

Perspectival and objective representations of space and time

Elisabeth Pacherie
Institut Jean Nicod
CNRS, Paris
pacherie@ehess.fr

Abstract

It is generally agreed that there is a distinction between two kinds of representations of space and time. Perspectival or egocentric representations are viewpoint-dependent in the sense that the way spatial and temporal positions and relations are represented is relative to one's own position in space or time. In contrast, objective representations are independent of one's position in space or time and thus viewpoint-invariant. For instance, I may represent event A as past or as more past than event B (perspectival representations of temporal position and temporal relation, respectively) or I may represent event A as occurring on September 11, 2001 and as earlier than event B (objective representations of temporal location and temporal relation, respectively). And similarly for spatial positions and relations.

One contentious issue, however, is whether perspectival and objective representations are independent or whether representations of one kind are constructed, at least in part, from representations of the other kind. One further issue is whether the analogy between space and time is strong enough that the answer given to the previous question in the case of space, say, should also hold for time, or vice-versa.

The notion of dependence can be understood in several ways and the dependence or independence claims can be given stronger and weaker readings. I try to disentangle these various readings and to sketch their relations. I also offer detailed characterizations of the distinction between egocentric and objective representations, first in the case of space and then in the case of time.

I examine how the different versions of the dependence/independence claims fare with respect to time and to space. I argue that for two of these claims the analogy between space and time breaks down. I propose that the reasons why the analogy is disrupted have to do with certain fundamental differences in the way we egocentrically apprehend temporal and spatial properties.

0. Introduction

I am not concerned here with the question of the nature of space and time as exemplified for instance in the Leibniz-Newton debate over their relational or absolute nature or in the more recent debates surrounding the status of space and time or space-time in contemporary physics. My concern is rather with our ways of thinking about or representing spatial and temporal locations and relations. I am therefore primarily interested in epistemic and semantic rather than metaphysical issues. I will try to remain neutral as to whether and to what extent if any a study of the way the mind apprehends spatial and temporal properties can shed light on the nature of space and time and hence have metaphysical import.

A number of philosophers and psychologists have distinguished between two ways in which we can represent spatial and temporal properties and relations. The distinction has been drawn in a number of ways and has been expressed in different terminologies. It is the distinction between objective (absolute, non-perspectival, detached, disengaged) and egocentric (perspectival, subjective, immersed, engaged indexical) representations. In a nutshell, perspectival or egocentric representations are viewpoint-dependent in the sense that the way spatial and temporal positions and relations are represented is relative to one's own position in space or time. In contrast, objective representations are independent of one's position in space or time and thus viewpoint-invariant. For instance, I may represent event A as past or as more past than event B (egocentric representations of temporal position and temporal relation, respectively) or I may represent event A as occurring on September 11, 2001 and as earlier than event B (objective representations of temporal location and temporal relation, respectively) And similarly for spatial positions and relations. I can represent object¹ A as to the right or to the right of object B or I may represent object A as 48° 51' 21" N and 2° 19' 43" E or as north of B. Both types of representations are obviously present at the linguistic level and presumably it is also the case that we have both egocentric and objective mental representations of space and time. It is doubtful whether it would make sense to draw this distinction at all levels of mental representations. It may be claimed for instance that certain forms of perceptual or motor representations are essentially perspectival or that linguistic and perceptual representations cannot be considered as perspectival in exactly the same sense. Although these are extremely interesting issues, I will not go into them here.

¹ In this paper, I will use 'object' as a general term for spatially located entities, including of course objects *stricto sensu* but also features.

Rather, my main purpose in this paper will be to investigate the relationships between egocentric representations (either linguistic or mental) of space and time and objective representations thereof. Are the two types of representations independent or not? Is there some form of priority of one way of representing over the other and if there is, how is it to be understood? Do objective and perspectival representations of time relate in the same way that objective and egocentric representations of space do? Are there rather fundamental differences in the way we apprehend temporal and spatial properties that disrupt the analogy between temporal and spatial thinking?

In a recent paper Robin Le Poidevin (1999) has tackled these very issues. His main claim is that we have objective representations of time and that these do not depend on perspectival representations to give them content. Since he takes it for granted that objective spatial representations are also independent of egocentric spatial representations, he also claims that in this respect, the analogy between space and time holds. Although I agree with Le Poidevin's main claim, I think he has perhaps not distinguished clearly enough between various versions of the question regarding the possible dependence of objective representations on perspectival representations. The notion of dependence can be understood in several ways and the dependence or independence claims can be given stronger and weaker readings. In the first section, I shall try to disentangle these various readings and to sketch their relations. The following two sections will provide fuller characterizations of the distinction between egocentric and objective representations, first in the case of space (section 2) and then in the case of time (section 3). In section 4, I will then examine how the different versions of the dependence/independence claims fare with respect to time and to space. I'll argue that for some of these claims the analogy between space and time breaks down. My purpose will be to try to pin down the reasons why it does.

1. Varieties of Dependence and Independence Claims

The idea of dependence for representations is the idea that representations of one type are constructed from representations of another type. Dependence can be understood in several ways, depending on its modal force, on its quantificational force, and on whether it is complete or merely partial. Let me here offer some clarifications. First, when I speak of modal force, I mean something weaker than the purely logical notions of necessity or possibility. Rather, what I have in mind may be termed cognitive necessity or possibility. Thus, for instance, the idea that a representation of type X is necessarily a construction from

representations of type Y may be rephrased as the idea that given our cognitive make-up, the only way we can form a representation of type X is by constructing it from representations of type Y. Second, dependence may hold for all tokens of representations of type X or only for some. This is one aspect of quantificational force. Third, one may also have either existential or universal quantification on representations of type Y. I call the dependence partial when a representation of type X is constructed at least in part from representations of type Y; I call it complete, when it is constructed from representations of type Y alone. In what follows, I will concentrate more specifically on two readings of the dependence claim:

(SD) Strong dependence: All representations of type X are, necessarily, constructions from representations of type Y alone.

(WD) Weak dependence: Some representations of type X are, necessarily, constructed at least in part from representations of type Y.

