Extending Spatial Frames of Reference to Temporal Concepts: An Embodied Perspective

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Abstract

EXTENDING SPATIAL FRAMES OF REFERENCE TO TEMPORAL CONCEPTS:

AN EMBODIED PERSPECTIVE

by

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Advisor: Professor Laraine McDonough

Three experiments investigate relations among spatial and temporal cognition, embodied experience and language. Experiment 1A uses vertical spatial primes and an ambiguous temporal question ("Next Wednesday's meeting has been moved forward two days") to test how time concepts could be constrained by the structure of spatial concepts. Vertical spatial orientation was found to influence temporal thinking in ways inconsistent with previous research using horizontal primes. Experiment 1B introduces a new ambiguous question that is more abstract and culturally neutral than the original, finding it to be similarly ambiguous in its capacity to produce "earlier" or "later" responses to suggestions of forward motion. The result is taken as further evidence that sequential temporal relations can be represented spatially without reference to an ego, suggesting that answers to the original ambiguous question about Wednesday's meeting can similarly be derived. The next section examines tripartite systems that are currently common to several theories concerned with spatial frames of reference distinctions. After reviewing three basic spatial frame of reference types, the results of recent empirical work investigating temporal metaphor is applied to a theoretical temporal frame of reference model. The concept of an extrinsic temporal frame of reference is introduced and supported by Experiments 2A-C. The last section argues that embodied views of cognition are important because they offer possible solutions to the long-standing symbol grounding problem. Experiment 3 investigates

how implicit embodied representations interact with linguistic concepts accessible to explicit awareness, and how these relations generate meaning. A novel method is introduced in which participants are asked to guess the location of picture tiles hidden in boxes placed in front or behind them (3A) or to their left or right (3B). Results demonstrate that in some instances guessing was assisted by the relative spatial locations of the boxes as concordant with the structure of particular temporal concepts. The pattern of results also suggests an interesting dynamic between implicit and explicit processes in the organization of abstract concepts and semantic representation. The discussion that follows explores how embodied and distributed implicit representations serve to ground more localized meanings (lexemes) in forms accessible to consciousness.

Dedicated to my family.

Acknowledgements

I would like to thank my advisor and collaborator, Professor Laraine McDonough, for teaching me how to carry out an experiment in psychology. It cannot be stressed enough how much each experiment reported in this dissertation was improved for having had so much of her attention over the years. Many of the ideas discussed in the pages that follow originated during our discussions. Above all, she has been a fair, generous and compassionate advisor to me throughout the course of my doctoral study.

She, along with the other members of my committee, provided comments on earlier drafts of the dissertation, many of which were incorporated somehow into this final product. I am indebted to them, along with the entire faculty and staff of the Department of Psychology, for everything I have learned at Brooklyn College.

Lastly, I would like to thank my parents for unconditionally supporting my decision to pursue a doctorate without asking too many questions, and my wife Danielle for understanding everything, always, for being so much fun to spend time with, and for her love.

Preface

> Consider the following scenario:
>
> You are outside a restaurant about to meet a good friend for lunch. The week before, this friend told you that he was looking forward to starting the new job he found (finally!) a while back. He said those dark days of his—that you'd both spent so much time going over and over and over together—were behind him now. In fact, your friend was in such good spirits, he even admitted that he was looking forward to an upcoming social obligation which was rapidly approaching; even though for the longest time, this had been creating nothing but anxiety for him. Unfortunately, just after leaving your friend last week you realized that you'd heard this all before. In fact, you have been having a similar conversation with him every other week or so since you've known him. And you are just now beginning to notice that the years are marching on by. You think to yourself, where has my youth gone? Time, you conclude, is a destroyer. You forgive your friend, deciding to live the rest of your life in the here and now.

Most people have no difficulty making sense of such a narrative. However, the typical reader would also probably fail to recognize the number of different ways that temporal relations are described using words that are not specific to the concept of time:

> You are outside a restaurant ***about*** to meet a good friend for lunch. The week ***before***, this friend told you that he was looking ***forward*** to starting the new job he found (***finally***!) a while ***back***. He said those dark days of his—that you'd both ***spent so much*** time ***going over and over and over together***—were ***behind*** him now. In fact, your friend was in such good spirits, he even admitted that he was looking ***forward*** to an ***upcoming*** social obligation which was ***rapidly approaching***; even though for the ***longest*** time, this had been creating nothing but anxiety for him. Unfortunately, just ***after*** leaving your friend ***last*** week you realized that you'd heard this all ***before***. In fact, you have been having a similar conversation with him ***every other*** week or so since you've known him. And you are just now beginning to notice that the years are ***marching on by***. You think to yourself, ***where*** has my youth ***gone***? Time, you conclude, is a ***destroyer***. You forgive your friend, deciding to live the rest of your life ***in*** the ***here*** and now.

A number of different words, enlisted from various domains of experience and elaborated by distinct metaphors are used to depict a dynamic complex of temporal relations oriented according to several different perspectives. Yet such a narrative is understood effortlessly. How is this achievement realized so easily and without our awareness of having done so? One of the indirect goals of this dissertation is

to gain a better understanding of how we regularly perform such spatiotemporal feats with no apparent difficulty.

Most generally, the three experiments reported below are all aimed at investigating the relations among spatial cognition, temporal experience and language. As the experiments progress, they begin to focus more specifically on the interaction between implicit spatial representations, motor behavior and explicit, abstract linguistic concepts (like time) as a means to better understand how symbols (i.e. lexical items that structure the time concept in English) are grounded in perception and action. However, it should be noted by the reader that the development of the experiments that follow is not best understood as linear in the sense that each experiment progressively refines questions posed by a prior result (although in some places this is the case). Rather, each experiment represents a kind of starting point, and the results of the experiments may create many more questions than they necessarily answer. At least I hope this is the case.

The dissertation begins with an abbreviated overview of the intellectual history of temporal concepts and other relevant areas of research in order to provide some background. It then shifts to a discussion of recent empirical research. The novel experimental work then follows.

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1. History

Time, as long as it has been lexicalized and objectified, has defied simple definition. Still, after one hundred years of relativity theory, most would still be inclined to think about time *per se* as a distinct entity, as Newton (2005) did—something that "from its own nature, flows equably without relation to anything external" (p. 6). This is not to say that the average person is regularly committed to pondering the nature of absolute time in the sense that Newton did, but merely that most would at least treat time as something 'real' or in a weaker sense, as a concrete, monolithic concept that can be directly referred to and communicated about (linguistically) in its own terms. However, an examination of recorded Western history reveals that the time concept is a fairly recent invention.

In fact, the ancient Israelites did not lexicalize time and they appear to have not possessed an abstract time concept comparable to our own. Stern (2003) suggests that, according to their world-view, "reality was conceived only as a series of discrete events and processes" (p. 124). That is, there is no explicit reference to an abstract conception of 'pure time' or a 'time dimension' in ancient Hebrew. Temporal aspects of events were described in terms of direct references to concrete processes or actions. It was not until the ancient Greeks that a more Western notion of time was clearly articulated. The Greeks named time. Later in history, Plato's use of the word *chronos* was generally understood to signify something like an eternal, flowing, independently existing continuum. Plato (1977) himself called time, an "eternal moving image" (p. 51). Relatively soon after its linguistic invention, the concept of what came to be known as absolute time was significantly refined. Aristotle (1999) called time "the number of motion according to prior and posterior" (p. 219). That is, temporality for Aristotle is conceived of in terms of event-relative, ordered relations that unfold in the direction of a *telos* (an endpoint defined in part by causal unidirectionality). Whereas a sense of temporal duration is

emphasized by Plato's conceptualization, a notion of temporal sequence emerges from Aristotle's definition.

However, neither Plato nor Aristotle say very much about how the structure of human consciousness itself might play an important role in the construction of temporal concepts. The relation between the structure of thought and the experience of time becomes clearer during the late classical period. In his *Confessions* (1969) Saint Augustine developed a tripartite model of perception consisting of *continuitus* (on-line perception), *memoria* (memory) and *expactacio* (expectation). His model postulates that our understanding of the time concept is based on the nature of human consciousness itself. "*Continuitus* represents actual perception and hence direct experience of the current moment…as each new moment is updated, it passes into memory, which gives rise to expectations of the future being formed" (Evans, 2004, pp. 24-25). Augustine's model, in contrast to those provided by Plato and Aristotle, emphasizes the psychological dimension of temporal experience describing why this *feeling* of the present, relative to remembrance of past and anticipation of the future, provides the basis for the abstract concept of time.[1]

Husserl similarly maps the concept of time onto the experience of consciousness itself. His conception of time, much like Augustine's, describes time in terms of human consciousness. This includes the perceptual integration of the experienced past, present and future. Evans (2004) aptly describes Husserl's diagram (see Fig. 1.1):

> The present moment (A) constitutes the perceptual starting point. The moment (A) which was once the future, gives rise to a retained present (A') which is held in memory when (A) is

[1] Following a scheme first suggested by McTaggert, (1908) the experience of time in terms of Past/Present/Future is generally referred to as *A-series* time. A-series time is necessarily relative and events described in terms of A-series time occupy temporary places in the "series". We can contrast this to *B-series* time that refers to Earlier/Later designations. B-series relations are merely sequential and permanent.

Also, it should be emphasized before going much further, that time is not a unitary concept. For example, the experience of *duration* and *sequence* may describe psychologically distinct cognitive processes. However, both rely on spatial-derived metaphor for linguistic expression (and perhaps conceptualization); specifically the TIME IS MOTION metaphor which will be discussed later in the paper. Regardless, the lexeme TIME is used to refer to both kinds of phenomena.

> superseded by moment (B). When (B) is superseded by moment (C) then the retention (A') is superseded by the retained present (B') resulting in the retention (A') giving rise to a new retention (A"). When moment (D) supersedes (C), (B') is superseded by (C') and gives rise to (B") being held in memory as a retention of (B'). Accordingly, (B") supersedes (A") causing (A'") to be held in memory as a retention of (A"). In this way the past is constantly being modified as the future becomes the present and the present becomes the past. (p. 25)

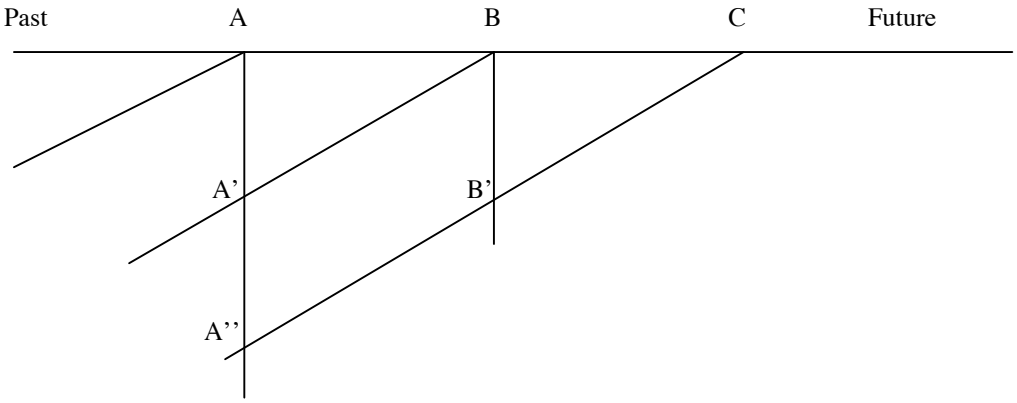

Figure 1.1. Husserl's diagram of the experience of time as a succession of moments (From Merleau-Ponty 1962, p. 417)

But it's much too simple to reduce temporal cognition to a series of connected perceptional processes and their corresponding representations in memory. After all, J.J Gibson (1975) wrote that "events are perceivable but time is not" (p. 295). This is intended to suggest that the experience of objects in space is concrete and direct in a way that the experience of time is not. So, some argue, temporal cognition is inherently conceptual whereas spatial cognition has a more concrete perceptual basis.[2] Before treading into such complex epistemological/metaphysical areas, here we must first attempt to differentiate between perception and conception, itself hardly an easy task. Quite generally though, we can say that concepts are constructed out of more basic, lower level perceptual representations and that concepts represent the relations among recurrent forms of percepts. Nonverbal concepts understood as such can be theorized in terms of *image schemas*.

[2] However, while it is obvious that one can experience the passage of time without the perception of discrete events, i.e. without motion taking place; the reverse, perceiving motion without experiencing the passage of time, is difficult to fathom.

The above discussion was based mainly on the notion that, historically, time has not always existed as a lexical item. When time was lexicalized explicitly, its definitions were gradually refined. However, it remains important to understand that just because a word is absent from one's vocabulary, it is not necessarily the case that the concept is absent too (McDonough, 2002; McDonough, Choi, & Mandler, 2003). So, although at some point in history we began to talk about time, the concept originates from previously held nonverbal ideas. Looking at the historical record left by Western philosophers, it's clear that time evolved in meaning as it was talked about. More recently, researchers have begun to consider these issues at the level of ontogeny, investigating how concepts are represented such that they can be thought about or accessed and potentially lexicalized to serve communicative functions. From these basic representations, more complex mappings of abstract concepts can be elaborated.

Mandler's (1988, 1992, 1996) theoretical work explores the question of how perceptual experience may influence the development of early nonlinguistic concepts understood as image schemas. According to her model, primitive abstract concepts develop through the process of categorizing perceptual patterns found in the world. Mandler calls this process *perceptual analysis*. The salient aspects of perceived patterns are initially categorized through an interaction with the world. Early concepts first develop via the "redescription" of "spatial structure and the structure of motion that is abstracted primarily from vision, touch, and one's own movement" (Mandler, 1992, from Evans, 2003, p. 51). Johnson's (1986) concept of an "image schema" upon which much of the cognitive theory of metaphor is grounded (and which will be discussed in more detail below) is consistent with Mandler's analysis. Shinohara (1999) provides a good working definition of Johnson's concept of image schema as: "a recurrent, dynamic pattern, shape, and regularity of our perceptual interactions and motor programs that gives coherence and structure to our experience, consisting of a small number of parts and

relations by virtue of which it can structure indefinitely many perceptions, images and schemas" (p. 231).

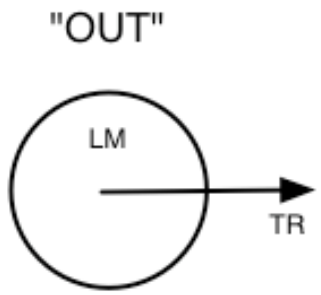

Figure 1.2. Image-Schema for Out. LM refers to the *landmark* and TR to the *trajector*. The LM defines the "ground" object; in this case the boundaries for the containment space. The TR defines the path of motion that a distinct "figure" object could take to exit out of the boundaries of the containment space.

Image schemas represent the organizational structure for very basic concepts. These basic concepts give rise to abstract meaning across conceptual domains. Consider the following description:

> You wake *out* of a deep sleep and peer *out* from beneath the covers *into* your room. You gradually emerge *out* of your stupor, pull yourself *out* from under the covers, climb *into* your robe, stretch *out* your limbs, and walk *in* a daze *out* of the bedroom and *into* the bathroom. You look *in* the mirror and see your face staring *out* at you. You reach *into* the medicine cabinet, take *out* the toothpaste, squeeze *out* some toothpaste, put the toothbrush *into* your mouth, brush your teeth *in* a hurry…(Johnson, 1987, pp. 30-31)

The meaning of the above paragraph is straightforward because relations of containment and boundedness are so pervasive in our everyday experiences. Our bodies are three-dimensional containers and the dynamics of these inside/outside relations are particularly salient to us: certain things go in, like food, air, and water; while other things such as waste and blood, come out. In turn, our surroundings contain us. We regularly move in and out of rooms, clothes, and other kinds of spaces. And we manipulate other objects in relation to containers; putting things in bags, boxes, bottles, etc., and taking them out. In general, then, experienced, repeatable kinds of spatial organizations provide a schema for 'containment'. Importantly, containment relations can describe concrete experiences like moving from

room to room or more abstract experiences like entering a conversation.

In order to avoid any confusion, it should be stressed that image schemas are not themselves veridical images of the world, but rather constructions based on our understanding of the world. It's argued that such constructions could potentially give rise to abstract concepts and meaningful thought (Johnson, 1987; Lakoff & Johnson, 1999). So, image schemas understood as abstract representations of prototypical spatial relations are not a form of percept as such, but rather serve to organize common forms of spatial experience. Several current cognitive models suggest that basic temporal concepts are themselves abstracted from such spatial representations. These models will be discussed next.

2. H. Clark: The semantics of space and time

Clark's coordinate system approach

Although the nature of spatial and temporal relations have been discussed for some time, the notion that abstract temporal concepts as reflected in language arise from more concrete spatial representations is a relatively novel one. Piaget (1954) explored the relation between spatial and temporal reasoning in child development, but it was Herb Clark (1973) who was the first to address the issue of temporal concepts in the context of semantic grounding and language development. Clark wrote that "the child acquires [linguistic] expressions for space and time by learning how to apply these expressions to the a priori knowledge he has about space and time" (p. 28). At the time that Clark was writing, it was not at all clear how temporal concepts could be predicated on representations of spatial relations.

Clark suggests that in order to understand the interactive nature of brain, body and the natural environment one must start by delineating the natural geometric relations that systematically define the quality of our interactions with the world. The basic structure of his argument is uncontroversial. In terms of biological constraints (at the level of gross physiological morphology) he emphasizes that humans walk upright and have eyes that point straight forward. People are physically asymmetrical when viewed from top to bottom (head to foot) and from front to back (the front being privileged perceptually) and symmetrical when viewed laterally (eyes and ears on either side). (See Figure 2.1.) Add to these corporeal parameters environmental spatial constraints that also serve to structure normative human interactions with the world. For example, the motion of objects is constrained by the laws of physics. The environment we inhabit possesses a general appearance and structure that normalizes and constrains particular kinds of routine actions. So, for example, the world is generally

experienced as having a flat ground that can be walked upon; and overhead and beyond the space occupied by an individual is a sky and horizon that defines natural boundaries.

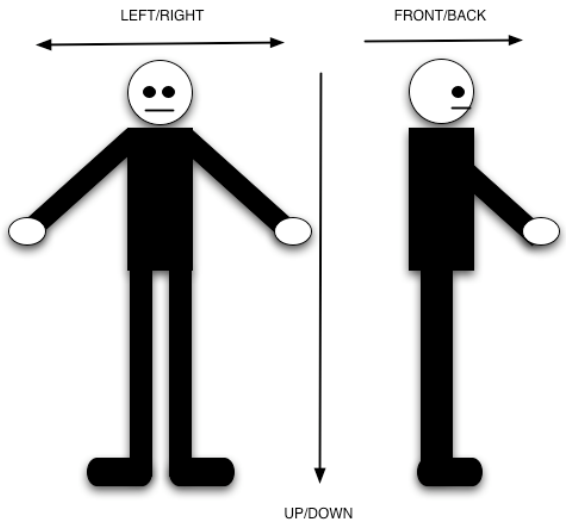

Figure 2.1. Symmetrical (left/right) and asymmetrical (up/down; front/back) body axes

The relation between the body and the environment is therefore defined by a series of planes with prescribed motion patterns. Clark's model is very much part of an "embodied" project although it emerged before more formal embodied theories of mental representation came to occupy a prominent place in the cognitive sciences. More recent embodied theories (Barsalou, 2003; Gibbs, 2006; Johnson 1987; Lakoff & Johnson 1999) stress the idea that categories and concepts are neither arbitrary nor the result of entirely "logical" or rule-based representational systems. Taking a general view that mirrors the one expressed in Clark's early paper, recent embodied theories argue that cognitive structures are dependent on the structure of perceptual systems, at the levels of physiology and neural organization, as well as on typical patterns of our bodily experience during canonical interactions with the environment.

For Clark, it makes common sense that our perceptual apparatus would take advantage of the natural relations between the body and space in constructing the basis for a conceptual system to structure cognition:

> These facts of perception also suggest how we could assign positive and negative values to the directions away from the two planes of asymmetry. First, since everything in front of the vertical plane is easily perceptible and everything behind is not, the forward direction can be considered the positive perceptual direction, and the backward the negative one, where positive is taken in its natural sense to mean the presence of something and negative, the absence. Similarly, since everything above ground level is perceptible and nothing below it is, upward is naturally positive and downward is naturally negative. On the other hand, the reference plane separating left from right is symmetrical, and therefore, there appears to be no reason, at least perceptually, to choose either leftward or rightward as being the positive direction (Clark, 1973, p. 33).

If the world is conceived in terms of such a Cartesian coordinate system, the individual person is the "zero reference point." It follows that, as forward-moving, upright bipeds, we would assign that which is perceptually "front" a positive value and that which is "back" a negative one. "Up" could be positive and "down" negative, not only based upon our perceptual relation with sky and ground, but due to our experience with the natural force of gravity in respect to its importance for maintaining balance and its effects on external motion events. Since Clark, something like a 'coordinate system' approach has emerged in the cognitive sciences in an effort to make sense of the relations between spatial cognition, language and other higher-level cognitive processes (Levelt, 1996; Levinson, 1996; 2003; Radden, 2003; Tversky, 1996).

According to Clark, ecological invariants are learned by the developing organism so that meaningful points of reference can be established.[3] Clark suggests that from these primitive invariants,

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[3] See also Gibson (1964):

> Perceptual development and perceptual learning are seen as a process of distinguishing the features of a rich input, not of enriching the data of a bare and meaningless input. A perceptual system hunts for a state of what we call *clarity*. Whatever this state is physiologically, it has probably governed the evolution of perception in the species, the maturation of perception in the young, and the learning of perception in the adult…Above all, the puzzle of meaning and value in perception takes entirely new form. If what things afford is specified in the light, sound, and odor around them, and does not consist of the subjective memories of what they have afforded in the past, then the

more complex percepts can be constructed and acted upon (an idea consistent with image schema theories). It would make sense then, if the initial spatial relations that Clark delineates were the first to emerge in infancy. Research supports such a point of view, as the ability to categorize left/right (Behl-Chadha & Eimas, 1995) and above/below (Antell & Caron, 1985; Quinn, 1994) appear only a few months after birth in human infants. By three months, infants are already showing signs that they can detect aspects of more complex spatial relations including those requiring knowledge of trajectory (Spelke, Breinlinger, Macomber & Johnson, 1992) and gravity (Needham & Baillargeon, 1993).

