children's gestures and their comprehension of temporal language, and possible links between the gestural use of horizontal space and experience with reading and artifacts like calendars.

Flexible foundations of time (Santiago)

Time, like many other abstract concepts, is understood with the help of projections from more concrete conceptual domains, which in turn are structured by means of image schemas (e.g., path, balance, containment). Yet there are many concrete schemas that could be fruitfully applied to any given abstract domain. Moreover, the alternatives are not only found in different languages and cultures, but they often coexist in individual minds. How are they selected in a given moment to deal with the task at hand? How do cross-cultural and cross-linguistic differences arise? In this talk we will show that both Moroccans and Spaniards, who speak about the future as being in front and the past behind, show evidence of an alternative spatial construal that places past in front and future behind. Whereas Moroccans use this mapping by default, Spaniards use it only when primed to think about their past. Cultural values, i.e., the importance given to the past, mediate the extent to which individuals in both cultures spontaneously place the past in front. The data suggest that the origin of this past-in-front mapping can be traced down to attentional strategies: what is in the focus of attention is in front. By providing extended practice in the application of such attentional strategies to the domain of time, culture can turn an optional construal into a default.

Reasoning about time in space (Walker, Bergen, & Núñez)

The conceptualization of time often employs spatial models. However, time is an incredibly rich and complex concept that encompasses a variety of quite distinct domains of temporal experience (e.g., duration perception, past and future, sequences of events). This complexity is reflected in the diversity of the spatial models recruited. Here we ask, “What particular aspects of spatial experience (e.g.,

location, movement, perspective) get recruited when reasoning about different types of time?” We present data from a suite of behavioural experiments and argue that while people are flexible in their use of spatial resources, there are consistent regularities in the ways that space tends to get recruited when reasoning about different types of time. We end by discussing how our spatial experience in the world, along with language and use of particular cultural artifacts, may contribute to the emergence of such patterns.

Relationships between spatial and temporal magnitudes: A tale of three theories (Casasanto)

Space and time are intertwined in the human mind, but the nature of space-time relationships remains controversial. According to one theory, A Theory of Magnitude (ATOM), spatial and temporal magnitudes are represented by a domain-general system that computes magnitudes across multiple “prothetic” domains: domains in which we experience quantitative variation, including time, space, number, and loudness. Since its introduction a decade ago, more than 500 papers have reported experimental tests of ATOM, and nearly all have concluded that their results support the theory. In this talk, I'll review the findings from a comparatively small number of experiments (about two-dozen) my collaborators and I have conducted to compare ATOM against two theories that make contrasting predictions: metaphor theory, and a newer theory we call A Theory of Change (ATOC). I will argue that, despite what appears to be overwhelming support for ATOM, (a) some foundational arguments for ATOM have mistaken metathetic (i.e., qualitative) relationships for prothetic (i.e., quantitative) ones, and are therefore irrelevant, (b) much of the data interpreted as evidence for ATOM must now be reinterpreted as support for ATOC, and (c) the relationship between time and space is not the same as the relationship between time and other prothetic domains, contra ATOM. The representational link between space and time appears to be most consistent with the predictions of metaphor theory, and reflects the correlation between spatial and temporal magnitudes in the natural world.

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