(SD) and (WD) differ in two respects. Their quantificational force is different, with (SD) applying to all tokens of type X and (WD) applying only to some. Moreover, in (SD) dependence is complete, whereas in (WD) it is only partial. Thus (SD) entails (WD) but not conversely. It is also important to note that (SI) is tantamount to the thesis that the meaning of representations of type X reduces to the meaning of representations of type Y. Thus, (SD) may read as semantic dependence. Note also that (SD) is stronger than the thesis that the truth conditions of representations of type X can be fully stated in terms of representations of type Y.²

I will be concerned with three forms of independence claims:

(SSI) Super Strong Independence: It is cognitively impossible that all representations of type X be constructed from representations of type Y alone.

(SI) Strong Independence: It is not the case that there are representations of type X that are, necessarily, constructed at least in part from representations of type Y.

(WI) Weak Independence: It is not the case that all representations of type X are, necessarily, constructions from representations of type Y alone.

(WI) is the negation of (SD). (SI) in turn is the negation of (WD). (SSI) is the claim that representations of type X cannot, given our cognitive make-up, be constructed from representations of type Y alone. Both (SSI) and (SI) are stronger than (WI) and entails it. But (SSI) compatible with the falsity of (SI), for it is in principle possible that no representations

² For instance, Hugh Mellor's (1998) defence of the claim that egocentric temporal sentences (what he calls A-sentences) have objective truthmakers (B-truthmakers) is not a version of the semantic dependence thesis. Indeed, he insists that it would be wrong to infer that "if A-sentences have B-truthmakers, they must mean the same as the B-sentences (i.e. objective temporal sentences) which state those truthmakers" (1998: 47).

of type x can be constructed from representations of type y alone but that some must be constructed in part from representations of type y.

Our project is to investigate the relation between objective and egocentric representations. We must therefore consider 10 possibilities:

- (OSD) Objective Strong Dependence:** All objective representations are, necessarily, constructions from egocentric representations alone.
- (OWD) Objective Weak Dependence:** Some objective representations are, necessarily, constructed at least in part from egocentric representations.
- (OWI) Objective Weak Independence:** It is not the case that all objective representations are, necessarily, constructions from egocentric representations alone.
- (OSI) Objective Strong Independence:** It is not the case that some objective representations are, necessarily, constructed at least in part from egocentric representations.
- (OSSI) Objective Super Strong Independence:** It is cognitively impossible that all objective representations be constructed from egocentric representations alone.
- (ESD) Egocentric Strong Dependence:** All egocentric representations are necessarily constructions from objective representations alone.*
- (EWD) Egocentric Weak Dependence:** Some egocentric representations are, necessarily, constructed at least in part from objective representations.
- (EWI) Egocentric Weak Independence:** It is not the case that all egocentric representations are, necessarily, constructions from objective representations alone.
- (ESI) Egocentric Strong Independence:** It is not the case that some egocentric representations are, necessarily, constructed at least in part from objective representations.
- (ESSI) Egocentric Super Strong Independence:** It is cognitively impossible that all egocentric representations be constructed from objective representations alone.

Some remarks. First, we can immediately note that (ESSI) is highly plausible for reasons well rehearsed in the literature on indexicality. As John Perry (1993) has forcefully argued, indexicals are essential in the sense that there can be no non-indexical replacement for indexicals in indexical beliefs that preserve the cognitive significance and explanatory force of the original beliefs. Attempts to construct the meaning of indexical sentences or thoughts from the meaning of objective sentences or thoughts are therefore doomed to failure as are attempts to extract egocentric information from purely objective information. Since (ESSI) implies (EWI) and (EWI) in turn is the negation of (ESD), we may set aside in order to concentrate on more problematic claims. Note, however, that although it appears wrong to

think that we could extract egocentric information from objective information alone, it is quite unproblematic to claim that the joint exploitation of objective and egocentric information can help us increase our stock of egocentric knowledge. That is what 'you are here' signs on maps are for. Looking at a map will not help you find your way if you don't know where you stand on the map, nor will the mere thought that you are here help you, since this thought is true wherever you are, but the two bits of information put together may be quite useful. It is obvious therefore that some egocentric representations are constructed in part from objective representations. It is not obvious however whether some egocentric representations are necessarily so constructed, hence the interest of examining (EWD).

Having set aside (ESD) as false and (EWI) and (ESSI) as both true, we can now devote our attention to the seven remaining claims and concentrate on the remaining claims and their possible combinations. All combinations of independence claims for objective and egocentric representations are obviously consistent and amount to claims of mutual (semantic) independence. All combinations of an independence claim with a dependence claim are also consistent and amount to one-way dependence, either egocentric or objective. The combination of weak dependence claims is also consistent, giving rise to a claim of partial mutual dependency. The only combination whose consistency appears problematic is that of (OSD) with (EWD). Recall that strong dependency is tantamount to a claim of semantic reducibility. But if objective representations were constructed from egocentric representations that were themselves dependent on objective representations, we would have circularity. Egocentric weak dependence states that some but not all egocentric representations are constructed in part from objective representations. We may then divide egocentric representations into independent ones and dependent ones. Consistency can be preserved only if objective representations are constructed from independent egocentric representations alone. If however, the egocentric representations that are needed to construct objective representations are dependent ones, (EWD) cannot be maintained consistently with (OSD).

My aim now will be to investigate which forms of dependence or independence hold for space and for time, whether the analogy holds in all cases, and, if it doesn't, what explains its disruption. As a preliminary step, I must start by giving a fuller characterisation of the distinction between perspectival and objective representations, starting with space.

2. Egocentric and Objective Representations of Space

Egocentric and objective representations of space can be distinguished in terms of their context-sensitivity or lack of it and in terms of their differential roles in thought and action.

Intuitively, egocentric representations are representations that are sensitive to one's perspective or viewpoint, one's position in space, whereas objective representations exhibit no such sensitivity. One way of specifying this distinction is in terms of the frames of reference used to encode spatial positions and relations. Egocentric representations make use of egocentric frames of reference. Thus, egocentric representations of space, as described by Gareth Evans work as follows:

The subject conceives himself to be in the centre of space (at its point of origin), with its co-ordinates given by the concepts 'up' and 'down', left' and 'right', and 'in front' and 'behind'. We may call this 'egocentric space', and we may call thinking about spatial position in this framework centring on the subject's body 'thinking egocentrically about space' (1982: 153-4).