Mapping relations between constrained spatial representations and temporal concepts

Clark (1973) further suggests that children learn to match linguistic terms (locatives, prepositions etc.) with such nonlinguistic concepts of space. Eventually, temporal concepts can be communicated through language using the language of space. Clark may have been the first to rigorously examine how the "description of time in English is based on quite a specific spatial metaphor" (p. 48). He notes that much like the physicist considers time in terms of a "one-dimensional continuum with asymmetrical properties" (p. 49) the English language uses asymmetrical one-dimensional relational prepositions.

> [T]he *front-back* prepositions are the only ones in English that do not presuppose more than one dimension in the space they describe [as opposed to say *deep-shallow* prepositions which imply three dimensions]; furthermore, they have the happy property that they are asymmetrical, with front positive and back negative. Significantly, the only relational prepositions used for time in English are those derived from *front* and *back*, i.e., *before, after, ahead, behind, in front, in back*, etc. English does not use relational terms derived from *top-bottom*, except in specialized terms like *over the weekend*… (p. 49).

Clark also noted that because time is used to describe events with dynamic properties, it follows that expressions concerning time should incorporate aspects of motion through space. This is apparent in English with expressions like, "*We're approaching the deadline," " My court date has passed*," etc.

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learning of a new meaning is an education of attention rather than an accrual of association (p. 320).

Time metaphors in English have another interesting characteristic. Clark describes time as "a highway consisting of a succession of discrete events" (p. 50). He identifies two classes of time metaphors. The distinction between the two depends on the particular point of view of the observer in respect to this (horizontally aligned) highway:

> …Either (1) we are moving along it, with future time ahead of us and the past behind us; or (2) the highway is moving past us from front to back. These two metaphors might be called the *moving ego* and *moving time* metaphors respectively (p. 50).

So, when adopting a moving time (MT) metaphor, one's *75th birthday* may be *coming* while a *15th birthday* has long since *passed*. With moving ego (ME) metaphors *I* might be *approaching* my college graduation, whereas *I* have long since *moved past* my days in nursery school. In Gestalt terms, these two mappings are figure-ground reversals of one another. [4]

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[4]Although Clark may have been the first to explicitly delineate ME and MT metaphors from a psycholinguistic perspective, interest in temporal metaphors has been with us for some time.

Maurice Merleau-Ponty:

"If time is similar to a river, it flows from the past towards the present and the future. The present is the consequent of the past, and the future of the present. But this often repeated metaphor is in reality extremely confused…Now, no sooner have I introduced an observer, whether he follows the river or whether he stands on the bank and observes its flow [then the] temporal relations are reversed" (Merleau-Ponty, 1962 p. 411).

Ludwig Wittgenstein:

"Where does the present go when it becomes the past, and where is the past?…It is clear that this question most easily arises if we are preoccupied with cases in which there are things flowing by us—as logs of wood float down a river. In such a case we can say the logs which *have passed* us are all down towards the left and the logs which *will pass* us are all down towards the right. We then use this situation as a simile for all happening in time and even embody the simile in our language, as when we say that 'the present event passes by' (a log passes by), 'the future event is to come' (a log is to come). We talk about the flow of events; but also about the flow of time—the river on which the logs travel…We say, "*Something* will happen", and also, "Something comes towards me"; we refer to the log as "something", but also the log's coming towards me…Thus it can come about that we aren't able to rid ourselves of the implications of our symbolism, which seems to admit of a question like "Where does the flame of the candle go to when it's blown out?" "Where does the light go to?", "Where does the past go to"? We have become obsessed with our symbolism.—We may say that we are led into puzzlement by an analogy which irresistibly drags us on" (Wittgenstein, 1965 pp. 107-108).

Jorge Luis Borges:

"Time is the substance I am made of. Time is a river that carries me away, but I am the river" (Borges, 1964 p. 167).

3. Current theoretical approaches and models of temporal conceptualization

Conceptual Metaphor Theory

Lakoff and Johnson (1983; 1999) have suggested that our entire system of conceptualization is built upon a limited number of *source domains* that emerge directly from experience. They argue that abstract domains of thought, whether one examines modes diverse as moral reasoning or temporal cognition, are generally understood and elaborated upon in terms of a more concrete source domain, like physical well-being or spatial cognition, respectively. Recent work in *conceptual metaphor theory* has begun to investigate the structure of mappings between concrete experiential domains, like space, and abstract concepts, like time.

According to conceptual metaphor theory, more abstract domains that lack direct perceptual support, like time, are *target domains* and understood metaphorically in terms of experientially concrete source domains, like space (see also Gentner, 1983; 2001). Metaphorical mappings are assumed to "preserve the cognitive topology (the image-schema structure) of the source domain, in a way consistent with the inherent structure of the target domain" (Lakoff, 1993, p. 215). In the case of time, the source domain consists of cognitive representations of basic spatial relations that emerge through the subject's experience navigating through, observing motion in, and orienting oneself within, space (Lakoff & Johnson, 1980; 1999).

Following work by Grady (1997) Lakoff and Johnson argue that TIME IS MOTION is a *primary metaphor*. Time is most often described in terms of motion through space and the following examples of sentences in English that make use of this primary metaphor require no cognitive effort to make sense of:

1. The hour *creeped* by.
2. One cannot stop the *flow* of time.
3. The time for action has *arrived*.

According to conceptual metaphor theory, primary metaphors are based on "experientially grounded mappings":

> All complex metaphors are "molecular," made up of "atomic" metaphorical parts called *primary metaphors*. Each primary metaphor has a minimal structure and arises naturally, automatically, and unconsciously through everyday experience by means of conflation, during which cross-domain associations are formed. Complex metaphors are formed by conceptual blending. Universal early experiences lead to universal conflations, which then develop into universal (or widespread) conventional conceptual metaphors (Grady, 1997, from Bernandez 2000, p. 286).

The use of the primary metaphor TIME IS MOTION has been identified in many other languages and it may be a linguistic universal. This is thought to be the case because such mappings are not mere social conventions but, rather, are "shaped by non-arbitrary species-specific peculiarities of our brains and bodies" (Núñez, 1999, p. 52). Lakoff (1993) wrote, "In our visual systems, we have detectors for motion and detectors for objects/locations. We do not have detectors for time (whatever that could mean). Thus it makes good biological sense that time should be understood in terms of things in motion" (p. 218). It also makes common sense, as experienced motion tends to be correlated with the experience of elapsed time. In the TIME IS MOTION metaphor, most generally, it "is presupposed that the *Path Schema* (an image schema which consists of a source, a goal, and a sequence of contiguous locations connecting the source and the goal) is the one preserved…" (Shinohara 1999, p. 231).

Lakoff and Johnson (1983; 1999) argue that across languages, TIME is talked about, and conceptualized in terms of, MOTION through SPACE. Borrowing from Clark's earlier theoretical work, they contend that this primary TIME IS MOTION metaphor is elaborated in English with the

Moving Time Metaphor (MT) and the Moving Ego Metaphor (ME). However, they further delineate this mapping in English, showing clearly how both are part of a larger "time orientation" metaphor where the location of the observer represents the "present" time, the future is *ahead*, and the past is *behind*. The difference of course being that in the MT metaphor, *time* is the point of reference whereas in the ME metaphor the *observer* is. Lakoff and Johnson agree that these two metaphors represent figure-ground reversals of one another.

According to such theories, cognitive metaphors are both corporal and spatial. Thus, figures (like those below) that pictorially represent such relations are often useful for understanding the organizations of ME and MT metaphors.

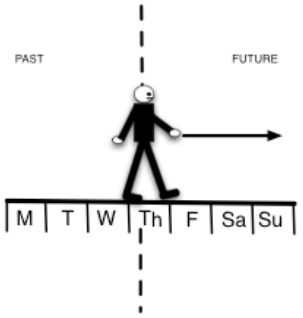

Figure 3.1a. The Moving-Ego model.

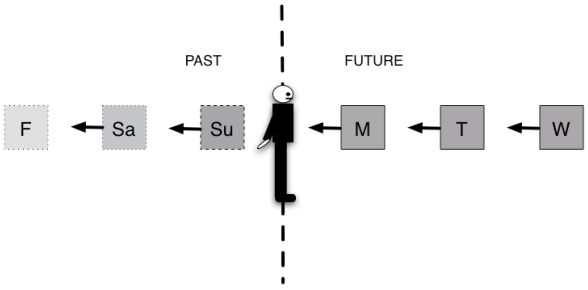

Figure 3.1b The Moving-Time model

The egocentric ME and MT metaphors both result from basic kinds of embodied experience. For example, when walking, distance traveled is correlated with duration and one is typically looking forward, either in the direction of our own motion or at objects or other people moving towards us. In general, one could say that there is a general experiential correlation between future encounters (including planning for those encounters) and what is *ahead* of us. Conversely, things that we have moved by, or have moved by us, although perhaps directly experienced and perceived when they were *present*, are now accessible only through memory now they have *passed* (into the past). This is what is meant when one argues that temporal orientation metaphors are not arbitrary. Rather, motion situations follow typical patterns that provide an experiential basis for their organization.[5]

Physical events (involving inanimate objects) also follow typical patterns amenable to experience and basic cognitive representations. Simple physical events unfold in a unidirectional way in time and are irreversible in the metaphysical sense (think about dropping a glass on the floor as it proceeds to shatter). In this sense, the perception of motion events in space is another category of primary experience and, for Lakoff and Johnson, such experiences are more basic than, and provide the structure for, the experience of time.[6] According to this line of reasoning, one cannot discuss time independently of human minds. Yet, this is not to say that time would "cease to exist" without a human

[5] Grady (1997) writes: "This spatial metaphor for time [ME and MT] seems to be an automatic part of our cognitive unconscious that structures not only the way we conceptualize the relation between events and time but the very way we **experience** time" (p. 153). Evans (2003) argues that the MT and ME are more complex *compound metaphors*, as compared to primary metaphors, and are thus culturally relative. This is why in some cultures the past is conceived as *in front* and the future *behind.* Even if this is the case, these metaphors still have an experiential basis, that is the past (memory) is accessible or mentally "visible" in a way that the future is not. As will be discussed later, Boroditsky's (2002) research suggests that thinking about time in terms of these metaphors, even if they are not strictly primary metaphors, is still "embodied", i.e. temporal cognition concordant with MT and ME metaphors is influenced by action, motion and perception in space.

[6] However, while it is obvious that one can experience the passage of time without the perception of discrete visual events, e.g. with one's eyes closed and without motion imagery; the reverse, motion without the passage of time, is difficult to fathom. From such a perspective, it would seem that temporal experience is "primary" relative to spatial experience. The notion that TIME IS MOTION is a primary metaphor is not universally accepted. For example Evans (2003) argues that the experience of duration is phenomenologically more basic than spatial event or motion perception and "licensed by antecedent lexical concepts."

to experience a particular interval. Lakoff and Johnson (1999) reject the very idea of broaching the subject of the "reality" or "unreality" of time because:

> It's a loaded question. The word *time* names a human concept of the sort we have described—partly characterized via the correlation of events and partly characterized via metaphor. Both the correlation of events and metaphor together structure our experience, giving us temporal experience. That experience, like our other experiences, is real. Thus time is something "created" via our bodies and brains, yet it structures our real experience and allows us an important understanding of our world, its physics, and its history. (p. 167)

According to Nelson (1996), the idea that spatial relations are more directly accessible to experience but that time concepts must be constructed or abstracted from experience is illustrated by her suggestion that concepts of space can be pointed to or communicated about through gesture (e.g. size, shape and location, are each concrete spatial descriptors), but time concepts cannot. Nelson also observes that time concepts emerge much later in childhood than spatial concepts and that time is communicated about in terms of spatial terms.

Cross Cultural and Developmental Psycholinguistics

How might one determine the extent to which an abstract concept displays consistency across cultures? One way to investigate questions concerning the universality of primary metaphors or conceptual schemas is through cross cultural and developmental linguistic research. In recent years a considerable amount of work has been aimed at investigating the extent to which different languages code spatial concepts similarly and when spatial cognitive structure emerges in development. According to Bowerman and Choi (2001) the picture that emerges is complex. Their work suggests that cross-linguistic differences don't simply reflect differences in cognitive structure but that language itself plays a large role in guiding differences in the development of conceptual structure across cultures. For example, their research on differences in spatial cognition in Korean and English speakers suggests that

"children construct spatial semantic categories over time on the basis of the way they hear words used in the input, and in doing so, draw on perceptual sensitivities and conceptual biases they bring with them to the task (p. 497)." This suggests a more dynamic view where language does not passively fill ready-made and universally shaped containers (as Clark claimed) but rather plays an active part in determining the "shape" of spatial concepts. McDonough, Choi and Mandler (2003) used a nonlinguistic categorization task and found that American and Korean infants were equally sensitive to the specific spatial relations involving containment and support that are coded for in Korean (but not in English). American adults had difficulty categorizing these kinds of relations, suggesting that the English language's indifference to Korean-style spatial parsing biased these subjects in the required sorting task. To date, there is no developmental research examining the structural relations between spatial and temporal conceptualization in infants and children across languages. However, the picture emerging from work in related areas suggests that this could be an interesting direction of investigation for future research. In the meantime, priming studies with adults can shed light on the organizational attributes of the sub-linguistic schemas that underpin particular abstract concepts, like time.

Contemporary Coordinate System Approaches

Coordinate system accounts, like Clark's early model discussed above, provide a natural starting point for the construction of a primitive semantics. Since Clark, such coordinate system or similar *frame of reference* approaches have flourished (Levelt, 1996; Levinson, 1996; 2003; Tversky, 1996). The notion of frame of reference in the context of spatial cognition refers to the "distinctions between underlying coordinate systems" (Levinson, 2003, p. 24) people use when thinking and talking about space. In general, frame of reference models can be understood as attempts to disambiguate and refine issues raised by the many disciplines in cognitive science where perspective and figure/ground relations are important. Generally, these models divide frame types by the main reference point used to establish

unambiguous relations: (a) of inherent object features or *intrinsic* relations; (b) according to viewer or ego-centered *deictic* frames; or (c) in respect to environmental or *extrinsic* reference axes. (See Figure 7.1a-c for concrete examples.)

Levinson's (2003) work has demonstrated that although we can generally shift flexibly from one frame type to another depending on context,[7] speakers of certain languages tend to cling to one frame of reference type over others when reasoning about spatial-relations that are ambiguous in respect to frame of reference. For example, data collected from field studies and experimental work shows that while English and Dutch speakers prefer to use egocentric (what Levinson calls "relative") or subject-oriented left/right relations to disambiguate spatial relations, speakers of Tzeltal, a Mayan language spoken in Chiapas, Mexico, tend to use extrinsic (what Levinson calls "absolute") or environment-oriented north/south/east/west relations in the same kinds of circumstances.

Although spatial frame of reference models have not been applied to models of temporal concepts, according to Levinson, there is no reason why they could not be. At this point it's not clear what the implications would be if space and time could both be modeled on the same three-part frame of reference scheme. However, the experiments described in Chapter 7, the results of which suggest that tripartite spatial reference models can in fact be extended to time, will address these issues more directly.

Cognitive Linguistics

Recently, Evans, Bergen and Zinken (2006) have argued for Cognitive Linguistics to be recognized as a distinct but comprehensive school of linguistics "concerned with investigating the relationship

[7] This phenomenon, where people show a natural facility for mixing spatial perspectives in language and thought, is more clearly supported by the empirical work of Tversky and her colleagues (e.g. Tversky, Lee & Mainwaring, 1999; Tversky 2005).

between human language, the mind and socio-physical experience" (pg. 1). In *The Structure of Time* (2003) Evans examines the existent relations between lexical and conceptual structure in the domain of time. That is, Evans looks at the way that the lexeme *time* and related temporal concepts (e.g. *past* and *future*) are used in English in the context of their (1) etymology, (2) predominance in semantic networks, (3) grammatical predictability, (4) cognitive antecedents, and (5) phenomenological distinctiveness. Evans takes a different approach than Lakoff and Johnson and comes to different conclusions. For example, he emphasizes that particular cognitive processes and forms of experience, like those associated with duration, sequence, memory and planning, exist prior to the metaphoric structuring of time in terms of motion. From these diverse but related cognitive processes, different senses[8] of the "time concept" in English can be distinguished and analyzed.

Embodiment

Each of these current approaches shares a common interest in taking an *embodied* view of cognitive science. According to Gibbs (2006) embodied approaches to cognitive science explore:

> …how people's subjective, felt experiences of their bodies in action provide part of the fundamental grounding for human cognition and language. Cognition is what occurs when the body engages the physical and cultural world, and it must be studied in terms if the dynamical interactions between people and the environment. Human language and thought emerge from recurring patterns of embodied activity that constrain ongoing intelligent behavior. We must not assume cognition to be purely internal, symbolic, computational, and disembodied, but seek out the gross and detailed ways in which language and thought are inextricably shaped by embodied action (Gibbs, p. i, 2006).

Understanding the brain is insufficient. Therefore, in some regard, embodied theories of cognition can be contrasted with more traditional, logical or propositional theories of mental representation. Although the seeds for such an embodied view have been with us for some time, empirical methods for investigating related issues represent a relatively recent development.

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[8] Evans (2003) calls these the *duration*, *matrix, moment* and *event* senses of the lexeme *time*.

4. Review of Empirical Research

McGlone and Harding

What has come to be called the *Ambiguous Question*—"Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?"—is a tool used for investigating the spatial structure of temporal concepts (Boroditsky, 2000; Boroditsky & Ramscar, 2003; Gentner, Imai & Boroditsky, 2002; McGlone & Harding, 1998; Motz & Núñez, 2004; Núñez, Motz & Teuscher, 2006). McGlone and Harding (1998) were initially interested in demonstrating that speed of processing and comprehension of temporal expressions utilizing a particular perspective (i.e. either a Moving-Ego or Moving-Time model) could be influenced by the prior reading of other temporal sentences that contained perspective information either concordant or discordant with the linguistic structure of the prior sentence. So, for example, after reading a sentence like "Christmas is approaching us" (which suggests a perspective where an event in time is moving towards a stationary observer) they showed that subjects take longer times to comprehend sentences like "We are moving closer to the deadline" (which suggests a perspective where the ego itself in moving to later times). McGlone and Harding's initial experiments show that there is a cognitive "cost" for switching perspectives when processing temporal expressions. On the other hand, reading sentences structured with consistent temporal metaphors facilitated comprehension as evidenced by subjects' decreased processing times.

McGlone and Harding then reasoned that a stronger argument could be made with a slightly different kind of task: "a more compelling demonstration of temporal perspective taking would involve showing that manipulation of the perspectival context in which a temporal sentence is encountered may influence not only the ease with which the sentence is interpreted but also the *product* of the interpretation process" (p. 1217, emphasis mine). Thus, they constructed the ambiguous question about

Wednesday's meeting:

> In some cases, the temporal relation conveyed by a spatiotemporal term is not only ambiguous but also defies classification as an ME or MT construction. For example, consider how one might interpret *The meeting originally scheduled for next Wednesday has been moved forward two days*. This statement is difficult to classify as ME or MT in nature for two reasons. First, ME and MT constructions are typically used to describe a fixed event sequence. In contrast, this sentence describes a situation in which an event has been intentionally moved (i.e., rescheduled) from one time to another. Second, the sentence is equivocal with respect to the implied direction of forward temporal movement. If one assumes that the direction of temporal movement is toward the future, then the sentence may be interpreted as an assertion that the meeting has been postponed. If, on the other hand, one assumes that the direction of temporal movement is toward the past, then the sentence may be taken to indicate that the meeting will occur earlier than originally scheduled (p. 1217).[9]

According to McGlone and Harding, forward movement can be interpreted either as movement towards earlier (Monday) or later (Friday) times depending on the spatial metaphor or perspective one adopts when answering. When using a ME metaphor, in which a representation of the subject is itself moving and events are stationary, words like *before* and *after* metaphorically can refer to the subject's *front* and *back*, and not to the events' intrinsic properties (e.g. 'The revolution is before us'). However, with MT metaphors, where "moving" events are approaching a stationary representation of the observer, according to Clark (and McGlone and Harding) future events are *coming* and past events have *passed*. In MT metaphors, the spatial prepositions *before* and *after* (which are now used almost exclusively to talk about time) are used such that *before* (derived from *front)* refers to past events and *after* (derived from *back*) refers to the future (e.g. 'The revolution was over before breakfast'). Thus, in English, the meaning of prepositions based on front/back relations is reversed depending on the temporal metaphor one is utilizing. McGlone and Harding found that after reading sentences consistent with a particular perspective (ME or MT) answers to the ambiguous question were more often consistent with the perspective expressed in the prior sentences.

In spatial terms, the answer to the question about Wednesday's meeting is ambiguous because it

[9] Note that McGlone and Harding conflate the concepts of *past* and *future* with *earlier* and *later.* This issue, and the various confusions created by this frequent error, will be addressed in more detail later.

depends on how the word *forward* is interpreted in the context of one's mental representation of the timeline. Since McGlone and Harding, it has been demonstrated that typically, when English speaking adults are asked the ambiguous question, "Monday" and "Friday" answers are observed in approximately equal proportions (Boroditsky, 2000; Núñez, Motz & Teuscher, 2006). Several studies by Boroditsky and her colleagues have tested the "psychological reality" of MT and ME metaphors in English. Their research addresses the concerns of "dubious experimental psychologists" who might argue that linguistic evidence pointing at two relatively distinct ways of talking about time might be interpreted as differences merely existing at the level of language:

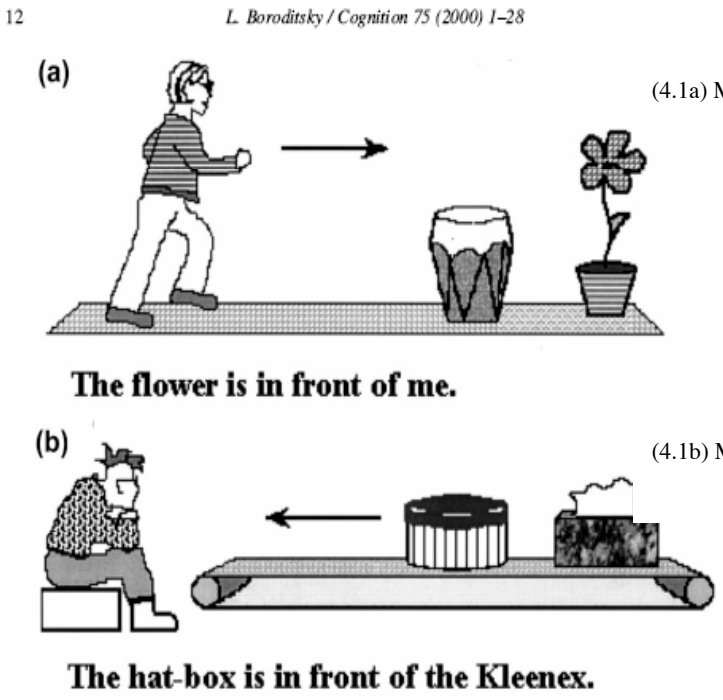
> A priori, there is no reason to believe that the linguistic distinction between the ego-moving and time-moving metaphors has any psychological implications regarding how these metaphors are processed. In the absence of further evidence, a more parsimonious view is that the distinction between these two different ways of talking about time is only language deep. A skeptic might argue that linguistic evidence such as that provided by Lakoff and colleagues is at best an imaginative cataloguing of etymological relics with no psychological consequences (2000, p. 6)…To argue against the claim that such relations are merely "language deep" is to suggest "that space and time have deeper conceptual similarities beyond just similarities in language." (2000, p.23)

At this point, a discussion of Boroditsky's research and what it reveals about the deeper conceptual similarities between space and time is warranted.

Boroditsky

In order to determine if the use of distinct metaphors for understanding time does in fact involve processing at the level of two distinct, representational structures for space, Boroditsky (2001; Experiment 1) primed subjects with spatial scenarios depicting either an "ego-moving" or "object-moving" frame of reference containing TRUE/FALSE questions. For instance, an example of an "ego-moving" prime consisted of a human figure in between two garbage cans with an arrow suggesting forward motion of the person. Below the scene one read, "The dark can is in front of me". In an "object moving" prime, two "widgets" (objects with no apparent front or back) were aligned side by

side, both with arrows suggesting motion in a common direction. Below the scene one read, "The light widget is in front of the dark widget." Subjects answered TRUE or FALSE based on the correspondence between scene and statement. (See Figs. 4.1a and 4.1b.)



(4.1a) Moving-Ego concordant spatial schema

(4.1b) Moving-Time concordant spatial schema

Figures 4.1a and 4.1b. Spatial Primes in Boroditsky 2001, Experiment 1.

In the test, subjects read the ambiguous temporal sentence, "Next Wednesday's meeting has been moved forward two days" and were instructed to answer the question "What day is the meeting now that is has been rescheduled?" Remember that the sentence is ambiguous because how one answers the question depends on the kind of temporal metaphor one employs; if one uses an ME metaphor (concordant with Fig. 4.1a) with the meeting should be moved to Friday, if one uses an MT metaphor (concordant with Fig. 4.1b) the meeting should be moved to Monday. Boroditsky found that, after priming, over 70% of her subjects responded in a schema consistent manner. That is, subjects primed with a spatial scenario depicting an "ego-moving" frame of reference were significantly more likely to

answer Friday when asked the ambiguous temporal question; subjects primed with the "object moving" frame of reference were more likely to answer Monday.

Alone however, this result doesn't demonstrate "that time is understood and structured online as a metaphor from space" (p. 10). In order to draw more concrete conclusions, in Experiments 2 and 3 Boroditsky reversed the directionality of the procedure asking, "Would making people think about time in a particular way affect how they think about space?" (p. 10). This manipulation is critical, not only in order to establish the primacy of spatial schemas in the construction of temporal concepts but also to rule out more traditional (linguistic) accounts for the priming effects found in Experiment 1.

Thus, Experiment 2 examined whether or not temporal primes (ME or MT statements) influenced subjects' interpretation of an ambiguous question about spatial relations. The temporal primes were TRUE/FALSE questions that employed either a "ego-moving" schema (e.g. 'On Thursday, Saturday is before us') or an "time-moving" schema (e.g. 'Thursday comes before Saturday').[10] After priming, an ambiguous question about the relative position of objects in a spatial array was asked (e.g. 'Which of these widgets is ahead?' See Figure 4.2.)

> The widgets…were arranged vertically [using three-point perspective] from closest to farthest so as not to introduce any left/right bias.[11] The widgets were designed to be frontless, vertically symmetrical, and mobile-looking. This was done so that a widget's `aheadness' could not be inferred from any intrinsic properties of the widget, but rather required the observer to impose either an object-moving or an ego-moving perspective on the picture. If the participants imagined the widgets as moving out of the page (the object-moving perspective), then the bottom or closest widget should be `ahead'. On the other hand, if the participants imagined themselves moving into the page toward the widgets (the ego-moving perspective), then the widget furthest along in the direction of motion of the observer (the top or farthest widget) should be `ahead' (pp. 12-13).

[10] Again, because concepts of past/future and earlier/later are conflated, one could question the extent to which these sentences adequately represent examples of ME and MT sentences.
[11] Of course, possible up/down bias is not accounted for.

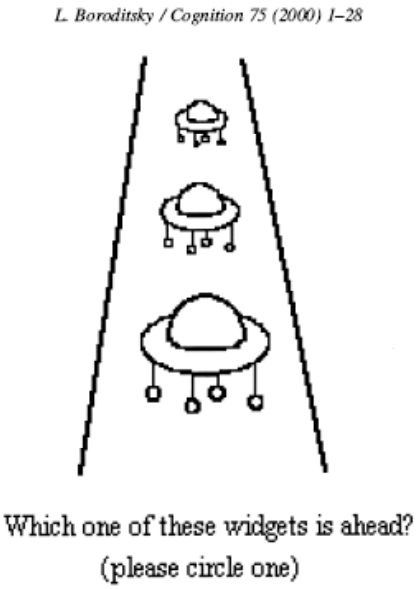


Figure 4.2. Ambiguous spatial target used in Boroditsky 2001, Experiment 2.

The results of Experiment 2 indicated that participants were **not** influenced by a particular temporal prime when thinking about the ambiguous spatial questions (i.e. no time → space priming). Importantly, two control groups found that (1) subjects' responses to the ambiguous spatial question could be influenced by prior spatial priming (space → space priming) and (2) linguistic temporal primes concordant with either ME or MT metaphoric structure also influenced responding to the ambiguous temporal question about Wednesday's meeting (time → time priming). Boroditsky takes these results as strong evidence for the directionality of metaphorical mapping from a concrete source domain (space), to an abstract target domain (time), but not vice-versa.

However, while the results of Experiment 2 suggest directionality in mapping relations between spatial and temporal representations, they do not rule out other explanations. According to Boroditsky:

> It could be that space and time both use a set of generic, domain-independent (neither spatial nor temporal) schemas that can be used to mentally organize objects in space as well as events in time. Let's call this alternative the Generic Schema View. According to the Generic Schema View, time is not thought of in spatial terms. Rather, both spatial and temporal reasoning is accomplished by referencing the same generic schemas. If this is the case, then the effect of

> consistency observed in Experiment 1 is the result of spatial primes activating the appropriate generic schema which makes it more likely to be used by the domain of time (since time makes use of the same schemas as space). The Generic Schema View might also be able to explain the asymmetry in transfer between space and time observed in Experiment 2. The domain of space might be more strongly associated with the generic schema than the domain of time (perhaps because spatial thinking is more common than temporal thinking) (p. 16).

Boroditsky proposes the Generic Schema View (see Fig. 4.3) to address dubious psycholinguists who might suggest the possibility that more traditional semantic network priming effects (among stored lexemes for example) are responsible for the results of Experiments 1 and 2. What Boroditsky calls a Generic Schema could just as well be conceived as a semantic network where common lexemes used to describe both spatial and temporal concepts are stored.

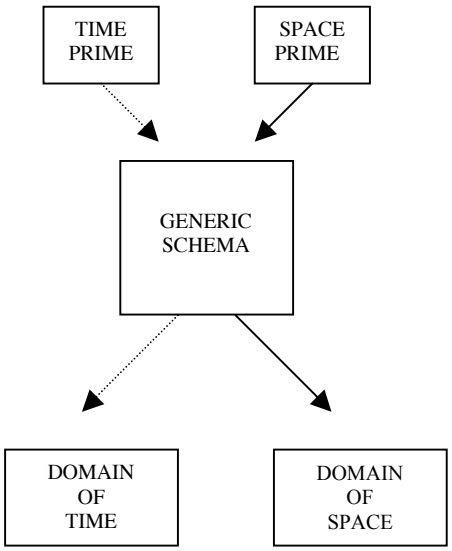


Figure 4.3. Generic schema model (dashed lines represent weaker connection strengths)

Regardless, if the Generic Schema View is correct, then one would counter intuitively predict that, based on the strength of network associations, "space should prime time better than time should prime itself" (p. 17). However this was not the case when, in Boroditsky's Experiment 3, reaction time was used as a more sensitive measure to examine the effects of cross-domain (e.g. space to time) priming vs.

within domain (e.g. time to time) processing. Perhaps it's unsurprising that, overall, subjects solved temporal target questions after schema consistent temporal primes (ego-moving or time-moving) faster than after schema-consistent spatial primes. Despite the overall difference, "the effect of schema consistency was the same regardless of whether the primes were spatial or temporal. This suggests that while purely temporal information was better activated by temporal primes, the relational information needed to organize these temporal components was equally useful whether it came from spatial or temporal primes" (p. 21). In addition, it was found again that schema-consistent temporal primes did not facilitate the solution of spatial questions as measured by reaction time. Besides providing a means to refute the validity of the Generic Schema View, reaction time measures also served to examine the effects of primes on online processing itself, as one could argue that the previous two experiments only examined the results of such processing. Thus the relation between time and space is shared and/or metaphoric, i.e., the processes may be shared but the domains remain distinct.

Boroditsky suggests that the Metaphoric Structuring View (see Fig. 4.4) provides the best account for the aggregate data. The effects of schema consistency are apparently asymmetric; although participants' thinking about time was influenced by spatial primes, their thinking about space was not influenced by temporal primes. However, the data also tell us that spatial schemata need not necessarily be accessed directly in order to talk and think about time (because time → time priming works). On the strength of this study, it seems at least that space and time share structural properties at a level beyond linguistic similarity.

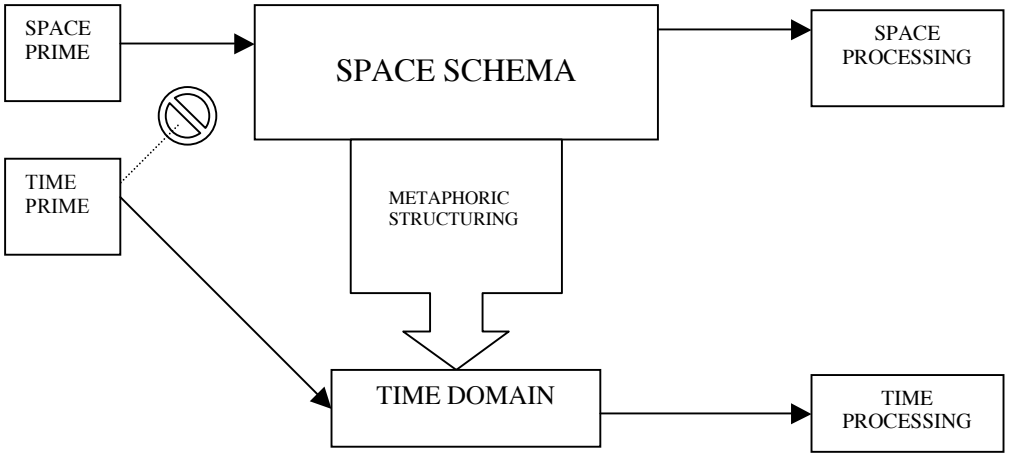


Figure 4.4. Metaphoric structuring model

The possibility that semantic priming could account for Boroditsky's results represents an important general criticism in this line of research. Boroditsky states that:

> …it is generally the case that the less familiar member of an asymmetrically associated pair (e.g. `leopard' of `leopard-tiger') is more likely to elicit the more familiar member (e.g. `tiger') than the reverse. Of space and time, space appears to be the richer, more elaborated, and more familiar domain; space has more dimensions than time, is more flexible with regard to direction of motion, and is more readily perceptible. From all this, one should predict that time (the smaller, less common domain) should remind us of space (the larger, more common domain) more than space should remind us of time. This prediction is, indeed, exactly the opposite of what was observed in Experiments 2 and 3 which showed that spatial thinking affected temporal thinking but not the reverse (p. 24).

And of course, in the analysis of common language usage, the directionality of linguistic metaphor has been well documented by Lakoff and Johnson (1983; 1999). Languages tend to allow us to express abstract concepts like LOVE in terms of a more concrete concept, like that of a JOURNEY. Empirical research like Boroditsky's is beginning to suggest that directionality in conceptual structure is more than "language deep" and that mental representations of abstract concepts are associated with highly conventional patterns of imagery.

Yet, to argue that nonlinguistic spatial structure is important for the organization of mental representations is not the same as saying that language does not play a critical role in shaping conceptual structure. Cross-linguistic studies are important in this line of research for a number of reasons. If the spatial structure of conceptual metaphors plays a role in shaping abstract domains of thought in psychologically interesting ways, then languages that differ in the way they use spatial language to communicate about abstract domains should be sensitive to spatial priming effects in ways different than English; however, these differences should also be predictable depending on how their particular language talks about time in terms of space.[12]

In another seminal paper, Boroditsky (2001) studied English and Mandarin speakers. She chose these groups to compare because they talk about time differently. With some rare exceptions, English speakers use mostly horizontal terms whereas Mandarin speakers use both horizontal and vertical terms to talk about time. As discussed earlier, English speakers primarily use front/back terms oriented along a horizontal axis to talk about time. And while in Mandarin Chinese front/back morphemes (*qián* and *hòu*, respectively) are common, Mandarin speakers also use spatial morphemes referring to up/down (*shàng* and *xià*) to talk about time; where earlier events are *always* "up" and later events "down." (That is, for a Mandarin speaker, no ambiguity would be recognized in an expression like, "Wednesday's meeting was moved up 2 days.") Although certain aspects of the time concept are thought to be universal across cultures, e.g., time is generally conceived of as "continuous" (time "flows" independent of human observation) and "unidirectional " (moments happen only once; change is marked by the appearance and disappearance of objects and events etc.), Boroditsky argues that other aspects of time

[12] Very recently Núñez and Sweetser (2006) discussed a language spoken by the Aymara of Bolivia that conceptualizes the past as *in front* of the speaker and the future as *behind.* It is hypothesized by the authors that this unusual (and perhaps unique) temporal structure reflects the fact that eyewitness knowledge is always marked linguistically in Aymara. So the past, which speakers have first hand knowledge of, is *in front* because from an embodied perspective we generally have knowledge of what we can see. On the other hand, we do not have as direct knowledge of what we cannot see. Hence the future, which hasn't happened yet, is placed *behind* the ego. This mapping is very counterintuitive for most non-Aymara speakers.

are not necessarily apparent as a result of direct experience with the world. According to Boroditsky, such aspects of our temporal concepts, e.g. whether time is conceptualized as moving horizontally or vertically, are marked by language.

Using a design that measured reaction times, Boroditsky demonstrated that native Mandarin speakers are indeed faster at answering 'purely temporal' questions after being primed with depictions of vertical spatial relations as compared to native English speakers who are faster after horizontal primes. In the experiment, different priming scenes depicted horizontal or vertical spatial relations and were accompanied with explanatory text (e.g. "The black worm is ahead of the white worm." or "The black ball is above the white ball." (See Figs. 4.5a and 4.5b.) Subjects were required to answer TRUE/FALSE questions about the spatial primes.

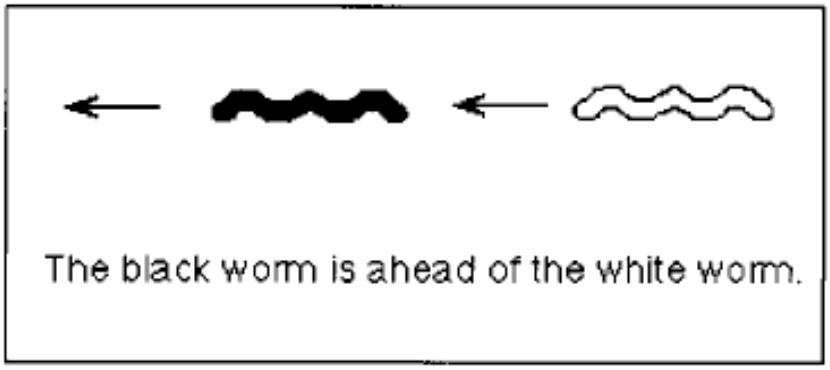


Figure 4.5a. Horizontal Prime in Boroditsky (2001)

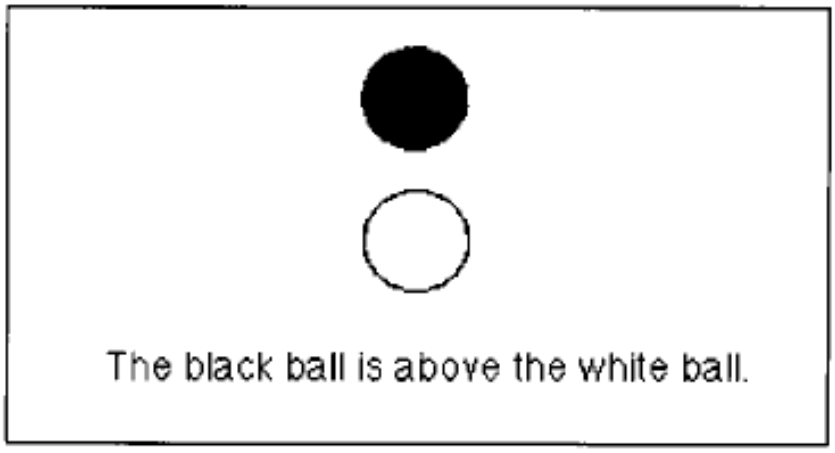


Figure 4.5b. Vertical Prime in Boroditsky (2001)

Participants were then asked "purely temporal questions" requiring TRUE/FALSE answers. Questions were "purely temporal" in that they used terms like "earlier" or "later" (e.g. March comes *earlier* than April) rather than spatiotemporal (e.g. March comes *before* April). English speakers answered the temporal questions faster after horizontal primes, whereas Mandarin speakers answered faster after vertical primes.

A second study found that "the acquisition of semantic biases (such as a habit of thinking about time vertically or horizontally) decreases with the age at which second-language exposure begins" (Boroditsky, 2001, p. 19). This suggests a pattern of development analogous to that seen in the development of spatial categorization in relation to language acquisition (Bowerman & Choi, 2001; McDonough et al., 2003).

A critical empirical issue in the study of conceptual metaphors concerns how one might demonstrate experimentally the extent to which such concepts are 'embodied'. In another paper, Boroditsky and Ramscar (2002) reported three studies that investigated the relationship between spatial experience and people's thinking about time. Specifically, these studies looked at how people's actual or imagined motion through space influences the way they think about time. Thus, in addition to looking at a picture and "actually" imagining oneself in the depicted situation, the "primes" in these studies involved mundane activities like standing in a lunch line or riding in a train. In each case, participants were asked the ambiguous question about Wednesday's meeting at some (experimentally interesting) point in whichever particular activity they were engaged in.

For example, in the lunch line study, Boroditsky and Ramscar (2002) found that people were more likely to use ME metaphors (and give Friday responses) if they were further along in the line, having experienced more forward motion compared to people standing in the back of the line (who more

often gave Monday responses). Interestingly, participants' own estimates of waiting time (duration) in line were *less* predictive of the type of temporal metaphor used to answer the ambiguous question than their relative spatial position in the line.

In the same paper, Boroditsky and Ramscar showed participants pictures depicting spatial scenes that afforded action concordant with either ME or MT metaphors. (See Fig. 4.6.) Participants were asked to imagine themselves in one or the other situation. In the ME condition, they were told, "You are sitting in the chair. While sitting in the chair, imagine how you would maneuver the chair to X. Draw an arrow indicating the path of motion." And in the MT condition, "You are holding a rope attached to a chair. With the rope imagine, imagine how you would maneuver the chair to X. Draw an X indicating the path of motion." Both groups were then tested with the ambiguous question about Wednesday's meeting. The results were as predicted, participants imaging their own motion in the ME condition more frequently gave Friday responses, participants in the MT condition, Monday responses.

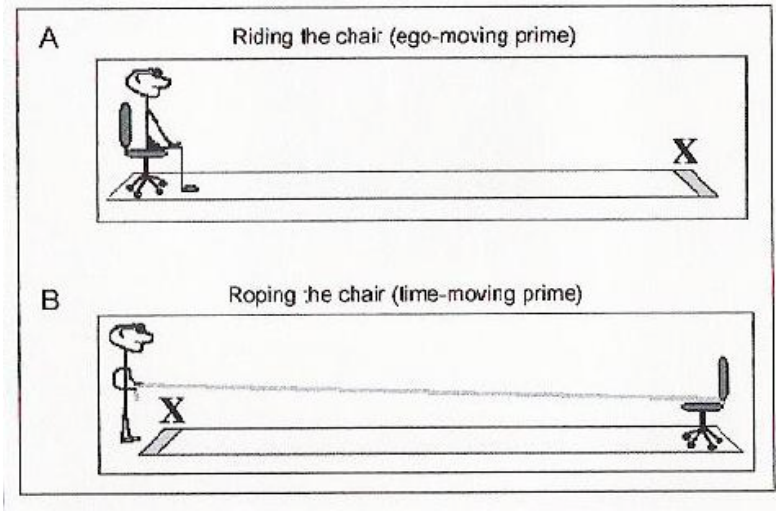


Figure 4.6. Primes used in Boroditsky & Ramscar 2002.

These results suggest that "just thinking about spatial motion is sufficient to change one's thinking about time" (p. 186). The authors concluded that:

> A very strong, embodied formulation might be that knowledge of abstract domains is tied directly to the body as such that abstract notions are understood through image schemas and motor schemas (Lakoff & Johnson, 1999). A milder view might be that abstract knowledge is based on representations of more experience based domains that are functionally separable from the representations directly involved in sensorimotor experience…contrary to the strong embodied view, it appears that abstract thinking is built on representations of more experienced-based domains, and not necessarily on the physical experience itself (Boroditsky & Ramscar 2002, p. 185).

The authors argue further that because people use metaphors to think about abstract domains in terms of more concrete, experienced-based domains, and these metaphors sometimes go beyond what one actually experiences, language may very well play an important role in the construction of certain aspects of fundamental abstract concepts like time. There is no reason to doubt this considering the numerous ways language transcends mundane experience in terms of what it is able to depict.