As pointed out by John Campbell (1994), however, not any way of thinking of the subject will do. Egocentric frames of reference are not to be thought of as a special case of an object-centred frame of reference, one where the object happens to be the subject's body. The notion of an egocentric frame of reference here at stake is a primitive psychological notion, not one that depends on the prior identification of a body. What gives an egocentric frame of reference its significance and makes it irreducible to an object-centred frame of reference, including one where the object happens to be ego is its intimate connection to action. Egocentric spatial information is immediately action-guiding, whether it be for navigating the environment or for interacting with physical objects. As Evans puts it:

Egocentric spatial terms are the terms in which the content of our spatial experiences would be formulated, and those in which our immediate behavioural plans would be expressed. This duality is no coincidence: an egocentric space can exist only for an animal in which a complex network of connections exists between perceptual input and behavioural output. (1982: 154).

As Evans also points out, a subject may be differentially sensitive to stimuli carrying different spatial information without grasping the spatial significance of the stimuli. We have evidence that the subject is sensitive to the spatial significance of the stimuli only if differences in stimuli are connected in a non-arbitrary manner to differences in spatial behaviour. Evans conclusion, not devoid of verificationist overtones, is that egocentric spatial terms 'derive their meanings in part from their complicated connections with the subject's actions' (1982: 155). It has also been argued, by Evans and many others after him that the content of egocentric perceptual representations of space was non-conceptual and that there was no reason to deny them to babies and creatures that do not possess concepts of space insofar as they are some complex but systematic enough connections between the spatial information contained in their perceptual input and their spatial behaviour.

Thus, we may say that egocentric representations of space have the following characteristics³:

- (1) Egocentric representations of space involve a subject-centred frame of reference. This frame of reference is intensional, in the sense that an identification of the egocentric position of an object does not rest on a prior identification of the subject's body.
- (2) Egocentric spatial terms work like indexicals: the egocentric spatial locations of objects vary as the subject moves around in space and thus the reference of a given monadic egocentric expression, such as 'to the left' or 'straight ahead' varies depending on context.
- (3) Egocentric representations of space are immediately action-guiding.
- (4) Egocentric representations of space do not require the subject to possess concepts of space, spatial positions and relations.
- (5) Egocentric spatial representations encode perceptual input.
- (6) The egocentric information provided by perception is not confined to one position: objects may occupy various positions in the visual or auditory fields.
- (7) The egocentric information provided by perception is not confined to one spatially located object: we can simultaneously perceive several objects occupying various locations in the visual or auditory field.
- (8) The egocentric information provided by perception is not confined to locations: we can perceive the spatial relations among objects in the visual field. We can see object A as being to the left of object B, above it, in front of it, behind it, between object B and object C, etc.⁴
- (9) The subject's behaviour is similarly not confined to one egocentric position.

³ The list I propose includes all items on Le Poidevin's own list, together with several additional items, namely (8), (9) and (10).

⁴ Note that the egocentric perceptual representations of spatial relations should be distinguished from spatial representations that make use of intrinsic frames of reference, i.e. frames of reference that exploit the intrinsic axes of one of the objects present in a visual scene. Thus there are two readings to the sentence "the dog is in front of the house". On the egocentric reading, there is a line of sight on which the dog and the house are aligned and the dog is closer to the perceiver than the house. On the intrinsic reading, there is an intrinsic frame of reference positioned on the house and whose axes exploit its intrinsic geometric or functional features, the house has a front and the dog is the region nearing the front. Notice that objects A, B, C, whose spatial relations are represented, may be such things as balls, with no salient intrinsic axes and that in such cases only the egocentric reading is possible.

- (10) Moreover, the subject can in principle move in any direction and his motions are reversible (he can revisit the positions in space he had occupied earlier). This is made possible by an important property of space, namely its isotropy.

By contrast, objective representations of space are non-perspectival in the sense that they do not involve intensional egocentric frames or references. They make use of either intrinsic, object-centred, frames of reference, or absolute, non-centred, frames of reference. An object-centred frame of reference may occasionally use the subject's body as its centre, but an important difference with an egocentric frame of reference *stricto sensu*, is that the construction of an objective subject-centred frame of reference requires a prior identification of the subject's body. A second distinctive feature of objective spatial representations is that they typically remain invariant with respect to the subject's movements. This assertion requires some qualifications. First, if the subject's position is an element of the objective representation and the representation is dynamic, his motion will induce a corresponding change in the objective representation. Second, by changing position, the subject may also gain access to new spatial information, the exploitation of which may help him update or enrich his objective representation. A third characteristic of objective representations is that objective spatial information is not immediately action-guiding. As our brief discussion of Perry's notion of essential indexicality has already shown, in order to be able to use objective spatial information to guide his behaviour, a subject must have bridging egocentric spatial information.

Typical examples of public objective representations are maps, models of objects, anatomical drawings, architectural blueprints, etc. There is also strong evidence that there exist mental objective representations of space, also known as cognitive maps. In a well-known book, *The Hippocampus as a Cognitive Map*, O'Keefe and Nadel offer powerful arguments in favour of the existence of such cognitive maps and their independence from egocentric representations:

...we think that the concept of absolute space is primary and that its elaboration does not depend upon prior notions of relative space... [there] are spaces centred on the eye, the head, and the body, all of which can be subsumed under the heading of egocentric space. In addition, there exists at least one neural system which provides the basis for an integrated model of the environment. This system underlies the notion of absolute, unitary space, which is a non-centred stationary framework through which the organism and its egocentric spaces move. (1978: 1-2).