However, this raises an important issue. The relations between fundamental concepts like space and time are more basic than those between "love" and "journeys." Temporal concepts that are grounded in experience in space may not be absolutely restricted by experience, but it may be the case that, to some extent, temporal concepts are constrained by experience in predictable ways. (Or, to paraphrase Núñez (1999) "The future could not taste purple.") Boroditsky suggests, "…language can be a powerful tool for shaping abstract thought. When sensory information is scarce or inconclusive (as with the direction of motion of time), languages may play the most important role in shaping how their speakers think" (Boroditsky 2001, p. 20). However, one could argue that she fails to adequately acknowledge that the world does provide highly constrained patterns of "sensory information" regarding the motion of objects in space and time. For example, both object and ego motion are less restricted along the horizontal plane than along the vertical. Gravity however, severely constrains motion along the vertical dimension. [13] And even along the horizontal plane the manner in which we talk about time

[13] This issue will be further explored in the experiments that follow.

appears to be restricted: time may *creep, crawl* or *march* but it rarely *skips* or *shuffles* (McGlone, Harding, & Glucksberg, 1995).

5. Ecological constraints: Exploring temporal structure in respect to spatial orientation

Axes, gravity and time?

To what extent are spatially grounded temporal mappings in different languages constrained by 'lower-level' perceptual and kinesthetic image schemas? As Clark originally suggested, there may be an underlying logic, based on the interface between body and environment, which provides the foundation for the construction of a rudimentary semantics. If one could establish a structural "starting point" we could then proceed to trace how particular temporal models are selected and developed. Recent scholarship in cognitive linguistics (Radden 2003; Evans 2004) has addressed the ways in which different languages elaborate upon particular aspects of spatiotemporal experience in order to construct new temporal concepts. Linguistic studies focus on the different attributes of space that can be elaborated upon (e.g., axis orientation of the time line, shape of the time line, position of places "in" time relative to the observer) and how different approaches to lexicalization lead to different structural organizations and hence, conceptualizations of time. However, there is little empirical work that examines the internal 'psychological' coherence of these organizations either within a language or across languages.

Empirical research could potentially provide evidence that the dynamic relations within particular elaborated temporal metaphors are consistent, predictable, and predicated on different kinds of embodied experiences. For example, a very ambitious research project could set out to demonstrate that during childhood the acquisition of different kinds of temporal metaphors entails qualitatively different kinds of experiences over the course of development, guided by the acquisition of distinct kinds of spatial concepts. As Bowerman and Choi (2001) suggest, the development of basic conceptual

structures is tied to increased attention to fundamentally different kinds of physical events and motion patterns made more salient by language and culture. In lieu of this, similar studies using adults subjects could possibly demonstrate similar, predictable kinds of covariations in the responses to questions about time after nonlinguistic priming tasks using both two-dimensional pictures and actual or imagined motion in space. It is reasonable to expect that, under experimental conditions, manipulating a subject's thinking about specific axis orientation in space (in this case by suggesting vertical rather than horizontal motion) would influence how one conceives of their movement through time.

Boroditsky (2001) did not discuss the distinction between MT vs. ME time metaphors in respect to Mandarin vs. English speaking subjects. When Lai (2003, unpublished thesis) set out to replicate Boroditsky and Ramscar's (2002) study using Mandarin speakers, she found that unlike English speakers, actual or imagined bodily movement in space did not effect how Mandarin-speaking individuals thought about temporal expressions. Chinese speakers, after actual or anticipated linear (horizontal) motion through space, almost always adopted a MT perspective when presented with a "moving forward" expression as gauged with the ambiguous question about next Wednesday's meeting. Lai was not clear about how this result should be interpreted (Ahrens, personal communication, 2004 and Lai, 2003).

Looking at how the terms *shàng* (up) and *xià* (down) are used when talking about time, it's fair to ask why these terms have acquired the meanings they have. Mandarin speakers use *up* terms to talk about earlier events and *down* terms to talk about later events. This is always the case when Mandarin speakers use these terms, i.e. the meaning of these terms is never inverted, as are front/back horizontal terms in English when speakers switch between time-moving or ego-moving temporal metaphors. There is reason to believe that up/down terms would have more constrained meanings when used to ground abstract concepts. This is the case because the natural dynamics and experience of gravity structure these relations. Clark wrote:

> Consider gravity. It defines a natural direction—verticality—which can be specified locally anywhere on earth…gravity helps us define a natural positive and negative direction, for gravity is asymmetrical, pulling objects in one direction and not the other (p. 32).

The experience of gravity, both in terms of its perceived effects on objects and one's body in motion, provides a natural starting point for establishing semantic valence. The up-down/earlier-later mapping evident in Mandarin may be universal in structuring events (e.g., kinship diagrams and writing systems are always organized as such.) Gravity provides a natural vertical reference plane with built-in unidirectionality. One can think of few other natural kinds of phenomenon that offer such a starting point. In terms of understanding simple temporal relations, (e.g., apples falling from trees) gravity is a force that provides a natural structure to events in the immediately observable world where prior events are always "up" and more recent events are "down." What other everyday pattern of phenomena so plainly represents a conventionalized path that naturally structures relations between space, motion and causality? Gravity provides a universal, earthly timepiece (think of an hourglass). And unlike the cycle of day and night, the change in the seasons and the growth of plants, the effects of gravity are immediately observable and regular even to infants early in development (Baillargeon et al., 1992).

Both ME and MT temporal metaphors use the ego as a deictic point of reference. The two mappings differ only in whether they represent either (1) the *ego* (2) or *moments* or *events in time* as 'in motion'. Time-space mappings that use the ego as a point of reference are justifiably organized along a horizontal axis because motion along this axis is typical from an embodied or ecological perspective. Furthermore, the horizontal axis supports figure-ground reversals because motion along the horizontal axis is less constrained (ecologically) in terms of directionality. However, along the vertical axis, where the natural direction of motion is less analogous to typical patterns of human locomotion, inherent directionality is provided by gravity. Shinohara's (2000) "slope model" (see Fig. 5.1) suggests the inferential structure suggested by a vertical spatiotemporal mapping constrained by gravity. "When we are on a slope, we are compelled by gravity to move in a downward direction, hence there is a tight

correlation between being located higher on a slope and an earlier point in an object's trajectory, due to the fact that being further down the slope correlates with a later point in a trajectory" (Evans 2004, p. 236)

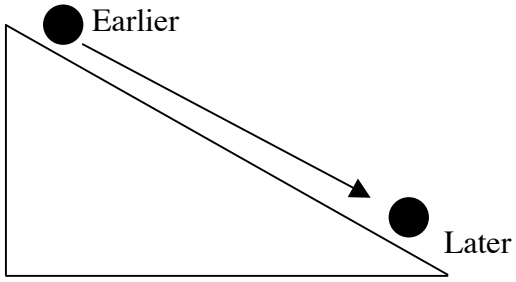


Figure 5.1. Shinohara's slope model (adapted from Evans 2004, p. 236). The model is based on a mapping of time onto vertical spatial structure in Japanese. The Japanese model shares a similar structure to the spatiotemporal mappings in Mandarin discussed in Boroditsky's (2001) paper. The ball, when at the top, is at an earlier time than the same ball after it has traveled to the bottom of the slope.

Note there is no need for a relative observer, or ego, along the timeline. The mere succession of events (as represented by the moving balls) relative to one another provides meaning about sequence. However, *some* point of reference is required. (The experiments reported in Chapter 7 will address these issues in detail.)

Yet since Boroditsky's (2001) study, researchers from diverse research fields, notably those doing work in cognitive linguistics, have taken an interest in the lexicalized verticality of the timeline in Mandarin. Radden (2003) writes:

> In Western cultures, the front-back orientation predominates in temporal scenes. We do not see a vertical or lateral movement underlying temporal expressions such as *this coming month*, *the days gone by* or *the following week,* i.e., we do not visualize a month approaching from above or from the left side…In Chinese, on the other hand, the vertical axis commonly applies in conceptualizing time. Earlier times are viewed as "up" and later times as "down"…A vertical axis of time is in conformity with the widespread view of time as flowing or the "river model' of time. In China, the cultural importance of the Yangtze River may have reinforced the preference for viewing time as vertical. Yu (1998: 111) conjectures that "up" and "front" have a common experiential basis: "When we lie down on our stomach and crawl, we normally

> move in the direction of head rather than feet. So our heads become fronts just like the fronts of any moving objects, such as cars, trains, ships, planes rockets, and so forth."

Shinohara's slope model, invoking the force of gravity, provides a more reasonable explanation than Yu's for suggesting a basis for the vertical mapping of time in Mandarin and other languages. This is the case not merely because the anecdotal evidence is more convincing. (While river models of time are common and support Shinohara's model, is there a cultural explanation for why Mandarin speakers might be likely to use the experience of crawling in order to establish a frame of reference for temporal relations?) First, Mandarin uses a vertical axis for structuring earlier/later relations but not for past/future relations (Lai, personal communication, 2005). Thus, we should be able to investigate empirically whether or not the particular axis (e.g. vertical vs. horizontal) utilized by distinct temporal concepts (e.g. past/future or early/later) provides the fundamental anchor for grounding meaning in the embodied, the ecological. That is, in a language that systematically uses both axes to structure temporal concepts, we should expect the horizontal axis to be used for past/future relations and the vertical axis to be used for earlier/later relations. These correlations are expected because (1) the ego is a necessary reference for defining past/future relations, ego-referenced temporal metaphors (MT and ME) involve motion relative to the body that is canonically horizontal and (2) earlier/later relations structured along the vertical axis are object-referenced and hypothesized emerge from the experience of gravity-caused motion. However, if a language doesn't conventionally use vertical terms and relations to talk abut space, how would speakers of that language respond to spatial manipulations (primes) that forced them to do so?[14]

Frame of reference must necessarily play a significant role in structuring the spatial relations among the objects represented in temporal metaphors.[15] If the relative position of the observer is

[14] See Experiment 1.
[15] A more thorough discussion concerning the relations between spatial frame of reference and temporal concepts takes place in the introduction to Experiment 2.

irrelevant in a model like Shinohara's, then environment-centered, absolute, or extrinsic frames of reference, in which "objects are represented with respect to salient features of the environment, such as gravity or prominent visual landmarks" (Carlson-Radvansky & Irwin, 1993, p. 224) should be invoked for purposes of orientation along the vertical axis. In fact, Carlson-Radvansky and Irwin found that the absolute frame of reference dominated responses to arrays of ambiguously oriented configurations of objects. Absolute above/below (e.g. "the ball is above the chair") labels tend to 'beat out' deictic or ego-centered frames (e.g. "the ball is to the left of the chair") and intrinsic or object-centered frames (e.g. "the ball is in front of the chair") when an above/below relation could potentially be used to describe the ambiguous configuration of objects (see Figure 5.2 and explanation). Franklin and Tversky (1990) also found that the vertical axis was privileged when constructing and retrieving memories for events:

> According to [*Spatial Framework Theory*] people remember locations of objects around the body by constructing a mental spatial framework consisting of extensions of the axes of the body, head/feet, front/back, and left/right, and attaching the objects to them. Accessibility of directions depends on asymmetries of the body and asymmetries of the world. The only asymmetric axis of the world is the up/down axis created by gravity. Gravity of course has broad effects on the way the world appears and the way we can act in it. For the upright observer, this axis coincides with the asymmetric head/feet axis of the body. Times to retrieve objects at head and feet are in fact, fastest. The front/back axis is also asymmetric, but does not coincide with any asymmetric axis of the world. The front/back axis separates the world that can be readily perceived and acted on from the world behind the back, difficult both for perception and action. Finally, the left/right axis lacks any salient asymmetries, and is, in fact, slowest (Tversky, 2005).

This is important because ambiguous configurations of objects and subjects naturally afford multiple frames of reference and can be described using different kinds of linguistic expressions. For example, in the drawing below, (Figure 5.2) if you imagine yourself as "person A" (lying down along the ground, on your side, facing "person B") where is the arrow in relation to person B? Where is the arrow at 'location C" in relation to you?

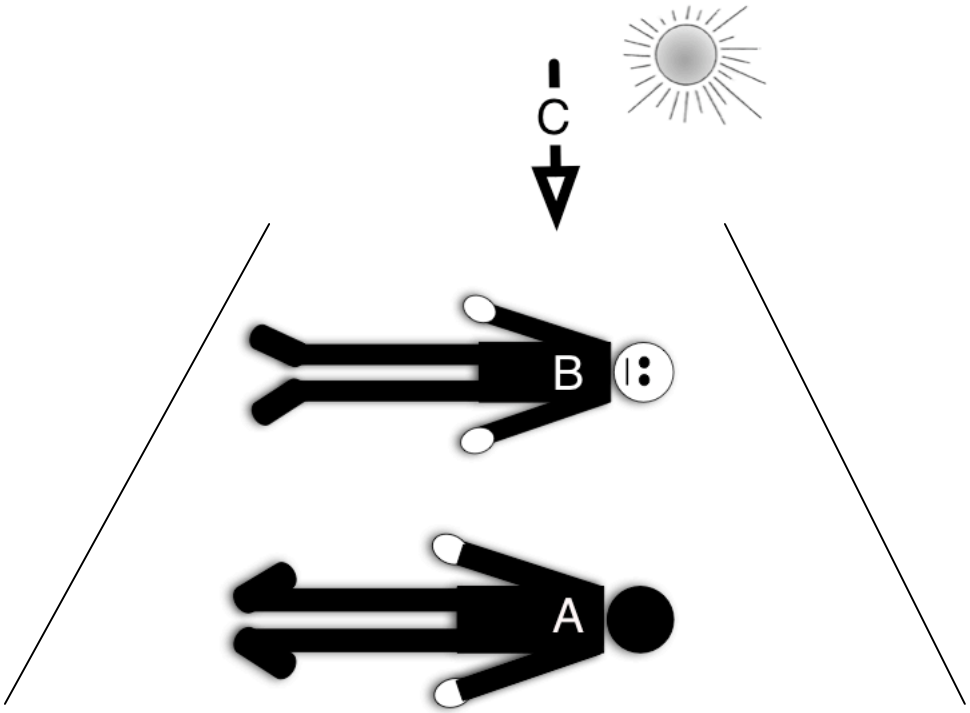


Figure 5.2. Ambiguous Spatial Relations

The claim suggesting that descriptions using absolute relations 'beat out' those using deictic or intrinsic relations argues that they are processed more quickly and accurately (Franklin & Tversky1990) and selected more often (Carlson-Radvansky & Irwin 1993) when recalling or disambiguating spatial relations in complex scenes. Using the above example, most people will claim that the arrow is *above* person B, rather than to the *right* of person B or in *front* of yourself (or person A). And the arrow is typically described as pointing down, rather than towards person B's left or your right (and this would be the case even without the added left/right ambiguity resulting from two, front-facing subjects). Additionally, if prominent landmarks (the sun, cardinal directions etc.) for force gradients (gravity) are imposed on a scene, absolute interpretations become even more likely. In addition, you will remember the spatial relations of the above figure primarily in terms of spatial orientation along the vertical axis.

In general, issues concerning frame of reference, although a major topic in spatial cognition, have yet to be rigorously applied to issues of temporal representation and metaphor. This may be because time is generally thought to be:

> less rich than the domain of space… spatial schemas imported into the domain of time may be simplified to include only those elements needed for time. For example, space has three dimensions, while time is generally thought of as one-dimensional. In space, objects have intrinsic fronts, and can face and move any which way in a layout. The domain of time, once again, is more restricted; events don't have intrinsic fronts per se and can only move in one dimension (Boroditsky, 2000, p. 10).

But this raises the question; what happens when this 'richness' in the domain of space is imposed on the domain of time? First, we need to test if the natural directionality provided by the force of gravity actually does play some role in providing an experiential grounding for temporal concepts and thus influences the way we think about time. If so, it may be important to develop new non-egocentric models for representing time. These issues will be addressed in the following experiments.

6. Experiment 1 (Pilot Research)

Experiment 1A: Introduction

By observing how subjects disambiguated the question about "…moving Wednesday's meeting forward 2 days…" Boroditsky and Ramscar (2002) showed that a particular temporal perspective (ME or MT) could be elicited by using horizontal spatial primes highlighting similar motion through space. Presently, Experiment 1 used vertical, rather than horizontal, spatial primes to illuminate how abstract domains may be constrained by the structure of their source domains in English speakers. Differences are expected because motion along the vertical axis is constrained by the force of gravity and experienced differently than motion along the horizontal axis.

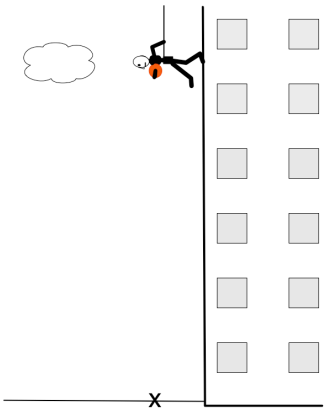
There are two main hypotheses. The first (Hypothesis 1) states that the inferential logic of temporal concepts as structured either along horizontal or vertical axes is arbitrary and marked (but not constrained) by language. This is the result predicted by Boroditsky (2001). In her experiment investigating differences between Mandarin and English speakers, she argued that aspects of conceptual organization related to orientational structure (like axis direction, e.g. whether time is conceived as moving vertically or horizontally) that are not critical in respect to organizing temporal relations (vs. aspects that are critical like unidirectionality) acquire meaning through linguistic marking but are arbitrary from an embodied or ecological perspective. The second (Hypothesis 2) predicts that changes in the orientation of the motion trajectory will elicit changes in how participants think about time. When the timeline is oriented vertically, our thinking about time is influenced by patterns of motion in space that are constrained by gravity.

Experiment 1A: Methods and Procedure

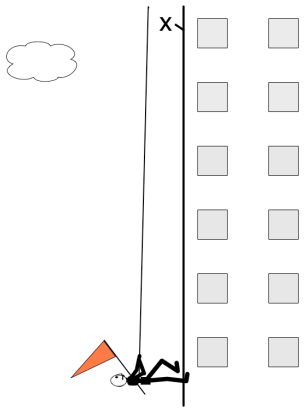
Subjects. A total of 50 undergraduate students enrolled in Introductory to Psychology classes participated for course credit.

Procedure. Primes were printed on paper. They were designed to represent spatial schemes concordant with the structure of either ME or MT temporal metaphors but oriented vertically instead of horizontally. Thus direction of motion (Up vs. Down) was also of particular interest. This created two factors (1) spatial schema type (ME vs. MT; represented by Figs. 6.1 vs. 6.2) and (2) direction (Down-Moving vs. Up-Moving; Figs. 6a vs. 6b). Participants received a pencil, were given one of four primes and asked to imagine that they were the person in the picture. Further instructions suggested imagined motion consistent with the spatial dynamics of the particular prime (e.g., "Imagine how you would move the flag to the X. Draw an arrow indicating the path of motion"). After the priming component of the experiment, participants were read the test question: "If next Wednesday's meeting has been moved forward two days, what day is the meeting now that it has been rescheduled?" Participants recorded their answers on a separate piece of paper.

66.7% answered Friday
(6.1a: ME / Down-Moving CONDITION)

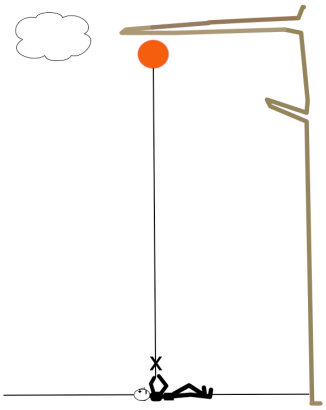


61.5% answered Friday
(6.1b: ME / Up-Moving CONDITION)

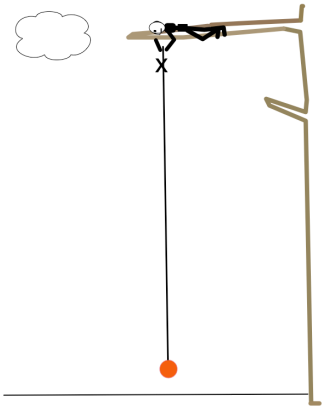


Figures 6.1a and 6.1b. Vertical Moving-Ego primes with result summary for Experiment 1A.

100% answered Friday
(6.2a. MT / Down-Moving CONDITION)



66.7% answered Friday
(6.2b. MT / Up-Moving CONDITION)



Figures 6.2a and 6.2b. Vertical Moving-Time primes with result summary for Experiment 1A.

Experiment 1A: Results (also refer to Figures 6.1a and b and 6.2a and b)

There were four main findings. First, significantly more participants gave Friday answers (72.0% or 36 out of 50 participants) to the ambiguous question about Wednesday's meeting compared to Monday answers (28.0% or 15 out of 50 participants). This difference was significant, $\chi^2(1, N=50) = 9.680$, $p = 0.002$. In a control group using the same materials, when asked the ambiguous question without priming, 46.2% of participants answered Monday and 53.8% of participants answered Friday ($N = 26$). This could suggest that just thinking about "verticality" influenced responding in the direction of later times.

Second, participants primed with MT schemas (Figs. 6.2a and 6.2b; $N=22$) were significantly more likely to move Wednesday's meeting forward to a later time (Friday). 81.8% or 18 out of 22 participants moved the meeting to a later time (Friday answers) compared to only18.2% or 4 out of 22

participants who moved the meeting to an earlier time (Monday answers); this difference was significant, $\chi^2(1, N=22) = 8.909, p = 0.003$. Responses by participants primed with ME schemas (Figs. 6.1a and 6.1b; $N=28$) did not differ significantly in terms of providing Monday answers (35.7% or 10 out of 28 participants) or Friday answers (64.3% or 18 out of 28 participants) to the ambiguous question. (See Fig. 6.3.) Importantly, this is the opposite pattern of results found by Boroditsky and Ramscar (2002) where analogous horizontal MT spatial primes resulted in participants more often moving the meeting to an earlier time (more Monday responses).

Third, participants primed to imagine downward motion (Figs. 6.1a and 6.2a; $N=25$) were more likely to move Wednesday's meeting forward to a later time (Friday). A total of 80.0% or 20 out of 25 participants moved the meeting to a later time (Friday answers) compared to only 20.0% or 5 out of 20 participants who moved the meeting to an earlier time (Monday answers) and this difference was also significant, $\chi^2(1, N=25) = 9.000, p = 0.003$. Participants primed with upward motion (Figs. 6.1b and 6.2b; $N=25$) did not differ significantly in terms of their Monday answers (36.0% or 9 out of 25 participants) or Friday answers (64.0% or 16 out of 28 subjects) to the ambiguous question about Wednesday's meeting. (See Fig. 6.4.)

Lastly, the significant factors interacted. That is, under the priming condition (6.2a) that crossed both significant factors (MT X Down-Moving), *all* participants, interestingly, answered Friday to the ambiguous question about Wednesday's meeting (100% or 10 out of 10). Whereas in the condition that crossed ME X Up-Moving motion (6.1b), the smallest proportion of Friday answers was observed (61.5%) although this difference was not significantly different than the proportions observed in the other two remaining conditions (6.1a and 6.2b).

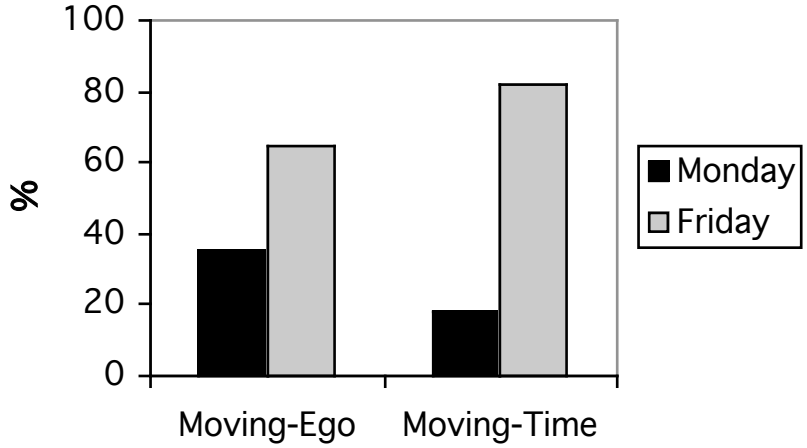


Figure 6.3. Percent answering Monday or Friday after Moving-Ego or Moving-Time primes for Experiment 1.

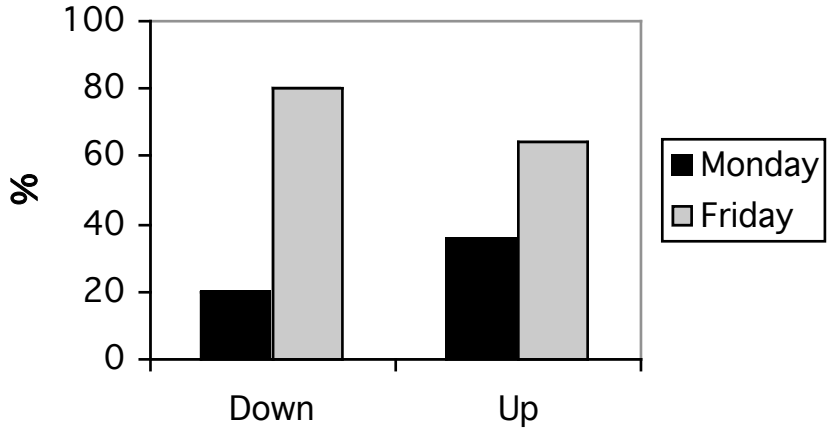


Figure 6.4. Percent answering Monday or Friday after Down-Moving or Up-Moving primes for Experiment 1.

Experiment 1A: Conclusions

The pattern of results suggests three main issues that might be useful in understanding the basis for the differences in participants' responses after receiving a particular prime type.

The first issue that should be considered concerns *gravity*. Gravity is a unidirectional force that makes motion events along the vertical dimension asymmetrical. Knowledge of gravity develops in infancy and evidence for a "straight down" bias also appears early in development. The pervasive force

of gravity not only constrains the motion of inanimate objects (so that they tend to fall down) but also makes vertical motion less conventional for animate objects (we tend to walk along horizontal planes).

Secondly, besides being figure-ground reversals of one another, the MT and ME spatial schemas differ in another way, namely the conceptualized *agency* or *animacy* of the moving trajector. That is, in the MT schema an inanimate object is represented as in motion, whereas in the ME schema an animate object is. Linguistic evidence also suggests that MT and ME metaphors are not merely figure-ground reversals and that the conceptualization of animacy plays a role in when a particular metaphor is selected for use in conventionalized expressions. For example, one might say, "*I feel a headache coming*" however, the sentence, "*I am approaching a headache*" sounds odd, presumably because we think of the headache in such expressions as having (a somewhat sinister) agency. This is the case because we commonly conceive of illness as something that frequently pursues us, rather than vice-versa.

So, when thinking about the motion of inanimate objects through vertically oriented space, earlier events are necessarily above later events. Therefore, it makes more intuitive sense that MT spatial schemas would more frequently evoke "forward-is-later" mappings (and Friday responses to the ambiguous question) along the vertical axis because inanimate objects' motion is specifically constrained on the vertical axis in a way that the motion of animate things is not. This might explain why all subjects primed with a MT Down-Moving schema answered Friday.

The last way to understand the results involves examining alternative temporal models. It has recently been suggested that non-ego-centered "time-referenced models" (Núñez & Sweetser, 2006) can represent sequential structure using the TIME IS MOTION metaphor without making reference to a representation of the self or an observer. Such models can currently map earlier or later events relative to the intrinsic properties of objects in motion (See Section 8). It's plausible to think that models that map times onto abstract, object-referenced motion trajectories make more sense when oriented along the vertical axis because human agents generally don't move along the vertical axis. And as discussed, it's

more intuitive to infer relations in time when organized along a vertical axis when later events are downward of earlier events.

To conclude, Experiment 1 examines the extent to which an abstract target domain is constrained by the properties of its source domain. The results suggest that:

(1) The natural directionality afforded by the force of gravity provides grounding for temporal concepts and influences the way we think about time.

(2) Orientation-specific constraints on our experience of motion influence the way we think about time. Abstract concepts pertaining to agency, force and directionality may "interact" within complex metaphorical mappings. "Embodiment" (in the sense that our motion and perception of motion events are influenced by laws of gravity) is likely to constrain our abstract representations of time. (See Appendix 1 for primes designed to disentangle *force* and *direction* factors)

(3) Different, non-egocentric models for representing time may need to be developed. One way to do this is to reexamine the structure of spatial frames of reference and see if they can be extended formally to temporal concepts. However, before doing so it may be useful to demonstrate unequivocally that temporal relations, structured via spatial terms, can be represented without reference to the self or ego.

Experiment 1B

Experiment 1B: Introduction

To review, when English-speaking adults are asked the ambiguous question, "Monday" and "Friday" answers are observed in approximately equal proportions. The answer to the question about Wednesday's meeting is ambiguous because it depends on how the word *forward* is interpreted in the context of one's mental representation of the timeline. Forward movement can be interpreted either as movement towards earlier (Monday) or later (Friday) times depending on the spatial metaphor or frame of reference one adopts when answering. Typically, explanations for why one observes differences in

responding to the ambiguous question invoke reference to the distinction between MT and ME metaphors.

A number of recent studies (Motz & Núñez, 2004; Núñez & Sweetser, 2006; Núñez, Motz & Teuscher, 2006; Torralbo, Santiago & Lupianez, 2006) suggest that non-egocentric (or non-deictic) temporal models are possible. The current experiment is designed in part to demonstrate that temporal relations can find grounding in relations that cannot easily be argued to be using a representation of the self in order to establish a point of reference in time. When using the old ambiguous question, which uses days of the week, this is always difficult to completely rule out.

Also, recent research has suggested that analogous questions using different temporal scales (e.g. hours instead of days of the week: "*Tomorrow's 12:00 (noon) meeting has been moved forward two hours. At what time will the meeting now take place?)* produces different patterns of results, suggesting "pragmatic constraints [which need] to be considered and…more complex variations of conceptual mappings from space to time" (Motz & Núñez, 2004). The current study tests the efficacy of a new, highly abstract, ambiguous question.

The new question is designed to minimize the influence of idiosyncratic spatial schemas (associated with lexical items used to elaborate particular temporal concepts) on the structure of participant's mental representations of time. For example, in Western cultures, days of the week are generally represented sequentially along a horizontal axis from left to right, whereas seconds, minutes and hours are often organized "clockwise." The new question reported here tightly controls for the spatial location of events and is "purely temporal" in the sense that temporal changes in the stimulus situation all occur at precisely the same place.

Experiment 1B: Methods and Procedure

Subjects. A total of 24 undergraduate students enrolled in Introductory to Psychology classes participated for course credit.

Procedure. Participants were seated in front of a computer monitor and asked to watch a simple animation. They were told that after viewing, they would be asked several basic questions about the animation. They were permitted to watch until they got bored.

The animation started with the presentation of a red circle in the middle of a white screen. The circle remained on the screen for 2.4 seconds and then disappeared for an interval of 2.4 seconds, after which, a yellow circle appeared in precisely the same screen location. (See Fig. 6.5.) In all, there were 5 circles of different colors (red-yellow-green-blue-purple) all presented in the same location for the same duration separated by the same temporal interval (i.e. the different colored circles regularly blinked "on" and "off" in the given sequence). This 24-second sequence was looped. Importantly, there was a black “X” contained within the green circle for each iteration of the sequence (Figure 6.5).

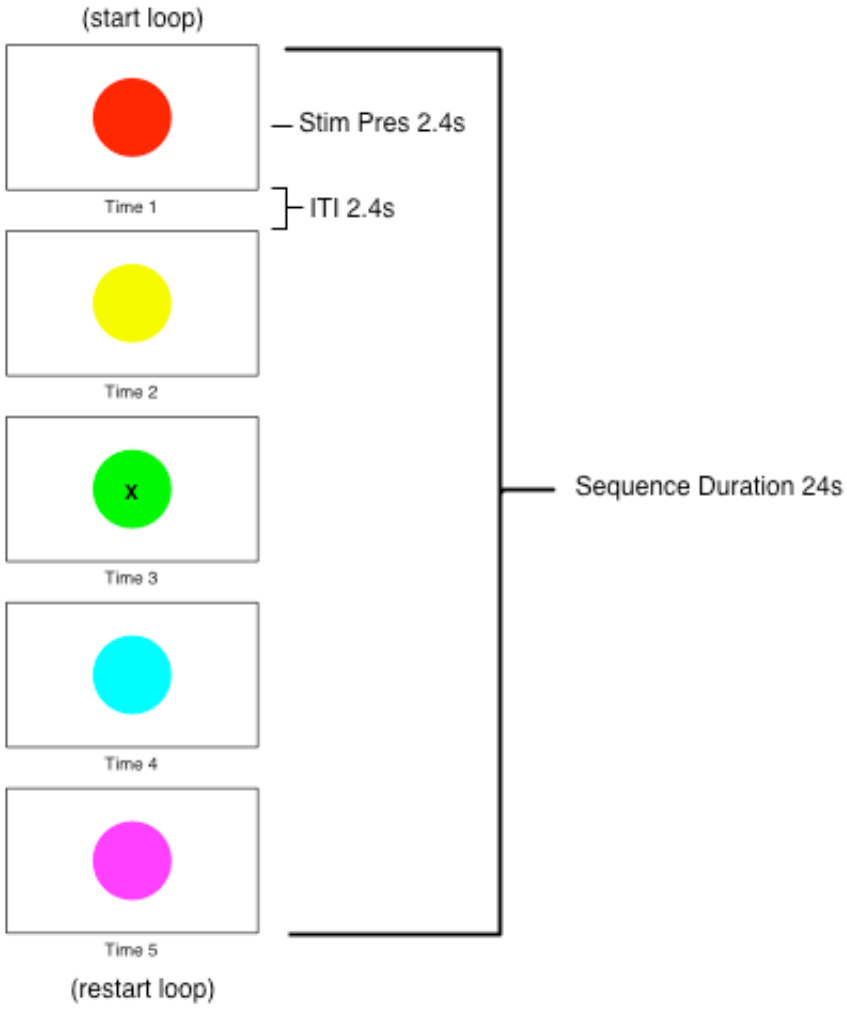


Figure 6.5. Stimulus structure for Experiment 1B.

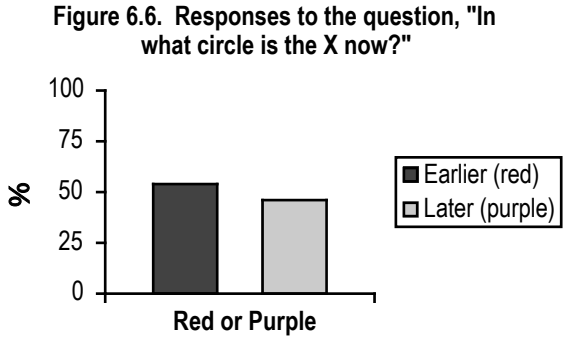
When participants were finished viewing[16], they were asked several simple questions about the concrete properties of the sequence (e.g. "In what color circle does the X appear?") after which they were asked the first of 2 target questions, *"Imagine that I played the sequence again but with the appearance of the X moved forward two circles. In what circle is the X now?"* Participants were then asked a second target question, the ambiguous question about Wednesday's meeting. Note that the structure of the first target question is analogous to the second target question about Wednesday's meeting. Thus, assuming concordance in spatiotemporal mental representations, if one "moves the X" to

[16] On average, participants watched approximately 2.5 cycles of the color dot sequence before "getting it."

the red circle we might predict that "Wednesday's meeting" would be moved in a consistent manner to the earlier time, Monday. Conversely, if one moves the X to the purple circle, 2 circles later in the sequence, we would expect a Friday response to the second target question.

Experiment 1B: Results

Participants uniformly gave either “red” or “purple” as their answers to the first target question. “Red” answers indicate that forward motion was interpreted to mean in the direction of earlier events while “purple” answers suggest the opposite, or motion in the direction of later events. As predicted, about half of all participants answered red (14 out of 24; 54.2%) and half answered purple (10 out of 24; 45.8%); there was no significant difference between responses (Fig. 6.5).

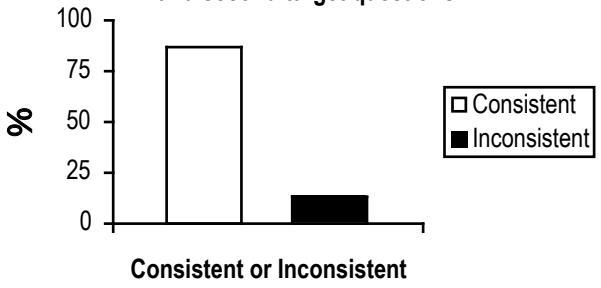


The results also indicate a very high level of consistency between participants’ answers to the first target question about the circles and the second target question about Wednesday's meeting; 87% answered consistently (red-and-Monday *or* purple-and-Friday) while only 13% answered inconsistently (red-and-Friday *or* purple-and-Monday) (Fig. 6.6). Of the 14 participants who answered red (moved the

X to an earlier dot) 11 answered the ambiguous question about Wednesday's meeting consistently (Monday) and 3 answered inconsistently (Friday). The pattern of responding was significantly different than chance, $\chi^2(1, N=14) = 4.571$, $p = 0.033$. All of the 10 subjects who answered purple (moved the X to a later dot) answered the follow-up ambiguous question consistently (Friday); no subjects answering purple also answered Monday. Because none of these subjects answered inconsistently, a Chi-square cannot be used to indicate different than chance levels of responding.

The results confirm that this new ambiguous temporal question is indeed ambiguous and suggest

Figure 6.7 Consistency of responses to first and second target questions.



that it is so in a way consistent with the original question on which it is based. As compared with past studies, which used questions requiring participants to mentally represent spatiotemporally loaded lexical items like days or hours, the present study concerns temporal relations for which there is no obvious or conventional spatial structure to aid in representation. Importantly, the results also confirm that sequential temporal relations can be represented spatially without reference to an ego and suggest that answers to the original ambiguous question about Wednesday's meeting can be derived from such representations.

7. Extending Spatial Frames of Reference to Temporal Concepts

Space is often divided into three frames of reference (see Levelt, 1996; Levinson, 1996; 2003; Tversky, 1996). Recall that *frame of reference* refers to the "distinctions between underlying coordinate systems" (Levinson, 2003 p. 24) people use when thinking and talking about space and that, generally, such models represent ways that scholars in assorted fields have tried to disambiguate and refine issues raised by the various disciplines in cognitive science where perspective and figure/ground relations is a problem. These models divide frame types by the main reference point used to establish spatial relations: (a) of inherent object features or *intrinsic* relations; (b) according to viewer or ego-centered *deictic* frames; or (c) in respect to environmental or *extrinsic* reference axes.

By now it should clear that time is often understood in terms of space. According to Lakoff and Johnson (1999) and Gentner (1983) our entire system of conceptualization is built upon a limited number of *source domains* that emerge directly from experience. These representations come to be mapped structurally onto more abstract domains that lack direct perceptual support, like time, called *target domains*. Put simply, abstract domains like time are understood metaphorically in terms of experientially concrete source domains, like space. Metaphorical mappings preserve the image-schema structure of the source domain, where in the case of time, the source domain consists of cognitive representations of basic spatial relations that emerge through the subject's experience navigating through, observing motion in, and orienting oneself within, space. Thus the extension of spatial frame of reference models to temporal concepts might illuminate similarities in the structure of spatial and temporal cognition.

Spatial Frames of Reference[17]

Intrinsic

The intrinsic frame of reference is an "object-centered" coordinate system where directional valences are based on the inherent formal properties or features of the object that is being used to ground a scene. In English, "sidedness" is often a saliency issue generally determined by an object's function and the manner in which one acts upon it. So, the front of a chair is the side aligned with our own front when in use (Fig. 7.1a). The front of a television is the side we watch. And the front of a car is the end facing the direction of its motion trajectory. If an object has no inherent front or back that can be determined by physical features, motion alone can provide a front and back. In the case of a cube sliding down a hill for example, the front of the cube is regularly assumed to be the side facing downhill.

Deictic

For the purposes of the present discussion the deictic frame of reference can be understood as ego-centered or grounded in a particular "viewpoint." Deictic coordinate systems tend to be based on the reference planes derived from bodily axes. The human body can be divided along three major planes. These divisions provide the anchor for

[17] Although terminology is a topic of some dispute in this area of research, for the present paper I have to chosen to evade excessive hand wringing on the matter. For example, "deictic" is being used although I could have chosen the term "egocentric" to define the sort of "viewer-centered" perspective described in this paper. Yet Levinson's (2003) term "relative" would have been inappropriate because his relative frame represents in some sense an attempt to reconcile ambiguities arising in 3-D space that are probably irrelevant in 1-D time. I have decided to use the term "extrinsic" because I interpret it to be a sufficiently general abstraction of the similarly conceived "allocentric" or "environment" centered frames that focus on the "ground" to establish reference. Another term that could have been used, "absolute," I thought carried too much philosophical baggage in the context of time.

left/right, top/bottom and front/back coordinates. As compared to the axis that gives left/right coordinates, front/back and top/bottom axes are asymmetrical (and hence will be more amenable to extension to temporal concepts). Deictic frames of reference determine an object's location relative to these axes and frequently an individual's direction of gaze (in canonical examples) (Fig. 7.1b).

Extrinsic

Extrinsic frames of reference anchor coordinates to fixed bearings like cardinal directions (e.g. north/south/east/west) and environmental gradients (e.g. uphill/downhill, wind direction, gravity). Extrinsic frames are fixed, and therefore independent in respect to the intrinsic properties of objects or the perspective of the viewer or ego. Thus, in Figure 7.1c the ball is south of the chair regardless of the position of the observer or the inherent orientation of the chair. Extrinsic coordinates are not necessarily environmentally based. They can also be culturally determined (e.g. reading direction).

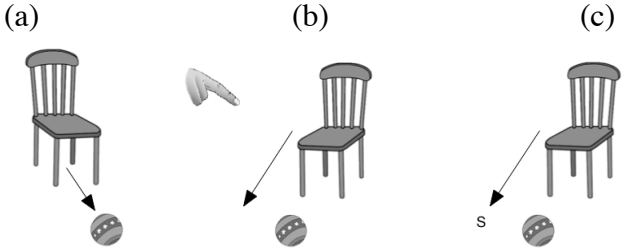


Figure 7.1a-c. Spatial Frames of Reference. (a) Intrinsic: "The ball is in front of the chair." (b) Deictic: "The ball is to the right of the chair." (c) Extrinsic: "The ball is south of the chair"

Integrating Spatial and Temporal Models

Although never fully integrated into a coherent model, notions relevant to distinct intrinsic, deictic and extrinsic frames of reference have been discussed to some extent in

research investigating the structure of temporal concepts. Thus far, no systematic attempt to extend a tripartite spatial frame of reference model to time has adequately described the common features of spatial frameworks and temporal concepts. Although Bender, Bernardo and Beller (2005) set out to extend a tripartite spatial frame of reference to temporal concepts, the authors failed to make the critical distinction between past/future and earlier/later relations. In the parlance of philosophy, this is the basic distinction between "A properties" of time which are in constant flux relative to our experience of change and "B properties" which represent static sequences. For example, my 50th birthday may currently reside in the future relative to my place in the present, but that status will eventually change as I grow older, until this particular day comes to occupy my past on February 18, 2022. In contrast, it is understood that the storming of the Bastille (1789) occurred earlier than the Tsar's abdication (1917) and that the temporal relation between these events is fixed. This fundamental bipartite division of the time concept would seem the basic starting point for any model hoping to extend spatial perspective to time. Indeed, recent work in cognitive linguistics and conceptual metaphor theory suggests that the distinction between lexical concepts like past/future and early/later is more than "language deep" and grounded in more basic cognitive processes that derive structure from simple schemas which reflect this perspective-based division.

In the following sections I will review how this two-part division emerges from current research on temporal metaphor. I'll demonstrate how deictic and intrinsic frames can be mapped onto several preexisting temporal models emerging from this research. Then, in order to argue for the possibility of extending a tripartite spatial frame of

reference model to time, I will introduce the idea of an extrinsic temporal concept and discuss new empirical evidence suggesting the "psychological reality" of an extrinsic temporal frame of reference.

Temporal Framework Models

Deictic

Researchers investigating temporal metaphors in English have traditionally focused on two distinct ego-centered metaphors, both of which can without difficulty be classified as deictic in terms of frame of reference (Clark, 1973; Gentner, 2001; Lakoff & Johnson, 1999). To review, these two distinct schemas, the Moving-Time (MT) and Moving-Ego (ME) metaphors, both map future events in front of the observer, the present moment (or "now") as co-locational with the observer, and past events behind the observer.