The neural system in question is the hippocampal system and the authors' hypothesis is that the spatial relationships between places in the environment are encoded by populations of hippocampal cells. The hippocampal map is used for navigation. In particular, it underlies the

ability to use a direct route from A to B, even when one has never before used that route. Research in cognitive psychology and neuroscience in the last two decades has yielded a vast amount of further experimental evidence supporting the existence of such cognitive maps as well as more detailed models of the way spatial information is encoded in the hippocampus⁵. Other evidence, adduced by Le Poidevin, in favour of the existence of an objective cognitive map is the fact that we engage in reciprocal communication with subjects who have different spatial perspectives and do not share our egocentric perspective. We may for instance give directions on the phone to another person on how to reach a certain location. Le Poidevin suggests that: "the best explanation of our ability to communicate with others in these situations is that we map their positions onto an objective space" (1999: 26).

3. Egocentric and Objective Representations of Time

It is obvious that at the linguistic level at least we have a distinction between egocentric and objective representations of time that parallels the distinction we have for space. Terms like 'now', 'then', 'past', 'present', 'future', 'yesterday', 'tomorrow' may be thought as temporal analogs to egocentric spatial expressions such as 'here', 'there', 'to the right', 'to the left', 'three feet down' or 'up'. And a similar parallel goes for objective temporal expressions ('before', 'after', simultaneous with, at 3 pm GMT on September 11, 2001) and spatial expressions ('adjacent' 'north of', 'at right angles to', at 48° 51' 21" N and 2° 19' 43" E).

It is interesting however to compare egocentric spatial with egocentric temporal representations. How many of the characteristic features of egocentric spatial representations do carry over to temporal representations?

Features (1), (2), (3) and (4) can be preserved with minor adjustments:

- (1') Egocentric representations of time involve a subject-centred frame of reference. This frame of reference is intensional, in the sense that an identification of the egocentric position of an event in time does not rest on a prior identification of the subject⁶.
- (2') Egocentric terms work like indexicals: the egocentric temporal locations of events vary as the subject moves through time and thus the reference of a given monadic egocentric expression, such as 'past' or 'future' varies depending on context.
- (3') Egocentric representations of time are immediately action-guiding.

⁵ See for instance, Squire (1992) and Redish (1999).

⁶ Note that, as in the case of space, objective representations can also be subject-centred in an extensional sense, as in "That happened before I was born".

(4') Egocentric representations of time do not require the subject to possess concepts of time and temporal positions.

The remaining six features however do not carry over from space to time. Perhaps the most crucial disanalogy arises with respect to feature (5), with important consequences for features (6) to (9), and to feature (10). Feature (5) of egocentric representations of space – that they encode perceptual input – may be rephrased more illuminatingly in the following way: the spatial content of perceptual state is encoded in an egocentric frame of reference. Clearly then, in the case of space, it is the spatial content of perception that is organized in an egocentric way. But it is much more dubious whether and to what extent temporal egocentric information is encoded as part of the content of perception rather than tied to the mode itself. Is it the case that for each perceptual experience of an event or state of affairs it is part of its representational content that the event or state of affairs has a certain egocentric temporal position (it is occurring 'now'), or, given that perceptual experiences are always experiences of present states of affairs or events, is it simply the case that the temporal egocentric information is implicit in the mode of experience? In other words, do we perceive the presentness of events (where egocentric temporal information would be part of the content of the perceptual experience) or do we simply experience present events? It may be argued that at least some perceptual experiences must have temporal content. The perception of music and more generally the perception of change are cases in point. It would seem that we could not perceptually experience music or change as such without experiencing the relations of precedence between events. But, even if we grant that a relation of precedence is perceptually represented in such cases, we need not grant that it is represented in egocentric temporal terms. It is at best unclear whether it makes sense to say that we see or hear the pastness of event A and the presentness of event B. It would seem much more plausible to say that we see or hear event B as coming after event A. But then we would have an argument that perception encodes temporally objective relations between events rather than temporally egocentric ones. Besides, one may well argue that we do not, strictly speaking, perceive precedence, but that rather the experience of precedence is a combination of perceptual and memory experience. We experience precedence when we link a recent memory of event A and a present perception of event B. Whether we adopt the first analysis or the second, the same conclusion ensues, the experience of precedence does not require perception (or memory) to have egocentric temporal information as part of its representational content. If, as the second analysis suggests, the experience of precedence exploits egocentric temporal information, this

information is directly associated with the mode (present for perception and past for memory) rather than being part of the representational content. Thus, the temporal, disanalogous, counterpart of (5) would be something like:

(5') Egocentric temporal information is tied to the attitude or mode of representing (present for perception, past for memory, future for prediction or anticipation) rather than being part of the representational content.

As a result, features (6) to (9) of egocentric representations of space have negative counterparts for time:

(6') The egocentric information provided by perception is confined to one temporal position: events can only be perceptually experienced as occurring now.

It follows from (6') that:

(7') The egocentric temporal information provided by perception is confined to one temporal location: we cannot simultaneously perceive several objects/events occupying different temporal egocentric locations.

And it follows from (7'):

(8') We cannot perceive egocentric temporal relations among events.

Given the relations between perception and behaviour, it also follows from (6') that:

(9') The subject's behaviour is similarly confined to one temporal position. Behaviour is always in the present.

Finally, given the directionality (or asymmetry) of time:

(10') The subject cannot freely move through time, he can only 'passively' move in one direction and cannot therefore revisit previously experienced temporal positions.

(7') and (8') are direct negative counterparts to (7) and (8), but more positive counterparts can also be derived from (5'):

(7'') The egocentric temporal information available to a subject at a time is not confined to one temporal position. He can, for instance, simultaneously perceive an event, remember another and anticipate a third.

(8'') The egocentric temporal information available to a subject at a time is not confined to position: by combining perception and memory, he can represent egocentric temporal relations among events.

The analogy between objective representations of space and time is much more robust. Like objective representations of space, objective representations of time are non-perspectival in

the sense that they do not involve intensional egocentric frames or references. They make use of either an absolute non-centred frame of reference, as when events are ordered in a series according to a relation of succession (or its converse, the relation of precedence) or of an event-centred frame of reference (the temporal equivalent of an object-centred spatial framework). Calendars, for instance, are typically anchored to some actual or purported event (such as the birth of Christ for the Christian calendar, the flight of Mohammed to Medina for the Muslim calendar, the first day of the first French Republic for the French revolutionary calendar, or, rather commonly in older times, the first day of the reign of a new king). Like objective spatial representations, objective temporal representations also remain invariant with respect to the subject's own changing position in time. Finally, it is also the case that objective temporal representations are not immediately action-guiding. I may believe that I should leave my office at 12 am to go to an important meeting, but unless I also believe that it is now 12 am, I won't budge.