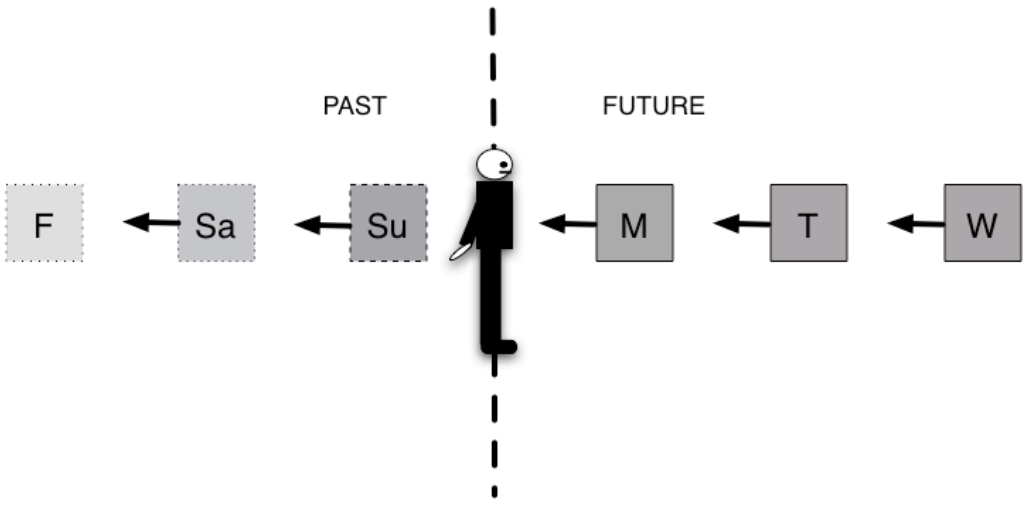


Figure 7.2. Deictic Temporal Framework: The Moving-Time model. Note that although the ego is used to define past/future relations, forward motion is in the direction of earlier times. Times are represented as objects in space.

In regard to spatial structure, MT and ME metaphors are figure-ground reversals of one another. With MT metaphors, the ego is stationary as future events approach from in front; in ME metaphors the ego moves forward in the direction of stationary events "located" in the future. As the ego and event come to occupy the same space, the event is conceptualized as present. When the event occupies the space behind the ego, it is in the past (Figs. 7.2 and 7.3). The difference between these mappings is apparent in sentences using spatial language for time like, "The deadline is almost here" (MT) and "We are approaching our first wedding anniversary" (ME).

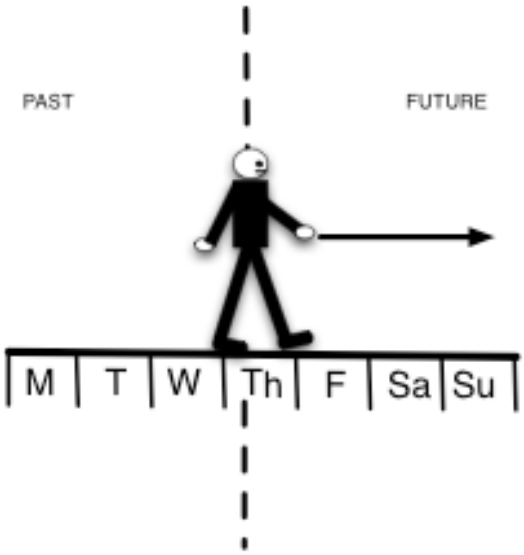


Figure 7.3. Deictic Temporal Framework: The Moving-Ego model. Note that although the ego is used to define past/future relations, forward motion is in the direction of later times. Times are represented as locations in space.

As part of a broad program of research, Boroditsky and her colleagues (Boroditsky, 2000; Boroditsky & Ramscar, 2002; Gentner, Imai & Boroditsky 2002)

have set out to demonstrate the psychological reality of such structural metaphors. The basic finding of these studies— that actual or imagined motion through space can influence the way people think about events in time—reveals interesting relations between spatial and temporal concepts. Recall the question, "Next Wednesday's meeting has been moved forward 2 days. What day is the meeting now that it has been rescheduled?" The question is ambiguous because it can be answered either Monday or Friday depending on the temporal metaphor one uses. If a person adopts a MT metaphor, where the ego is stationary as events in the future move towards the observer, forward motion moves the meeting to an earlier time along the motion trajectory of sequenced events, in a direction towards the position of the stationary observer (leading to a Monday response). On the other hand, if one takes the perspective of a ME metaphor, forward motion is directed away from the ego, moving the meeting to a later time (leading to a Friday response). When asked the ambiguous question with no experimental manipulation Boroditsky (2000) reports that people will answer Monday or Friday with approximately equal proportions.[18] However, if participants are primed to imagine or experience motion through space in a manner concordant with the spatial structure of either the MT or ME metaphors (e.g. pulling a chair towards oneself while standing stationary vs. riding in an office chair along a straight path) then answers to the ambiguous question tend to match the primed perspective. What this suggests is that our experience of space actually influences the way we think about time. Boroditsky's studies suggest that a deictic coordinate system, based on the reference planes derived from bodily axes, can serve to structure temporal concepts.

[18] When asked the ambiguous question without priming, using the materials for the current study's Experiments 2a-c, 46.2% of participants answered Monday and 53.8% Friday ($N = 26$).

Intrinsic

However, are the Moving-Time and Moving-Ego metaphors necessary for conceptualizing temporal relations in spatial terms? If one considers sentences like, "Wednesday follows Tuesday and Monday precedes Tuesday" it would seem not. Such expressions do not require a deictic center to establish a point of reference but rather derive sequential relations from intrinsic features. The asymmetrical, unidirectional nature of causal relations makes representing discrete events in terms of a beginning (a front) and an end (a back) quite ordinary. In spatial metaphors that structure time in terms of objects moving through space, the intrinsic fronts of events (objects in space) are defined relative to their direction of motion. Events in front of other events are earlier times and events in back of other events are later times (Fig. 7.4). Note that an intrinsic temporal model only maps earlier/later relations and is distinct from deictic models that can specify past, present and future temporal relations with respect to an ego.

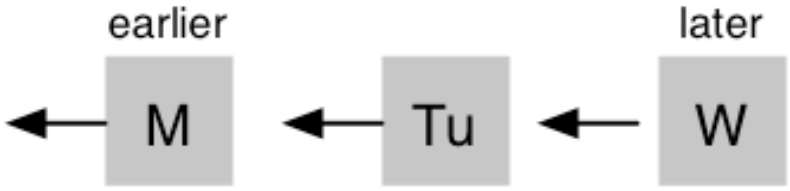


Figure 7.4. Intrinsic Temporal Framework. Note that forward motion is in the direction of earlier times.

In two recent papers, Núñez and his colleagues (Núñez & Sweetser, 2006; Núñez, Motz & Teuscher, 2006) lucidly make a similar distinction between intrinsic and deictic temporal models, choosing to label them, *Time-Reference-Point* metaphors (*Time-RP*)

and *Ego-Reference-Point* metaphors (*Ego-RP*) respectively. The major difference between the two metaphors they describe is that in Time-RP metaphors "there is no compulsory specification of 'Now' " (Núñez et al., 2006).

In priming studies using an animated sequence of cubes moving across a screen horizontally (counterbalanced for direction) Núñez and his colleagues find that spatial priming, without any reference to the ego, influenced participant's answers to the ambiguous temporal question about Wednesday's meeting. That is, after priming with moving sequences of cubes designed to highlight the intrinsic structure of non-ego referenced sequential temporal relations, participants more often moved Wednesday's meeting to Monday, an earlier time. The result is consistent with the structure of the intrinsic temporal model (see Fig. 7.4) where forward motion is in the direction of earlier times. The authors conclude:

> The results of our experiments suggest that when people give a "Monday" answer to the "Next Wednesday's meeting …" question, they are not drawing the essential inferential organization from "an entity moving toward *me*," as it is usually suggested, but from the intrinsic front/back relationship of the spatial sequence itself (i.e., anteriority/posteriority). The Time-RP metaphor, in which "moving forward" is "moving earlier," thus provides a more precise and parsimonious account of "Monday" answers than the one found in the literature (Núñez et al., 2006).

Extrinsic

Newton (2005) in the *Principia Mathematica*, writes "Time, of itself, and from its own nature, flows equably without relation to anything external" (p. 5). Perhaps, in the context of modern physics, this conceptualization of time seems rather old-fashioned. However, the notion that time itself is a backdrop, or something understood to move

forward, independent of particular events embedded within it, is a very common one.[19] The extrinsic frame of reference is invoked with expressions like "across time, the effect of variable X is minimal" or "time flows on forever" where both examples involve motion yet neither requires a deictic reference point. An extrinsic temporal frame of reference can be distinguished from intrinsic temporal frames as well.

Consider a single car moving from one end (A) of a one-way street to the other end (B). When the car is at location (A) it is at an earlier time relative to its time at location (B). Location (B) can be said to be in front of location (A) relative to the path of motion taken by the car. The car brings attention to its abstracted trajectory, but the path itself, or the ground—which in an extrinsic temporal frame serves to establish relations between earlier and later events—*is* the reference object.[20] According to this schema, time really *is* motion, where forward motion is in the direction of later times (Fig. 7.5). Note that this relation between forward motion and locations later in time is opposite to that in intrinsic temporal frames where forward motion is correlated with earlier times.

Like the Moving-Ego metaphor, times represented in an extrinsic frame are represented as locations in space. However, the presence of a reference object that can take the position of discrete locations along a path is not a necessary feature of an extrinsic temporal framework. As long as a path of motion is defined relative to some stable ground, extrinsic temporal models can have meaningful structure (Fig. 7.6).

[19] Evans (2003) calls this aspect of the time concept the "matrix sense."
[20] A *time path* if you will.

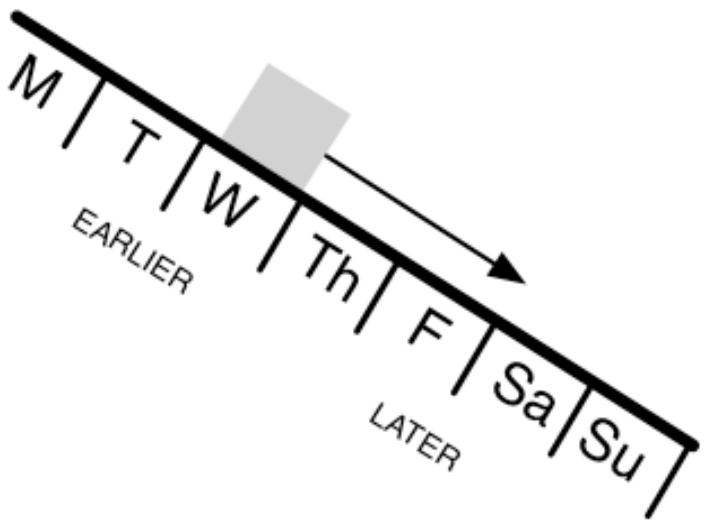


Figure 7.5. Extrinsic Temporal Framework. Note that forward motion is in the direction of later times.

Importantly, there is already some empirical evidence suggesting that temporal 'cardinal directions' like reading direction can serve to provide extrinsic temporal structure to a spatial array. However this evidence has not been discussed in the context of distinguishing distinct temporal models from one another (Chan & Bergen, 2005; Dehaene, Bossimi, & Giraux, 1993; Tversky, Kugelmass & Winter, 1991).

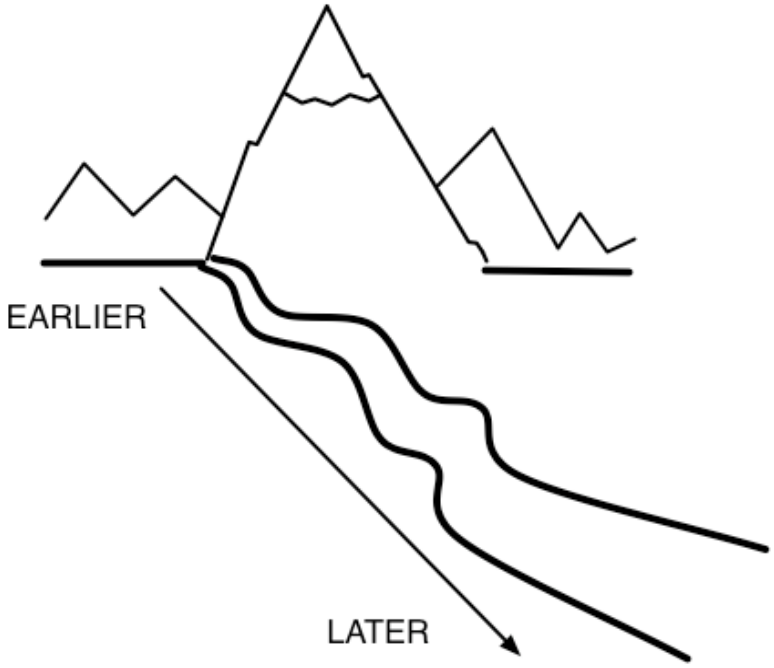


Figure 7.6. Extrinsic Temporal Framework. Note that forward motion is in the direction of later times.

Priming Studies

In order to examine the extent to which extrinsically framed models influence temporal thought, three priming experiments were conducted.

Experiment 2A

In Experiment 2A, 26 participants viewed a color animation that showed a blue square moving horizontally (in either direction) over a rectangular bar spanning the display screen. The rectangular bar depicted the gray scale (Fig. 7.7). The animation was looped and participants were permitted to watch until they got bored. Afterwards, they were asked several questions including (1) "What color was the square?" and (2) "Which side of the floor did the square get to first: the dark side or the light side?" This

was followed by the target question, "Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?"[21]

There was no reference to an ego in Experiment 2A. If participants are using an extrinsic frame to answer the question about Wednesday's meeting, then the meeting should be moved to Friday, a later time. This was indeed the result. 75% of participants answered Friday (later) and only 25% answered Monday (earlier), $\chi^2(1, N=16) = 4.00$, $p = 0.046$. There was no effect for direction.

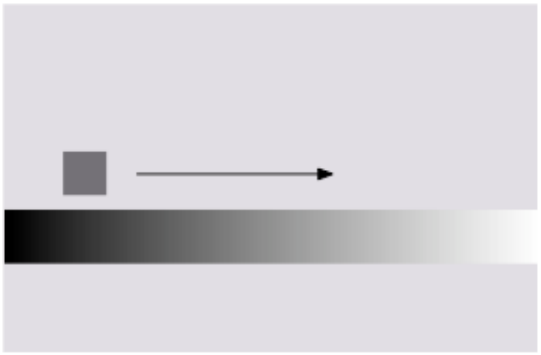


Figure 7.7. One box extrinsic prime. (The arrow was not present during the experiment.)

Experiment 2B

For Experiment 2B a paper and pencil test was used. 28 participants received a 2-page survey. On the first page was a scene depicting a mountain range and river. Adopting the general method of Boroditsky & Ramscar (2002) participants were directed to follow the instructions written on the first page and then complete the question on the

[21] This "ambiguous question" (rather than the novel one discussed in Experiment 1B) was used primarily because it has been used in all past research in this specific area, and comparing results across methods might have created problems. Also, the results of Experiment 1B also served to validate the question about Wednesday's meeting, which, as it happens, is easier to administer.

second page (Fig. 7.8). The second page contained the ambiguous question about Wednesday's meeting.

In what direction would the water flow in the picture?_____
Imagine how the water would flow.
Draw a straight arrow indicating the general path of motion.

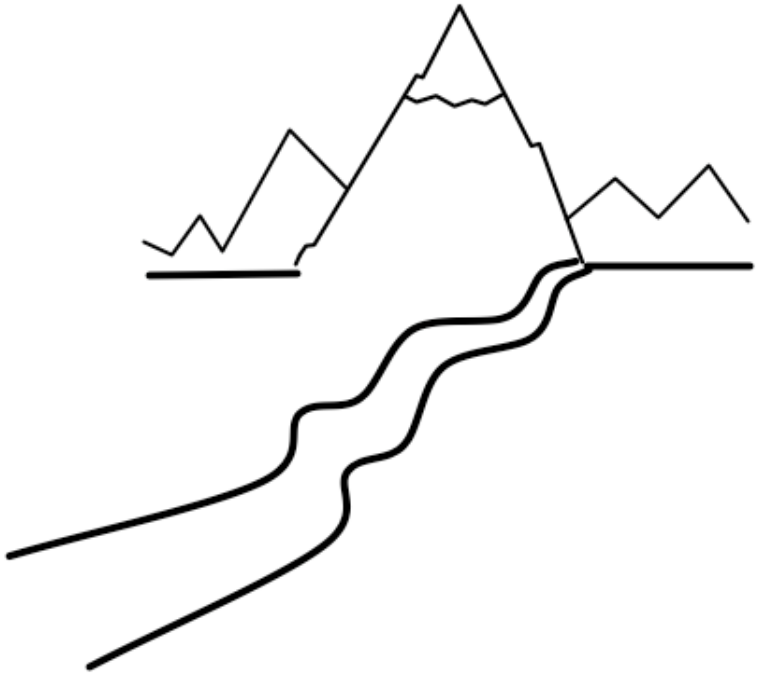


Figure 7.8. Mountain extrinsic prime with instructions.

As with Experiment 2A, there is no reference to the ego in Experiment 2B. However, this study has the added benefit of controlling for deictic explanations. Since almost all participants imagined the water moving "down" (96.4%) towards the bottom of the paper, if participants were adopting a deictic frame in order to answer the target question, the Moving-Time metaphor would be the most coherent model to adopt. *Thus we could predict alternative results for deictic and extrinsic frames.* A Moving-Time model maps earlier times onto objects in space as they move closer to the ego. If participants are using a deictic frame to answer the ambiguous question about

Wednesday's meeting, they should provide more answers of Monday. Extrinsic models map locations further along an abstracted path as later times. If adopting an extrinsic frame, Friday answers should be more abundant.

Again the results were as predicted. Participants used an extrinsic frame of reference. 71% of participants answered Friday (later) and 29% answered Monday (earlier), $\chi^2(1, N=28) = 5.14, p = 0.02$.

Experiment 2C

Experiment 2C uses a spatial prime intended to elicit an intrinsic temporal frame in responses to the ambiguous question (i.e. more "Monday" responses). It is very similar in design to studies discussed above (Núñez et al., 2006). A total of 36 participants were permitted to watch a looped color animation depicting a simple motion scene until they became bored. In Experiment 2C, five differently colored squares moved across a computer screen in either direction. The green square in the middle had a black "X" (Fig. 7.9).

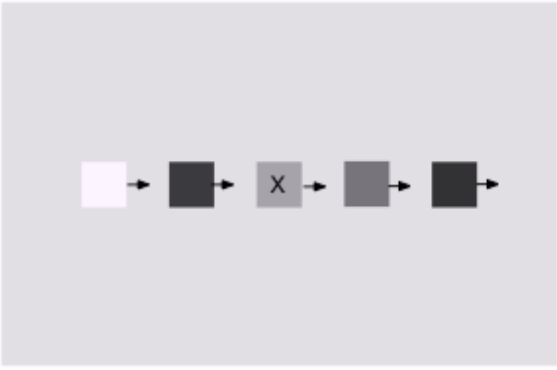


Figure 7.9. Five box intrinsic prime. (The arrows were not present during the experiment.)

After priming, participants answered several simple questions including, (1) "What color square was the X in?" and (2) "What color square was in the front? What color square was in the back?" These questions were followed by the target question about Wednesday's meeting.

As predicted, more participants adopted an intrinsic temporal frame after intrinsic spatial priming. 61% of participants answered Monday and 39% answered Friday $\chi^2(1, N=36) = 1.778$, $p = 0.182$. Although the results in Experiment 3 are not statistically significant, the direction of responding is consistent with the theoretical framework presented in this study (Fig. 7.10).

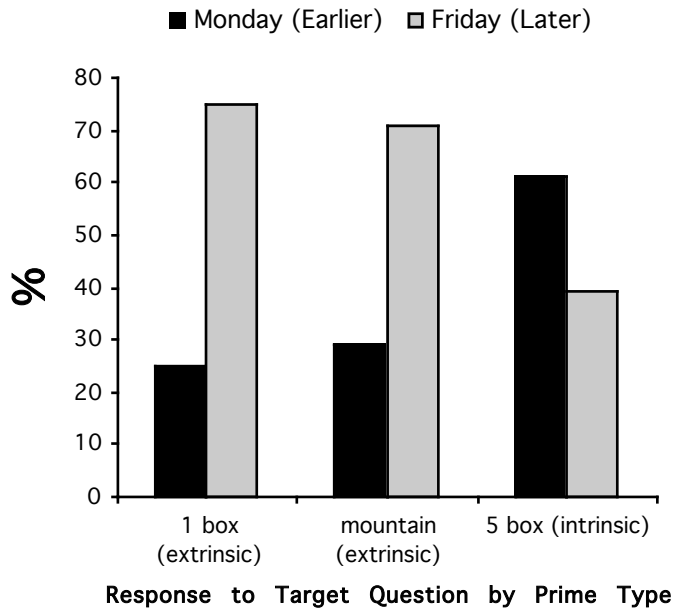


Figure 7.10. Responses to ambiguous target question in Experiments 2A-C.

Experiments 2A, 2B and 2C: Conclusions

Whenever possible, it is best to avoid monocausal explanations. Much as the experiments reported in Núñez et al. (2006) demonstrate that "Monday" answers to the ambiguous question about Wednesday's meeting can arise from at least 2 distinct mental representations, the current study provides evidence that "Friday" answers can also be derived from a non-egocentric temporal model. And because an extrinsic temporal model makes predictions opposite to those for an intrinsic model (regarding forward motion in space and before/after relations in time) the evidence from the experiments reported here suggest a temporal model distinct from what Núñez calls "Time-Reference-Point" metaphors.

The current study also orients the results of several empirical studies within the broader context of the spatial frame of reference literature. If a coherent relation exists between spatial and temporal frames of reference, then empirically testable predictions can be made about the degree to which shared reference frames interact.