Le Poidevin mentions two disanalogies between objective representations of time and space. I am not convinced however that these purported disanalogies are really substantial. First, Le Poidevin claims that: "*Reciprocal communication* is not normally possible between subjects who have different temporal perspectives – we share a common now. So that there is no need, apparently, to reconcile different egocentric times" (1999: 27). This statement can only be accepted as true, almost by definition, if reciprocal communication is understood in a very restrictive way, where participants must communicate face to face, so to speak. But if we adopt a less stringent criterion and count an exchange of letters as an instance of reciprocal communication, then certainly Le Poidevin's point does not hold. The 'now' of writing is not the 'now' of the reading. Reciprocal communication is possible between subjects who do not share the same temporal perspective. The different egocentric perspectives of the subjects must be reconciled. The common practise of dating letters is one way of solving the problem. Indeed, more clearly even than in the case of space, the best way to reconcile different egocentric temporal perspectives is by mapping them onto a common objective representation of time.

Le Poidevin describes as follows his second purported asymmetry:

There is no need to locate events in 'objective time' in order to encode information from different temporal perspectives. In contrast, given space's three-dimensionality and lack of intrinsic directedness, any attempt to encode different perspectives in a single egocentric representation would soon involve inconvenient complexity. (1999: 27).

Note first that what Le Poidevin is concerned with here is not the combination of different perspectives held by different agents, but the combination of different perspectives of a single agent. Note also that the problem should not be considered only at the linguistic level. One obvious difference between linguistic egocentric representations of time and space is that tense is in many, but not all languages, heavily grammaticalized. It may well be the case that the linguistic integration of different spatial perspectives appears more awkward in part because we have grammatical tools for the recursive iteration of tenses but lack those tools for the recursive iteration of spatial perspectives. But iteration may be concatenative as well as recursive, and here spatial egocentric representations, whether linguistic or not do not seem to be at a disadvantage. Think, for instance, of how you would explain to someone how to get from your office to the Dean's office in another part of the building. Presumably, you will not simply point out to her the egocentric direction of the Dean's office from your own present perspective. Instead, you will give her directions such as: Go to the right when you leave my office, at the end of the corridor take the stairway, go up one floor, on the landing take the corridor in front of you, turn right after the coffee machine and it will be the second door on the left. Indeed we could easily construct a language with the means to express this in a recursive fashion. Something like:

Right (up (straight ahead (right (left (here is the dean's office))))))

would then be a straightforward spatial analogue to Le Poidevin's temporal example:

It was the case (it is about to be the case that (someone is in tears)).

Of course, there are working memory limitations that make it difficult for us to understand a sentence that includes too many recursive steps, but there is no reason to think that the memory limitations would be different for spatial and for temporal recursion. It is certainly not easy to understand a temporal sentence such as:

It will be the case (it is the case (it was the case (it is about to be the case that (someone is in tears))))

Having reviewed the analogies and disanalogies between egocentric and objective representations of time and space, it is now time for us to ask what their implications might be for the various versions of the dependence or independence thesis.

4. Dependence and independence claims for time and space: does the analogy hold?

As I argued in section 1, egocentric representations are indexical representations and the meaning of indexical thoughts is irreducible to the meaning of non-indexical thoughts. Therefore, if some form of strong dependence (i.e. semantic dependence) holds, it can only

be a form of objective dependence (OSD), i.e. dependence of objective representations on egocentric ones. Moreover, the claim that objective spatial representations are strongly dependent on egocentric spatial expressions appears quite implausible. If O'Keefe and Nadel are right, objective cognitive maps of the environment need not be constructed from egocentric representations. The only strong dependence claim worth examining is therefore the claim that objective representations of time strongly depend on egocentric representations of time. Although, Le Poidevin does not explicitly distinguish between the various forms of dependence I identified in section 1, it is clear that this claim is his main target. Using the distinctions from section 1, we can also redescribe his argumentative strategy as follows. Le Poidevin proceeds to undermine (OSD) by arguing that it presupposes a thoroughly implausible conception of human time memory and that, if anything, experimental evidence on the nature of human time memory supports a form of egocentric weak dependence (EWD) incompatible with (OSD). Of course, the falsity of (OSD) amounts to the truth of (OWI). Since Le Poidevin thinks that ESD is also unsupported (hence that (EWI holds), he concludes that the analogy between time and space holds with respect to semantic independence. Let me now examine his main argument for the independence of objective temporal representations more closely. Since I think the argument is sound, my purpose in so doing is simply to get clearer as to the exact form of egocentric dependence the experimental data he adduces are evidence for.

A number of philosophers hold the view that time is essentially tensed, hence essentially egocentric (Lucas, 1973; Prior, 1967; Dummett, 1960; Geach, 1979). Their problem is to reconcile this view with the existence of apparently objective representations of time, such as 'x is earlier than y'. To effect this conciliation, they must show that all purported objective temporal expressions are analysable in terms of tensed, egocentric expressions.

Le Poidevin starts by showing that all but one of the various reductive analyses that have been proposed in the literature are defective and exhibit some form of circularity (i.e. the right-hand side contains hidden objective time specifications). He then proceeds to show that the one remaining analysis entails a particular thesis about time memory and that this thesis is quite implausible.

The analysis is as follows:

- (A) x is earlier than y if and only if x is n units past and y is n units past, and $n > m$, or x is v units future and y is w units future, and $v < w$.