For example, if spatial and temporal frames are structurally related, would priming a more general spatial frame of reference engage a corresponding temporal frame of reference? (Would looking in a mirror prime a deictic temporal frame; reading a compass, an extrinsic temporal frame?) It may also be possible to predict the particular sense a temporal concept will take across languages by examining the orientation of the spatial axis used to provide structure. That is, one would expect past/future relations, where ego-reference is an experiential and conceptual requirement for grounding, to be more frequently structured along the asymmetric, deictic front/back axis, where ego-motion along a horizontal plane is canonical. However, across languages, the past/future

concept is less likely to be mapped along an extrinsic vertical axis, where earlier/later relations could more regularly find grounding in a natural environmental slope gradient, like that provided by gravity.[22]

Although past research in this area has clearly demonstrated that structural relations between spatial and temporal conceptualization exist, most of this work has described space—time relations in terms of asymmetrical metaphorical mappings from a concrete source domain (space) to an abstract target domain (time). If spatial and temporal frames of reference are tightly connected, the notion that a strict asymmetry exists between source and target domains, a principle of sorts in conceptual metaphor theory, is in need of further examination. The framework presented here suggests that, in the case of space and time, both domains share something more fundamental in common; namely the constraints imposed by a more dynamically represented spatiotemporal coordinate system.

Lastly, the results suggest that different senses of the time concept as expressed in English are supported by different kinds of embodied representations, grounded in distinct forms of experience, percepts and image schemas. However, if our deictic temporal concepts of *past* and *future* are indeed based on different kinds of embodied representations than intrinsic or extrinsic temporal concepts of *earlier* and *later* (which may perhaps be further parsed into distinct concepts involving representations of *duration, sequence, posteriority* and *anteriority*), the relations between such explicit linguistic concepts and implicit spatiotemporal representations is still unclear. The issues raised here have broader implications, beyond the relations between spatial and temporal

[22] This prediction is also consistent with the results of Experiment 1A.

cognition. Greater understanding in this area can tell us something more general about how words come to be infused with meaning.

8. Embodiment, Awareness and Symbolic Thought

Generally, we are not aware of the structure of our conceptual system. This notion is close to an axiom in conceptual metaphor theory and cognitive linguistics. Lakoff and Johnson (1980) write, "We simply think and act more or less automatically along certain lines. Just what these lines are is by no means obvious" (p. 3). At least since Clark's work (1977), many have hypothesized that these "lines" ground meaning. However, empirical evidence supporting the idea that abstract reasoning and language emerge from implicitly represented patterns of perception, action and image schema content is scarce compared to the corpus data compiled by linguists. As embodied views of cognition become more popular, however, there has been increasing interest in developing new experimental techniques for investigating the cognitive basis for semantic representation using empirical methods (Bergen, 2006).

Experiment 3A: Introduction

All languages code the temporal concepts of past, present and future in terms of spatial locations relative to a deictic reference frame. With very rare exceptions (see Núñez & Sweetser, 2006) languages conceptualize the past as "behind," the future as "in front of," and the present as co-locational with the space around the body. This mapping convention for the temporal concepts of *past* and *future* is assumed to be non-arbitrary, arising from patterns of *embodied* experience.

However, the temporal concepts of *earlier* and *later* are distinct from, although often confused with, the concepts of past and future. Recall that this distinction comes

across in McTaggart's (1908) description of A-properties and B-properties of temporal relations. Whereas A-properties are in constant flux (relative to the point of view of a conscious individual, i.e., a deictic model) B-properties describe static, sequential temporal relations defined relative to particular events (an intrinsic model) or a comprehensive temporal matrix (an extrinsic model). And although the distinct temporal models as described in the preceding chapter are all regarded as grounded in embodied representations (in the sense that they rely on common percept forms and image schema structure),[23] only the deictic models find direct grounding in the experience of inhabiting a asymmetric body with a front and a back.

The constraints imposed by human physiology, perception and action correlate with linguistic construals of time, suggesting that temporal concepts are grounded in representations possessing a psychological reality deeper than spoken language. Embodied views of cognition are important because they offer possible solutions to the long-standing symbol grounding problem. However, little empirical research has explored how implicit embodied representations interact with linguistic concepts accessible to explicit awareness, and how this might give rise to meaning.

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[23] The psychological reality of an Ego-free conceptual metaphor ought not to be interpreted as evidence of a "disembodied" human mechanism for thought. Conceiving embodied experience exclusively in terms of situations centered only on an Ego's body and its associated sensations is, at best, unnecessarily restrictive, and, at worst, untenable. A substantial amount of everyday bodily-grounded experiences, such as visual and acoustic perception of distant objects in the environment, are not captured by that limited conception of embodied experience. For instance, almost all humans share the experience of observing ants prototypically moving in the direction of the frontal part of their bodies. Furthermore, the ants that are ahead in the line of motion arrive earlier to a specified location than those who are behind. Crucially, in these cases, our point of observation of such events is irrelevant. Irrespective of the Ego's point of view, the ants still move in the direction of their fronts, and those who are ahead still arrive earlier than those who are behind. Ascribing the same "orientation" to other non-living moving objects that don't have heads, faces, or noses (such as a group of rocks sliding down the hill) is then a coherent natural extension of the inferential structure of such visual experiences. (p. 13, Núñez et al. 2006)

Experiment 3A: Methods and Procedure

27 Brooklyn College undergraduates participated for course credit. Each participant was tested separately. On the face of it, the study resembled a parapsychology task. Two opaque boxes containing 32 randomly placed picture tiles were situated as illustrated in Figure 8.1. These instructions were read aloud:

> *One at a time, I will read from a list of the tiles used in this experiment. Your task is simply to point at the box (either in front or behind you) where, according to your best guess or intuition, you think a particular tile is located. Try to imagine the thing and make a picture of it in your mind before pointing. OK? Just guess.*

Figure 8.1. Schematic diagram of the absurd situation for Experiment 3A.

Because there is no readily apparent logic to govern responding for naïve participants in the above-described task, let's call it the *Absurd Situation*. Broadly speaking, the experimental question of interest concerns how subjects will come to make sense of this absurd situation.

After receiving the instructions, participants then heard short descriptions of the picture tiles. One item was described per trial (total of 32 item/trials). The descriptions portrayed things representing (1) deictic PAST/FUTURE relations (e.g. "World Trade Center" or "Freedom Tower") or (2) non-deictic EARLIER/LATER relations (e.g. "caterpillar" or "butterfly"). Pairs were presented separately. The experimenter recorded the direction of pointing for each item. Item sequence (the list of tiles) was pseudorandom and counterbalanced. This was done such that item types (PAST/FUTURE or EARLIER/LATER items) were each presented equally as often in each of the 32 list sequence locations and particular items were not regularly presented in proximity to one another. Also, if one item in a pair (e.g. "butterfly") was presented in the first 16 trials (1-16) the second item in the pair (e.g. "caterpillar") was presented in last 16 trials (17-32). This meant that an equal number of a particular item type was presented in each half as well. Lastly, each component of a pair was as likely to appear during the first or last 16 trials of the experiment. So, for example, for half of the participants, "butterfly" (the LATER component) was presented somewhere during trials 1-16 and therefore "caterpillar" (the EARLIER component) was presented during trials 17-32, while for the other half of participants, this order was reversed. (See Appendix 2 for complete list of tiles/test items.)

In line with the structure of the PAST/FUTURE concept, participants were expected to point more often at the box "in front" to indicate the location of FUTURE things and "behind" when asked about the location of PAST things. No initial difference between "in front" and "behind" responses for EARLIER things compared to LATER things was expected however, as non-deictic concepts are not directly grounded in

observer centered reference frames. Whereas PAST/FUTURE concepts are anchored to front/back relations relative to the body, EARLIER/LATER concepts are anchored to intrinsic before/after relations relative to the events themselves or the inferential structure of an extrinsically defined time path. However, the possibility that participants would show some increased performance on EARLIER/LATER items during the second half of the experiment (presentations 17-32) was considered. Perhaps, it was speculated, participants would use the first presentation of the item pair to ground the second presentation. For PAST/FUTURE items a correct response was counted when subjects pointed at the box *in front* for FUTURE items (e.g. "Freedom Tower") and at the box *behind* for PAST items (e.g. "World Trade Center"). For EARLIER/LATER items, a correct response was counted when subjects pointed at the box *in front* for EARLIER (or "before") items (e.g. "caterpillar") and at the box *behind* for LATER (or "after") items (e.g. "butterfly"). Note that the basis for scoring responses to EARLIER/LATER items is somewhat meaningful, as before/after relations are used almost exclusively to describe EARLIER/LATER temporal relations.

After the final item was presented and the last response was recorded, participants were told that the experiment was over and debriefing began. Of most interest was (1) whether or not the participant used a system or strategy for pointing at one box rather than another as a means to group together different kinds of items, and (2) if a strategy was used, at what point in the experiment was this particular strategy adopted? Also, of interest was the general question of how participants interpreted the purpose of the experiment. (That is, did they have any theories concerning the nature of psychological phenomenon the experiment was designed to investigate?) If a participant mentioned the

word “time” or made any general reference to temporal concepts using spatiotemporal terms at any point during the debriefing, this participant was later coded as *AWARE*. If a participant did not make any such reference, this participant was coded as *NAÏVE*.

Experiment 3A: Results and Discussion

(See Fig. 8.2.) Overall, participants made more correct responses for PAST/FUTURE items (mean = 9.81 out of 16; 61.3% correct) compared to their responses for EARLIER/LATER items (mean = 7.74 out of 16; 48.4% correct). A One-way ANOVA comparing item types (PAST/FUTURE X EARLIER/LATER) indicated that participants made significantly more correct responses for PAST/FUTURE items compared to EARLIER/LATER items, $F(1,54) = 8.134$, $p = 0.006$. However, responding appeared to be well above chance only for PAST/FUTURE items presented at the beginning of each session (the first 2 presentations) and at the end of each session (the last two presentations). Chi-square analyses indicated responding was indeed significantly above chance for PAST/FUTURE items in Block One, $\chi^2(1, N=54) = 6.000$, $p = 0.014$, and in Block Eight, $\chi^2(1, N=54) = 6.000$, $p = 0.014$, but for no other blocks.

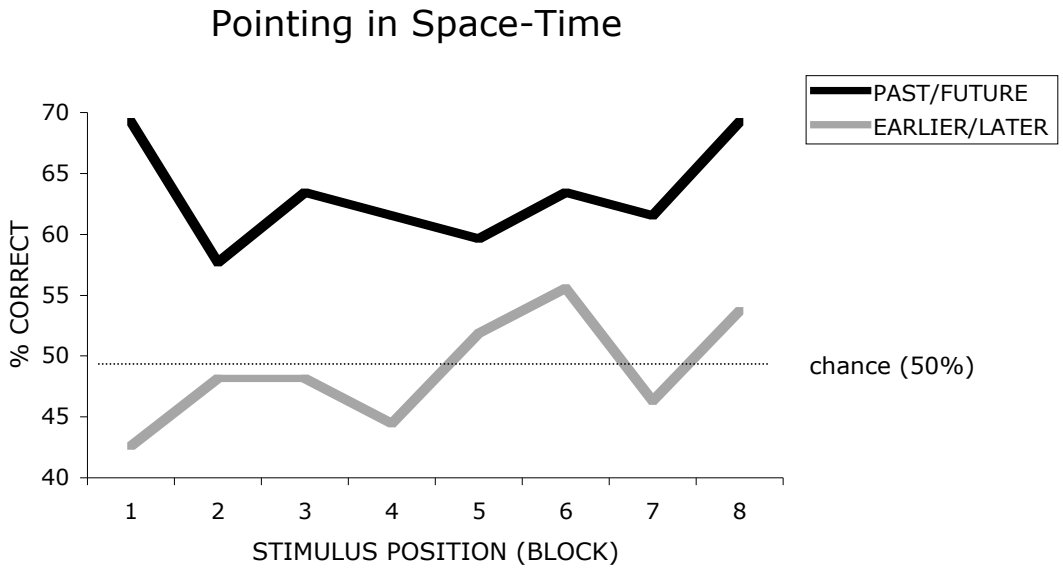


Figure 8.2. Percentage of "correct" responses to PAST/FUTURE and EARLIER/LATER items for all participants in Experiment 3A. Blocks represent 2 trials.

Interviews conducted after testing revealed that 9 participants invoked temporal concepts when justifying their pointing (the "AWARE" group). The other 18 subjects did not report using time (the "NAÏVE" group). (See Fig. 8.3.) Overall, AWARE participants made more correct responses for PAST/FUTURE items (mean = 12.48 out of 16; 78.0% correct) compared to EARLIER/LATER items (mean = 7.36 out of 16; 46.0% correct). NAÏVE participants' responding remained close to chance levels for both item types over the course of the session.

For AWARE participants, responding on PAST/FUTURE items appeared to be well above chance at the beginning of a session (Blocks One-Three) and near the end (Blocks Six-Eight), but much closer to chance levels in the middle (Blocks Four and Five). This was borne out with a Chi-square analysis (see Table 8.1). NAÏVE

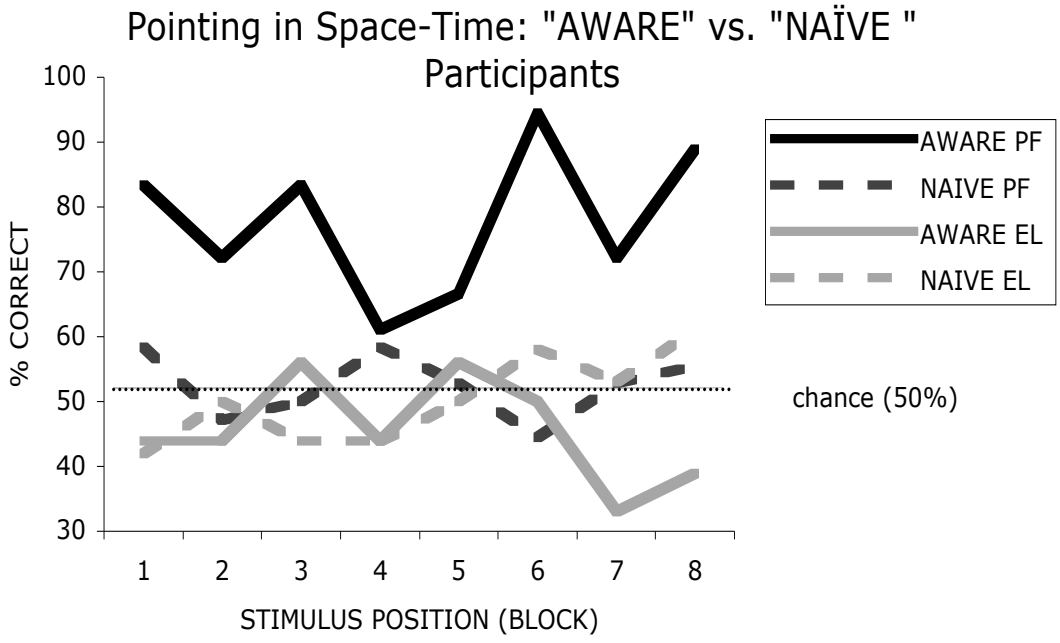


Figure 8.3. Percentage of "correct" responses to PAST/FUTURE (PF) and EARLIER/LATER (EL) items for AWARE vs. NAÏVE participants in Experiment 3A.

$\chi^2(1, N=54)$

Test Statistics

	Block One	Block Two	Block Three	Block Four	Block Five	Block Six	Block Seven	Block Eight
Chi-Square	8.000	3.556	8.000	.889	2.000	14.222	3.556	10.889
Significance	.005*	.059^	.005*	.346	.157	<. 0001*	.059^	.001*

Table 8.1. Test Statistics for AWARE participants' responding on PAST/FUTURE items over Blocks 1-8
*indicates statistical significance for above chance responding
^indicates statistic is marginally significant

During debriefing, AWARE participants also reported that temporal structure was used to guide pointing no earlier than after the first 3 presentations (i.e., after Block One).

Although one can't entirely rely on the accuracy of self-reports in the present experiment, if one keeps the "absurd" nature of the task in mind, and the implication that participants have very little to go on when they first sit down to begin responding, the results suggest that implicit, unconscious processes are guiding behavior for the AWARE participants at the start of testing. That is, according to interviews after testing, and the pattern of results, those ultimately categorized as AWARE participants appear to be performing at a relatively high level at the very beginning of task, when they are still unaware of the nature of the task. As these participants become conscious of the experiment's design, and of the temporal structure that motivates the design, their explicit analysis appears to interfere with the consistency of their responses as demonstrated by the decrease in the accuracy of responding during the middle of the session. However, by the end of the session, consistency returns, presumably as an explicit, analytical strategy is adopted. This relation between implicit and explicit processes, where explicit reasoning appears to interfere with a previously learned implicit task, is a basic finding in the literature on implicit-explicit cognitive interactions (Reber, 1989). Also, a U-shaped curve such as the one suggested by the pattern of results in Experiment 3A is common in development, where a process or ability is first assumed to be under the control of implicit processes, and later comes under conscious control only after a period of decreased ability or performance (Zelazo, 2004).

At this point though, we still can't be certain that the relative spatial orientation of the boxes played a critical role in anchoring the semantic relations among PAST/FUTURE items. Perhaps the observed pattern of responding had less to do with the structurally analogous spatial relations shared between the English time concept and

the experimental situation, but instead, was merely a function of a more conventional "disembodied" semantic network. In order to determine if the relative positions of the boxes was critical in establishing semantic relations among the test items, in Experiment 3B the boxes were moved.

Experiment 3B: Introduction

Do the locations of the boxes play a major role in how AWARE participants behave in the experimental situation? To find out, Experiment 3B replicates the procedure used in Experiment 3A, but changes the locations of the boxes relative to the participant. In Experiment 3B, the boxes are placed both in front and positioned to the left and right of participants (Fig. 8.4). Otherwise, the procedure and test items (the list of tiles) were identical to Experiment 3A.

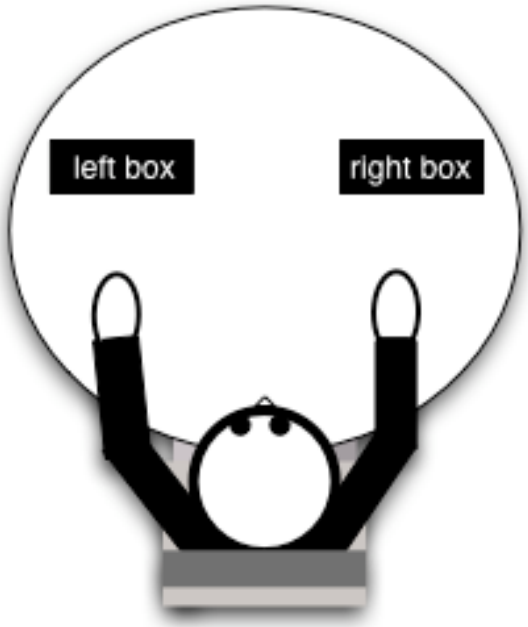


Figure 8.4. Schematic diagram of the absurd situation for Experiment 3B.

Experiment 3B: Methods

24 Brooklyn College undergraduates participated for course credit In Experiment 3B. The boxes were placed on a table in front of participants as depicted in Figure 8.4. The current experiment used the same items as in the previous experiment. The instructions were slightly different as compared to Experiment 3A merely to adjust for the new spatial orientation of the boxes:

> *One at a time, I will read from a list of the tiles used in this experiment. Your task is simply to point at the box (either to your left, with your left hand or to your right, with your right hand) where, according to your best guess or intuition, you think a particular tile is located. Try to imagine the thing and make a picture of it in your mind before pointing. OK? Just guess.*

For PAST/FUTURE items, a correct response was scored if participants pointed at the *left box* for a PAST item and the *right box* for a FUTURE item. For EARLIER/LATER items, a correct response was scored if participants pointed at the *left box* for an EARLIER item and the *right box* for a LATER item. This scheme seemed reasonable, as it is concordant with reading direction in English, comics, calendar structure, etc.

Experiment 3B: Results

As expected, responding for both PAST/FUTURE items and EARLIER/LATER items was not significantly different from chance levels (Fig. 8.5). (For PAST/FUTURE items, mean = 8.29 out of 16; 51.8% correct. For EARLIER/LATER items mean = 8.75 out of 16; 54.7% correct.) As compared to the pattern of results observed in Experiment

3A, the spatial location of the two boxes in Experiment 3B did not suggest a coherent framework for dividing the stimuli along lines demarcated by the structure of temporal concepts.

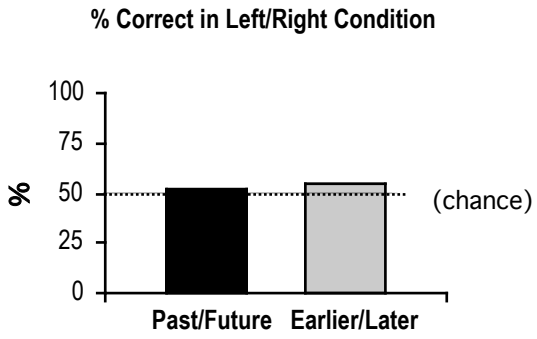


Figure 8.5. Results for Experiment 3B

Interviews conducted after testing suggested that none of the subjects became aware that the experiment concerned temporal structure. That is, in Experiment 3B *no subjects could be classified as AWARE* as no subjects mentioned *time* or any related temporal concept as being important to the experiment or as a factor influencing their own behavior over the course of the session. Despite that the individual items were identical in both Experiments 3A and 3B, when the boxes were placed such that they were not directly analogous with the deictic structure of the past/future concept in English, there was no difference in responding to item types (and therefore no interesting patterns of responding over the course of sessions) and no participants became aware of the intended semantic relations among test items. Thus we can conclude that the specific front/back spatial structure used in the design of Experiment 3A, motivated by both

embodied theories of mental representation and the linguistic structure of the past/future concept in English, was critical for producing the pattern of results observed above.

Experiments 3A and 3B: Discussion

Reber (1989) has argued that under some circumstances, verbalization and the explicit knowledge that results can impede implicit learning and temporarily obstruct access to representations constructed during prior implicit learning. Although Reber made his claims regarding this notion—that verbalization alone could bring about an explicit learning mode—regarding participants' performance on a task not suitable for learning in an explicit way (e.g., an artificial grammar) he also suggested that in real world situations, where people use complex skills, implicit and explicit processes, despite their independence as distinct systems, must necessarily interact in complex ways. Still, to date, very little is known about how distinct implicit and explicit cognitive systems interact (Mathews & Sun, 2006). Certainly, much of the mystery surrounding these issues concerns the inherent difficulty in understanding how two systems, conceived as functionally independent, can also be said to interact in meaningful ways.