What Le Poidevin points out is that in those cases where both x and y are past, as when one remembers meeting Claudia before meeting Terence, (A) implies that the memory

representation 'I met Claudia before I met Terence' must be built from two egocentric memory representations: 'I met Claudia n units ago' and 'I met Terence m units ago'. The thesis about memory forced on us by (A) is then that memory is irreducibly egocentric and involves dynamically keeping track of how long ago an event occurred. Of the models of time memory that have been proposed in the literature the only one that seems compatible with this view is the model known as the strength model. The idea is that from the moment a memory trace is formed, it decays, so that we can judge the age of a memory from the strength of the trace. However, it is also known that there are serious problems with this model. The strength and the rate of decay of a memory trace is not a function just of its age but also of the saliency of the remembered event (where saliency itself is a function of many factors). For instance, it may be presumed that my memory of what I had for breakfast yesterday morning will fade more rapidly than my memory of my being hit by a car on that same day. Le Poidevin contrasts the strength model with another model, the inference model, better supported by experimental data. According to this latter model, the date of an event is not read off from the memory of it, but is inferred from other information, specifically information about the relations between this event and other events whose time or date are known. For instance, the reason why I can say that I met Claudia before I met Terence may be that I remember meeting Claudia in Venice, I remember that my last trip to Venice was in 1996, I remember meeting Terence just after I broke my arm and I remember that I broke my arm on Christmas Eve 1998. As Poidevin stresses, the interesting thing about this model is that it suggests both that objective information is being used to generate egocentric information, rather than vice-versa and that we have a way of storing objective temporal information that is not simply a derivation from egocentric information.

To sum up, then, Le Poidevin's argument is the following. A defence of (OSD) for time requires, among other things, that objective representations of the precedence relations among past events A and B be constructed from egocentric representations of how long ago A occurred and how long ago B occurred. But these representations are in turn constructed in part from objective representations of the time of some other events A and B are related to. In other words, some of the egocentric representations needed to construct objective representations must therefore be constructed themselves in part from objective representations. Therefore, (OSD) is false and (OWI) holds.

Le Poidevin's argument is aimed against a purported disanalogy between space and time, namely that objective representations of time are strongly (or semantically) dependent on

egocentric representations, whereas objective representations of space are not so dependent. Note, however, that his argument opens the way for another possible disanalogy. It exploits the idea that there is some form of dependence of egocentric representations of time on objective representations. But does such a dependence also hold for space? If it doesn't, we have a disanalogy.

As we have just seen, Le Poidevin suggests that evidence in favour of the inference model of time memory is also evidence that a certain form of epistemic dependence of egocentric representations of time on objective ones holds. Let me start by making it clearer what form of dependence the experimental data he adduces are evidence for. First, note that the inference model is used to explain not all egocentric representations, but only representations of how long ago an event occurred. There is no need to appeal to this model to explain how representations that something is past, present or future are generated. We may judge that an event is past, present or future simply on the basis of the mode under which the representation of the event is entertained (perception, memory, prevision). So we are concerned only with what we may call representations of egocentric temporal dating (how long ago something occurred). Second, note also that Le Poidevin does not claim that the strength model lacks all validity, but simply that it cannot constitute a general account of time memory. In some instances at least, the inference model does a better job at explaining time memory. Simple judgments of pastness do not depend on objective temporal information and it is not the case that objective information is used to generate all representations of egocentric temporal dating. It appears therefore that the evidence in favour of the inference model of time memory can only be evidence for a weak dependence of egocentric representations of time (EWD) and not for a strong dependence (ESD).

The question we must now therefore consider is whether (EWD) also holds for space. In other words, is it the case that some egocentric representations of space must be constructed in part from objective representations? I have already pointed out in section 1 that the joint exploitation of egocentric and objective spatial information may yield new egocentric information. But couldn't this new egocentric information be obtained from egocentric sources alone?

The way I will proceed is by asking which features of egocentric representations of time are responsible for (EWD) and whether the parallel holds for space. One crucial disanalogy between egocentric representations of time and space is that egocentric temporal information

is encoded in the mode of representing rather than in the content of the representations. But the only reliable egocentric temporal information we can extract from modes is whether an event is past, present or future. Given the equivocality of trace strength information, information about the relative pastness of two events cannot reliably be extracted from egocentric temporal information alone and we must therefore resort to objective temporal information, information that can be encoded in the content of representations. This situation is to be contrasted with the situation that holds for space, where spatial information is part of the content of representations and where the spatial information perception carries is neither confined to one position in the perceptual field nor to positions alone. In other words, egocentric spatial representations encode as part of their content information about spatial relations among objects. To sum up, the reasons why (EWD) holds for time have to do with features specific to egocentric temporal representations. We don't therefore have parallel reasons for claiming that (EWD) also holds for space.

It may be objected, however, that there may be other reasons why (EWD) should hold for space as well. It may well be, for instance, that we do not now simultaneously perceive both A and B. For instance, A, and its egocentric position may be the object of our present perception, B and its egocentric position the object of an earlier perception. How can we form a representation of the spatial egocentric relations of A and B, relative say, to our present perspective? Is B, say, to the right of A or to its left? Couldn't it be the case that, on some occasions at least, we must use objective information to generate this egocentric information? There are two reasons why we may answer this question in the negative. First, we may take advantage of the fact that perceptual representations contain information not just about positions but also about spatial relations. Admittedly, in the case at hand, we have no perception that contains spatial information about both A and B. But it may well be that we have representations of the egocentric spatial relation of A to other objects and similarly for B and that an egocentric representation of the relations between A and B may be constructed from these egocentric representations. The objector again: your having a perceptual representation of A as to the right of C and a memory representation of B as to the left of C does not allow you to infer that B is to the right of A from your present perspective, for this perspective might be different from the perspective your memory is encoded from. The question now becomes: can the fact that two representations are encoded from the same perspective be established from egocentric information alone? The answer is a qualified yes: Yes, provided that each representations encode the egocentric spatial relations among three

objects. If I have a perceptual representation of the relative positions of A, C and D and a memory representation of the relative position of B, C and D, then if the egocentric spatial relation between C and D is the same in the two representations, the perspective is the same and the egocentric spatial relations between A and B can be worked out. It may finally be objected that the chain of representations linking A to B may be quite long and involve a number of intermediary links, making the required calculations long and impractical. One answer to that is that long and impractical is not the same as impossible. A second answer is that, anyhow, we have another way to find out whether B is to the right of A. Here the recipe is quite simple and exploits the direct link between perception and action: move to the right of A and look whether you find B. Once again, what we are exploiting here is a crucial disanalogy between egocentric representations of time and space. A subject can freely move through space and change is spatial perspective, but he can only be passively moved in one temporal direction. There seem therefore not to be any good reason why (EWD) should hold for space. We have therefore one disanalogy between temporal and spatial representations with respect to dependence: (EWD) holds for time; it doesn't for space.

The last dependence claim we must consider is (OWD). Are there reasons to think that it holds for time? For space?

To answer these questions, we may consider one last time and from a slightly different angle why (EWD) holds for time in order to see whether they are analogous reasons to think (OWD) holds. The basic problem with egocentric temporal information is that a classification of events as past, present or future on the basis of the mode under which we represent them does not suffice for a complete egocentric temporal ordering of these events. If you have information that A is past and B present you can order them temporally. But if you have information that A is past and that B is past, you have not enough information to order them, and similarly for future events. What is therefore needed for a complete egocentric temporal ordering is information about relative pastness or futurity. What we have seen, in the case of the past, is that to get this kind of egocentric information, say that A is more past than B, we must typically exploit objective temporal information. Hence (EWD). But no such problem arises when one considers the objective temporal ordering of events. A complete temporal ordering can be achieved through the use of the 'earlier than' (or, equivalently, 'later than') relation alone. It seems therefore that no case can arise where objective temporal information need be constructed in part from egocentric temporal information. The same reasoning applies to space. A complete objective spatial ordering can be obtained from information about

objective spatial relations alone. Hence (OWD) doesn't hold for time and it doesn't for space either.

To sum up, our examination of the various dependence claims yields the following conclusion. The analogy between time and space appears robust except for (EWD) that holds for time but not for space.

Let us now consider the independence claims that are yet undecided. Two of the three independence claims that were introduced in section 1 are simply negations of corresponding dependence claims. (WI) is the negation of (SD) and (SI) is the negation of (WD). Moreover, we have seen in section 1 that (ESSI) was highly likely for both space and time and that therefore the weaker thesis (EWI) should hold for both space and time. Some of our conclusions about dependence from the previous section can also be rephrased as results about independence. With respect to time, we have reached the following conclusions: (EWD) holds but neither do (OSD) nor (OWD). It follows that (ESI) doesn't hold, but that both (OWI) and (OSI) do. In other words, egocentric and objective representations of time are mutually weakly independent. Neither kind of representation reduces to the other. On the side of space, we reached the conclusion that neither (OSD) nor (OWD) nor (EWD) hold. It follows that (OWI), (OSI) and (ESI) all hold. The only question that remains open is therefore that of super strong independence for objective representations (OSSSI), the claim that it is cognitively impossible that all objective representations be constructed from egocentric representations alone.

Let me start with time. Claiming that (OSSSI) holds for time amounts to claiming that it is cognitively impossible to construct a complete objective temporal ordering of events from egocentric temporal information alone. By a complete objective ordering⁷, I mean an ordering such that for any pair of represented events, A and B, we can say whether A is earlier than B, simultaneous with B, or later than B. By contrast, a complete egocentric ordering is one that involves an egocentric frame of reference, with 'now' as its origin and axes labelled past and future, and that is such that for any two events lying in the same direction, it is possible to say which one is closer to the origin. We can now be more precise. To claim that (OSSSI) holds is to claim that it is impossible to derive a complete objective temporal ordering from an independent complete egocentric ordering. There can be two different reasons why this derivation is impossible and thus why (OSSSI) holds. First, it may be that there is no such thing

⁷ Note that I am not using the notion of complete ordering in the strictly mathematical sense, for I allow for the possibility that two different events occupy the same temporal position.

as an independent egocentric temporal ordering, because such an ordering can only be achieved through the use of objective temporal information. Second, it may be that although such an egocentric ordering exists, the relation(s) in terms of which it is defined are somehow incommensurable with the relation(s) that define(s) an objective ordering, or, to put it otherwise the egocentric frame of reference used for the egocentric ordering is somehow incommensurable with the objective framework used for the objective temporal ordering. Once the question whether (OSSI) holds is stated in those terms, it is easy to see that we already have an answer to it. In our discussion of (EWD), we have argued that the reason it holds for time is that a complete egocentric temporal ordering could not be achieved without using objective information. Thus (OSSI) holds for the first of the two possible reasons just mentioned.

Last but not least, let us consider (OSSI) for space. Here again, (OSSI) can be reformulated in terms of ordering. It claims that it is impossible to derive a complete objective spatial ordering of spatial entities from an egocentric one. An egocentric spatial ordering is one that involves an egocentric frame of reference and is such that, for any two spatial objects A and B and any of the egocentric axes, we can say whether A lies closer to the origin than B on that axis or not. An objective ordering is one that involves either an object-centred or an absolute frame of reference and that is such that for any two spatial entities and any axis, we can say what the relative positions of A and B are on that axis. Once again, (OSSI) may hold for two reasons. Either there exists no independent egocentric spatial ordering or, if there is, the egocentric and objective frames of reference are in a sense incommensurable. I have already argued that it is possible to construct a complete egocentric spatial ordering independently of objective information. This was my main reason for rejecting (EWD) for space. So if (OSSI) holds, it can only be for the second reason. Is it the case then that egocentric spatial frames of reference are somehow incommensurable with objective ones.