Although it is a fundamental idea common to all embodied theories of cognition, perhaps even less in known about how words, symbols and concepts accessible to explicit awareness might be related to, or in indeed grounded in, implicit representations. At least since Searle's (1980) *Chinese Room* argument, questions about the relations between symbol systems, understanding and intentionality have eluded straightforward answers. Searle's thought experiment goes like this:

> Suppose that I'm locked in a room and given a large batch of Chinese writing…to me, Chinese writing is just so many meaningless squiggles. Now suppose further that after this first batch of Chinese writing I am given a second batch of Chinese script together with a set of rules for correlating the second batch with the first batch…They enable me to correlate one set of formal symbols with another set of formal symbols, and all that "formal" means here is that I can identify the symbols entirely by their shapes…Suppose also that after a while I get so good at following the instructions for manipulating the Chinese symbols and the programmers get so good at writing the programs that from the external point of view—that is, from the point of view of somebody outside the room in which I am locked—my answers to the questions are absolutely indistinguishable from those of native Chinese speakers. Nobody just looking at my answers can tell that I don't speak a word of Chinese (Searle, 1980).

The purpose of Searle's thought experiment is to demonstrate that the instantiation of a formal (computer or AI) program is insufficient to produce the kind of semantic understanding one typically associates with intentional language use. But Searle is also making an important point about how language works in relation to consciousness in human brains as well. The Chinese Room makes the following point rather simply and elegantly: i.e., a strictly rule-based system or syntax is simply not enough to explain how explicit awareness comes to accompany the ability to use language, to understand, and think in terms of, semantic reference. If the instantiation of a formal syntax is not enough, how perhaps could semantic understanding emerge from the kinds of implicit cognitive processes common to many organisms?

In Experiment 3A, the appearance of a U-shaped curve[24], in conjunction with the self-reports at least suggests a process of *Representational Redescription* (Karmiloff-Smith, 1992, 1994). Representational Redescription is a framework model that suggests how knowledge initially predicated on implicitly learned representations, comes to be

[24] However, a statistical analysis did not find the quadratic trend to be significant.

accessible to explicit manipulation. It describes a process where relatively concrete implicit representations are transformed (or "redescribed") into more flexible abstract formats. According to Karmiloff-Smith's model, during learning itself, knowledge is progressively rendered more explicit as representations are re-represented and re-re-represented in a reiterative redescription process. This results in a hierarchy of representations with increasing levels of explicit accessibility:

> My claim is that a specifically human way to gain knowledge is for the mind to exploit internally the information that it has already stored, by redescribing its representations or, more precisely, by iteratively re-representing in different representational formats what its internal representations represent. This is what I hypothesize is particular to human cognition (Karmiloff-Smith, 1994, p. 710).

The most common example used to illustrate her model involves learning to play the piano. At first, relatively inflexible motor representations are "put down" procedurally, over the course of much practice. The representations thus formed are inaccessible to consciousness (e.g. rote action sequences, motor actions directed at increasing finger speed, etc.). Gradually, these representations are redescribed into more flexible intermediate formats (e.g. one can stop/restart in the middle of a tune). The last phase allows for maximum flexibility and some degree of verbal report regarding the mental processes involved (e.g. intentional improvisation with awareness). The end result consists of multiple representations, in different formats and with varying degrees of explicit accessibility, for the same task.

Karmiloff-Smith's model is often discussed in the context of cognitive development or domain specific learning. However, this model seems particularly well suited for developing a keener understanding for how abstract concepts (like particular

temporal concepts) could be grounded in embodied representations. The below description of a particular kind of language change seems especially relevant in the context of Experiment 3A's results:

> Finally, there is a form of knowledge change that is far more obviously restricted to the human species: explicit theory change, which involves conscious construction and exploration of analogies, thought experiments and real experiments, typical of older children and adults…But I argue that this more obvious characteristic of human cognition is possible only on the basis of the more subtle prior representational redescription, which turns IMPLICIT information embedded in special-purpose procedures into EXPLICIT knowledge but which is not yet available to conscious verbal report. (Karmiloff-Smith, 1994, p. 710)

Therefore, there is no reason to think that representational redescription cannot occur online.

Lastly, consider Dennett's (1993) discussion on a related subject:

> How could it not be the case that implicit or tacit knowledge becomes explicit by being expressed or rendered in some medium of "explicit" representation? Symbols, unlike the nodes woven into connectionist networks, are "movable"; they can be "manipulated"; they can be composed into larger structures where their contribution to the meaning of the whole can be a definite and generatable function of the structure…of the parts.
>
> Labeling is a non-trivial cognitive tactic, and it is worth a moment's digression to consider the conditions under which it works. Why does anyone ever label anything, and what does it take to label something? Suppose you were searching through thousands of boxes of shoes, looking for a housekey that you had good reason to believe had been hidden in one of them. Unless you are an idiot, or so frantic in your quest that you cannot pause to consider the wisest course, you will devise some handy scheme for cutting down your task by preventing you from looking more than once in each box. One way would be to move the boxes from one stack (the unexamined stack) to another stack (the examined stack). Another way, potentially more energy efficient, is to put a check mark on each box as you examine it, and then adopt the rule never to bother looking in a box with a check mark on it. A check mark is a way of making the world simpler; it

> cuts down on your cognitive load by giving you a simple perceptual task in place of a more difficult--perhaps impossible--task. Notice that if the boxes are all lined up in a single row, and you don't have to worry about unnoticed re-orderings of the queue, you don't need to put check marks--you can just work your way from left to right, using the simple distinguisher nature has already provided you, the left/right distinction… (Dennett, 1993, pp. 543-544).

Perhaps, Dennett has it a bit backwards. Wouldn't it make more sense to *start* with what nature has provided in terms of a bio-ecological spatial pragmatics? And didn't we all start as "idiots" (Dennett's word!) frantically searching for some way to make sense of a world that could not possibly have made any sense during early development? Still as adults, we are often confronted with situations that seem absurd on the surface as we struggle (consciously or unconsciously) to give meaning to what is put in front of us.

Consider this question: In Searle's thought experiment is the task of *problem solving* always an explicit one? On the one hand, the person in the Chinese Room is always aware of his basic task, despite his ignorance of the broader purpose of the system (to transmit semantic content). Thus despite his lack of comprehensive awareness, he intentionally performs his small duty as defined; and importantly he is not guessing. Unlike participants in the Absurd Situation, his task in the room is entirely explicit and constrained.

However, is Searle's Chinese Room really a valid model for how language is acquired, represented and used? (Obviously, Searle would say no.) The Absurd Situation however, unlike the Chinese Room, is a game of sorts where the rules, although not apparent at first, can be learned by those successful players who happen to unconsciously extract their structure from the dynamic relations between words, the body and the environment. This seems a better way of describing where meaning comes from.

Understood as such, the Absurd Situation seems to provide a good model for meaning acquisition and understanding. And because it is a thought experiment realized as an executable experimental methodology that could theoretically be extended to abstract concepts other than time, its potential as a tool for investigating the psychology of meaning construction is great.

9. General Conclusions

The results of the three experiments reported above provide further evidence that particular kinds of mental habits relevant to the way we think about time find structure in the general patterns of action and perception that emerge from our experience as embodied organisms living in space. Of course, living in space necessarily requires living in time. So, whereas past research emphasized the asymmetrical nature of mapping relations from the concrete domain of space to the abstract domain of time, further stressing the role that language plays in structuring relations between spatial and temporal concepts, the model suggested by the current experiments is intentionally less dogmatic regarding directionality of mapping issues and linguistic or Whorfian influences on temporal cognition.

The pilot work presented in Experiments 1A and 1B showed, respectively, that (1) orientation-specific constraints on our experience of motion influence the way we think about time and that (2) humans can represent temporal relations spatially without a deictic reference point. These general conclusions led to the hypothesis that temporal frames of reference may be structured according to the same basic principles suggested by existing spatial frame of reference models. This hypothesis inspired Experiments 2A, 2B and 2C and the resulting tripartite temporal frame of reference model. The extension of well-documented spatial frame of reference models to our understanding of temporal structure has potentially wide ranging implications. However, the particular consequences of this extension are still unclear, especially in the context of conceptual metaphor theory.

One of the axiomatic principles of conceptual metaphor theory concerns the unidirectionality of mapping relations from concrete source domains, like space, to abstract target domains, like time. The logic behind cross-domain mapping relations understood as such, applied to the particular case of space-and-time, implies that our phenomenological contact with space is more direct or primary than is our connection with the temporal domain. It's often argued that this asymmetry is reflected in our language. So just as it's conventional to talk about romantic relationships in terms of journeys because such a mapping can produce an almost endless stream of meaningful expressions (e.g. "We're at: the beginning of a long trip together / the end of the road / the cross roads") it's argued that we also talk about time using spatial language because we have a richer set of concrete experiences to build from in the spatial domain relative to the temporal one. And not only do we often talk about more abstract social relationships in the language of more concrete journeys through space, it's further noted that we rarely talk about journeys in terms of relationships, and even if we did, it would be entirely optional whereas the pervasive use of spatial relations to structure abstract concepts seems to operate at a level below awareness.[25]

Without question space *is* special to cognition. Every language uses spatial terms in order to provide structure for a variety of abstract concepts. However, the results of the experiments reported here indicate that the relation between the domains of space and time is also special. This statement should strike no one as entirely controversial. The current research suggests more than this though. I suggest that both the domains of space and time share something more fundamental in common, namely the constraints imposed

[25] Actually, we do often talk about space in terms of time. For example, if someone asks an explicitly spatial question like, "How far is your place from the subway?" one could quite naturally, and without too much conscious reflection, reply "Five minutes."

by the dynamic relations among embodied cognitive processes and the environment, or a *spatiotemporal coordinate system*. Compared to the kind of argument conventionally put forward by adherents of conceptual metaphor theory, the present position represents a subtle distinction; that the *relation* between space and time, as experienced psychologically, is more basic than either individual domain understood separately, *and* that action and motion defined as inherently spatiotemporal phenomena make this shared structure salient. It is a subtle distinction because describing such relations, and our mental representation of them, as fundamentally spatiotemporal, does not necessarily contradict the core principles of conceptual metaphor theory. However, it does suggest to me that our propensity to talk about time in terms of space is more a product of our species' reliance on visual information in general, and motion information in particular, than it is a function of the spatial domain's "concreteness" or phenomenological primacy, relative to the temporal domain's "abstractness." There has been a general tendency for those conceptual metaphor and structure-mapping theorists who investigate the (so-called) TIME is MOTION metaphor to ignore the very basic fact that motion *is* fundamentally temporal. And while we can certainly experience time (as duration for example) without perceived or imagined motion, the idea of experiencing motion without time is absurd. Of course, these are deeply philosophical questions, raised by what appears to be a high concordance between spatial and temporal coordinate systems.

An interesting question for consideration concerns the extent to which different frames of reference and axis orientations are amenable to distinct temporal concepts. This notion was addressed in Experiment 3. The results of Experiment 3 suggest that the past/future concept lends itself to mappings along a deictically referenced, asymmetrical

front/back axis in a manner that a distinct earlier/later concept does not and hint at why this is the case. The recent work of Núñez and Sweetser (2006) also supports this idea. They found that speakers of Aymara spontaneously produced different kinds of gestures, along different body axes, when describing earlier/later relations and past/future relations. For example, whereas descriptions of past/future relations (during story telling) produced pointing towards the front of or behind the speaker, descriptions of culturally established sequential relations (e.g. days of the week) produced gestures along the left/right axis (all in front of the speaker of course). Future research could address lingering questions concerning a more extensive parsing of the earlier/later concept into distinct senses of sequence and duration. The current model suggests that, if given free range, intrinsic temporal frames of reference would be more suitable for structuring sequential relations whereas extrinsic frames of reference would seem best for supporting representations of absolute duration. However, this is still rather speculative.

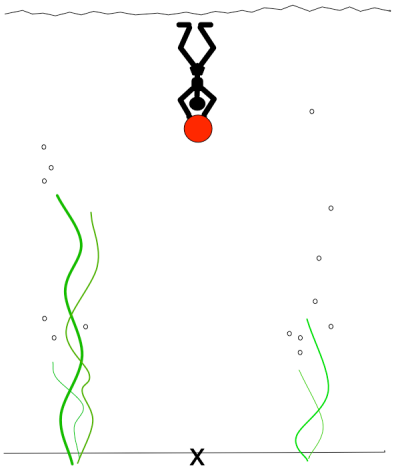
It may very well be the case that the temporal information contained within a complex scene is coded redundantly using multiple representations in ways that reflect the structure of a tripartite temporal model. In the case of spatial information this certainly seems to be the case, and some recent work in this area is beginning to investigate the links between the growing evidence from the field of cognitive neuroscience and the more interdisciplinary, inherently theoretical work (Zacks, 2006; Zacks & Tversky, in press). It would make sense that much like different spatial frames of reference and image-like representations are better suited to particular kinds of cognitive tasks, different temporal frames of reference also support particular kinds of tasks or activities depending on the kinds of temporal relations in need of representation.

So, for example, as reading a map in order to find your way home requires a different set of spatial skills than folding a map so that it fit's in your pocket, distinct temporal tasks also might call for specific kinds of mental representations to aid in reasoning, problem solving and inference making.

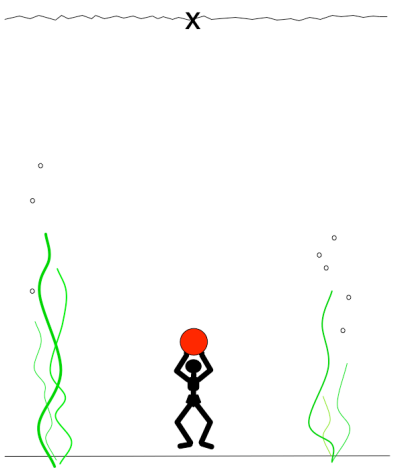
Appendix 1. Hypothetical underwater "force" controls for Experiment 1A.

Moving-Ego Primes

Down-Moving

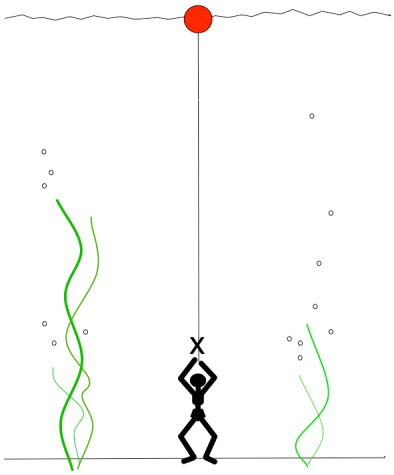


Up-Moving

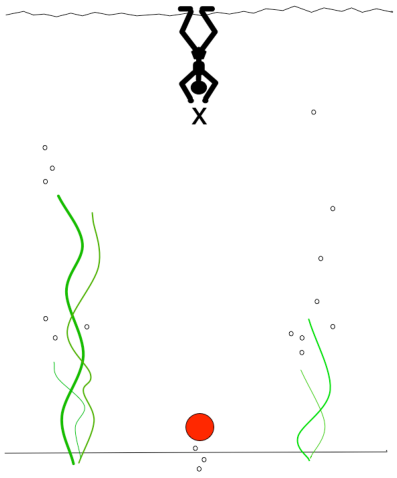


Moving-Time Primes

Down-Moving



Up-Moving

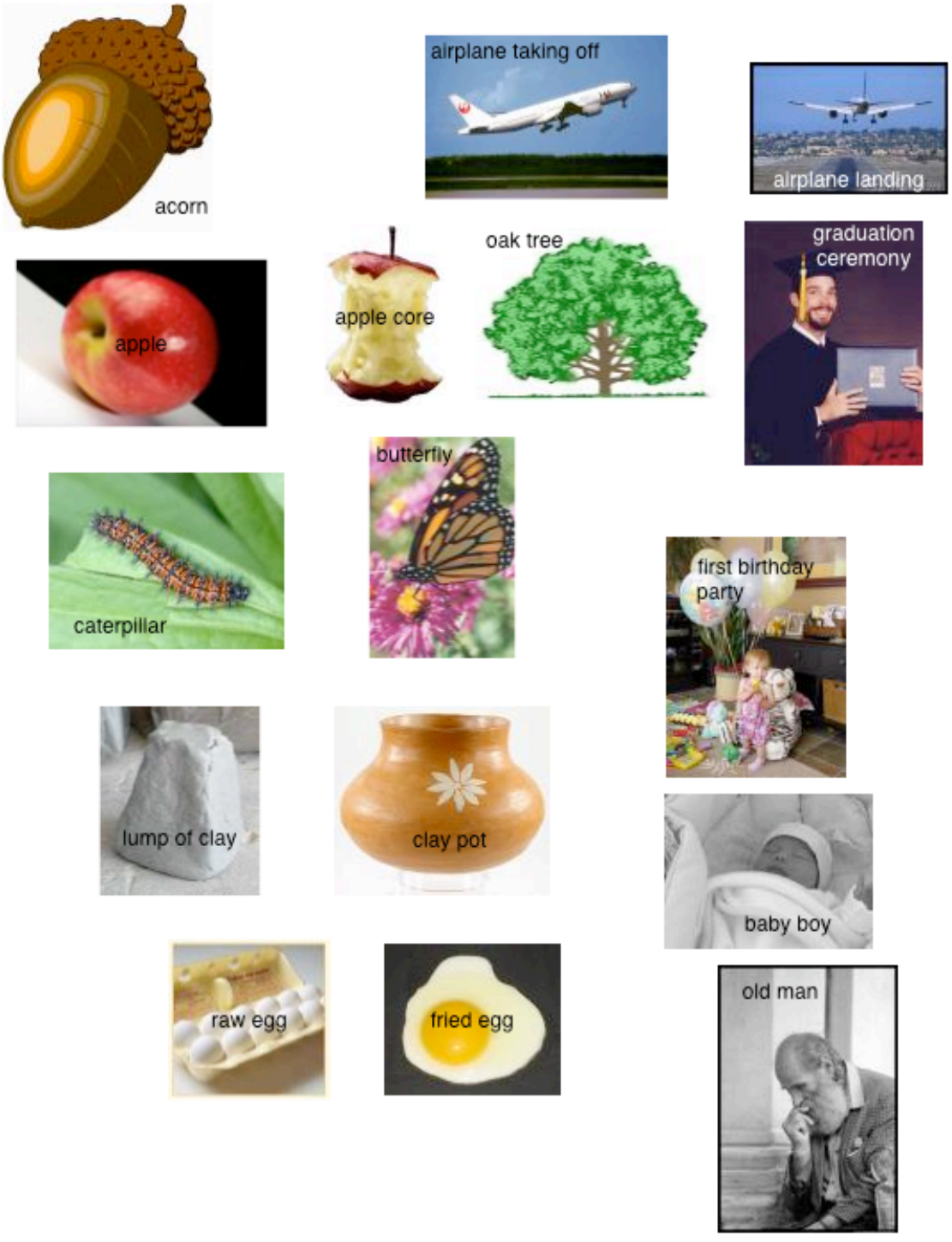


Appendix 2. Stimulus Tiles for Experiments 3A and 3B.

PAST/FUTURE stimuli:

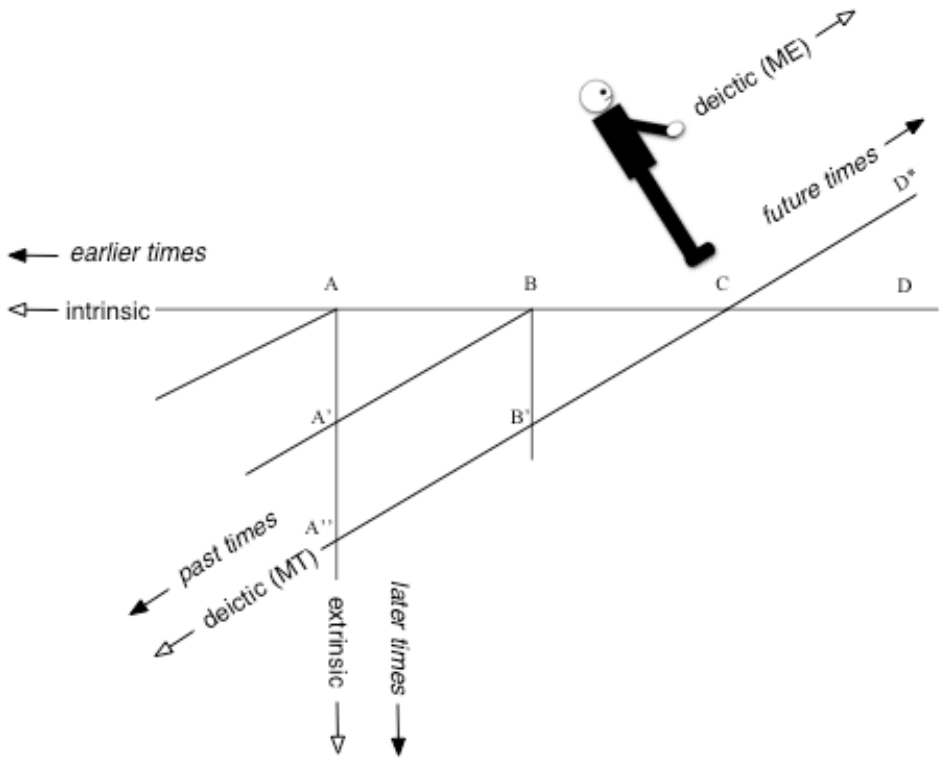
Appendix 2. Stimulus Tiles for Experiments 3A and 3B (continued).

EARLIER/LATER stimuli:



Appendix 3. Adapting Husserl's model to a tripartite temporal frame of reference model.

If we return to Husserl's early temporal frame of reference model, without too much effort we can impose a tripartite model simply with the addition of a deictic reference point. With this, we establish "true" past/future relations onto his model that, despite his original labels, only suggested such mappings (Fig. A3.1). Intrinsic relations (along the top) describe sequential relations between events (e.g. the temporal relation between events A and B); extrinsic relations (moving downward) describe events in respect to themselves and the flow of time itself (the temporal relations between A and A'); and deictic relations (in respect to a changing ego reference point) describe our experience of events relative to independent intrinsic and extrinsic temporal relations (our experience of this general temporal topography described in terms of past/future conceptual relations, autobiographic memory, planning, etc.).



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