To see why some people may think there is incommensurability, a comparison with time will once again be useful. Note that given the one-dimensionality and directionality of time, possible egocentric frames of reference are highly constrained. The only possible difference between various egocentric temporal frames of reference is a difference in the position of the origin, i.e. 'now'. The temporal axis and its labels remain invariant; they are always positioned in the same way. If there were independent complete egocentric orderings of events, converting them into an objective ordering would therefore be a simple affair. It would be enough to get rid of the origin, that is, abstract away from it. Now the situation with respect to

space appears much more complex. Space is three-dimensional, isotropic and we can move freely through it. Thus, egocentric spatial frames of reference may differ in the position of the origins, in the direction of the axes and in their labelling. Suppose I am standing still, my perceptual input will be encoded in terms of an egocentric frame of reference centred on my body and whose axes correspond to my bodily axes ('up', 'down', 'left', 'right', 'in front', 'behind'). If I now move one step ahead, the frame of reference will change in one way: the origin will be different, but the axes and their labels will remain the same. Suppose that instead of moving one step ahead, I rotate by 180°. In that case the origin remains the same, so do the axes, but the labels of two of them are inverted, 'in front' becomes 'behind' and 'right' becomes 'left'. Finally, imagine I rotate by 43°, now the axes also change. And since we can combine rotation and translation, two egocentric perspectives may differ on all three respects. The constraints on temporal egocentric perspectives make it impossible to have two perspectives that differ in that, according to one, event A is past and event B is future (or A is more past than B) while, according to the other, event A is future and event B is past (or B is more past than A). It is easy therefore to see how objective temporal relations could be mapped on egocentric temporal relations and properties. But take space, the object A that is to the right of B from a certain perspective may well be to the left of B from a second perspective, above B from a third one, behind B from a fourth one, and so on. Now, how do you map objective spatial relations on egocentric ones? The feeling of hopelessness is here probably at the root of the idea that egocentric and objective spatial frames of reference are incommensurable.

In the case of space, trying to derive an objective ordering from an objective one through a mapping of objective relations onto egocentric ones is a strategy doomed to failure, but it is not the only move open to us. With space, we have resources that we lack for time. In particular, features (7) and (8) of egocentric spatial representations come in very handy. The spatial egocentric information provided by perception is not confined to one object and it is not confined to locations. In other words, we can simultaneously perceive several objects occupying various locations in the visual or auditory field and we can perceive the spatial relations among them. This gives us the necessary ingredients for the definition of an objective frame of reference. An objective frame of reference may dispense with an origin (it need not have a centre), but it requires a set of axes, together with a way of distinguishing the two ends of each axes (we may call that a labelling system, although obviously language is not required). Now, the recipe is quite simple, use the spatial relations among some objects or

among the parts of an object to define and label axes. We may call anchors the objects so used. You now have an objective frame of reference and can use it to represent the positions of other objects and relations among them. For this recipe to work, a little cooperation from the world is needed: there must be either one stable enduring non-symmetrical object or several enduring discriminable objects or features in a stable configuration to serve as anchors for a set of labelled axes. (Note that, anyway, objective spatial representations would be of no great use, if space was either a barren solitude or a complete chaos.) Once this frame of reference has been built, any complete egocentric spatial ordering, whatever the perspective it is from, can be converted into an objective spatial ordering. For each perspective, the egocentric representation of the relations among anchors tells you what the mapping should be. Our final conclusion regarding (OSSSI) is therefore that it doesn't hold for space.

	Space	Time
Objective Strong Dependence (OSD)	N	N
Objective Weak Dependence (OWD)	N	N
Objective Weak Independence (OWI)	Y	Y
Objective Strong Independence (OSI)	Y	Y
Objective Super Strong Independence (OSSSI)	N	Y
Egocentric Strong Dependence (ESD)	N	N
Egocentric Weak Dependence (EWD)	N	Y
Egocentric Weak Independence (EWI)	Y	Y
Egocentric Strong Independence (ESI)	Y	N
Egocentric Super Strong Independence (ESSSI)	Y	Y

Table 1.

Table 1 recapitulates the results of this investigation of dependence/independence. We have found two main disanalogies between temporal and spatial representations. First, egocentric temporal representations are weakly dependent on objective representations, but not so for egocentric spatial relations. Second, objective temporal representations are super strongly independent of egocentric ones, whereas this super strong independence does hold for space. In both cases, the reason why the analogy breaks down have to do with differences between egocentric representations of time and egocentric representations of space. Three differences

play a crucial role. First egocentric spatial information is encoded as part of the content of egocentric spatial representations whereas egocentric temporal information is associated with the mode not the content of egocentric representations. Second, the spatial egocentric information provided by perception is not confined to one object and it is not confined to locations but can be about spatial relations among objects (other than the perceiver). Third, a subject can in principle move in any direction in space and his motions are reversible, whereas he can only passively move in time in one direction.

Let me offer two final thoughts. First, it is worth pointing that ultimately, these disanalogies are a consequence of our cognitive make-up. For suppose for instance that our time memory worked according to different principles, Suppose that all memories had initially traces of the same strength and that the rate of decay of the traces was a function of time only. The strength model would then be an adequate model of time memory and the 'more past than' could be defined in a purely egocentric way. This means that (EWD) would cease to hold. Note, in particular, that the 'more future than' relation could be defined using the 'more past than' relation and this in the following way: x is more future than y if and only if it will be the case that y is more past than x. Thus, an independent complete egocentric temporal ordering of events could be constructed and (OSSI) would also cease to hold. In other words, a complete analogy would be restored. Given that it could be restored as a result of a simple change in cognitive make-up, the disanalogy appears to be merely a matter of cognitive necessity, i.e. to be necessary only with respect to our particular cognitive make-up. Finally, it may seem somewhat strange that a mere change in the workings of time memory would suffice to restore a complete analogy between the way egocentric and objective representations relate in the case of space and in the case of time. There would still be disanalogies between egocentric temporal representations and allocentric ones, in particular regarding features (6)-(10) vs. (6')-(10'). Why is it then that such local disanalogies have no global effects? The answer lies, I think, in the fact that certain differences in features counterbalance others. The relation between egocentric and objective spatial representations is more complex than for temporal representations insofar as the represented space is 3D and non-oriented and thus allows for a huge range of different perspectives. Yet, the fact that perception is not confined to one egocentric position but encodes as part of its content egocentric information on the positions of objects in the perceptual fields and on the spatial relations among these objects together with the fact together with the fact that we can move freely through space compensate for this complexity. Conversely, the relation between egocentric and objective representations of

space is rather simple insofar as egocentric represented time is one-dimensional and oriented. Yet, perception does not yield information about egocentric temporal relations and thus it is not easier to work out the relations between egocentric and objective temporal representations than to work out those relations for space.

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