

The structure of egocentric space

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13.1 Introduction

In *The Varieties of Reference*, Gareth Evans rightfully notes that any talk of ‘egocentric space’ picks out not a special *kind* of space, but rather a special *way* of representing space (Evans, 1982, p. 157). Shortly afterwards, he claims that ‘a fundamental point of similarity’ between auditory and haptic (and presumably visual) experience is that their spatial content can be specified in egocentric terms.¹ And that it is ‘a consequence of this that perceptions from both systems will be used to build up a unitary picture of the world. There is only one egocentric space, because there is only one behavioural space’ (Evans, 1982, p. 160). Although I agree with Evans’ conclusion, I share the suspicions of any reader who thinks that the reasoning here might have moved a little quickly.

For one thing, they might not accept what one might call the ‘Evansian’ conception of egocentric space. On that conception, perceptual experience is egocentrically structured in virtue of its connection to the subject’s capacity to act appropriately in relation to what she perceives.² Thus, Dominic Gregory writes: ‘On the face of it [...] it is bizarre to think that auditory and visual directions derive from apparent action-involving relationships between sights, sounds, and our conscious selves’ (Gregory, 2013, p. 38). For another, they might not see exactly the relevance of this idea to the matter of building up ‘a unitary picture of the world’ from the various egocentrically structured presentations of that world available to the perceiver.

The purpose of this chapter is to offer an indirect defence of the Evansian conception of egocentric space. It will do so by showing how it resolves a puzzle concerning the notion of ‘a unitary picture of the world’, as ‘one egocentric space’. It shows how one can experience the world from multiple egocentric perspectives, unified relative to a single egocentric perspective.

I will begin by outlining, in section 13.2, several natural assumptions about egocentric perspectival structures. I will then show, in section 13.3, that a subject’s experience, both within and across her sensory modalities, may involve multiple structures of this kind. This

¹ Evans’ language actually suggests the stronger view that the spatial content of perceptual experience *must* be specified in egocentric terms. It can surely also be specified, for example, in terms of relations between objects themselves, or in terms of their relation to a more fundamental frame not essentially involving some privileged entity. But whether it can be specified in these ways, without presupposing some egocentric specification, is an issue that we cannot address here.

² See Evans (1982, pp. 154–162; 1985, pp. 383–389). This broad idea is, of course, not original to Evans. He evidently takes inspiration from Pitcher (1971), as well as Taylor’s (1978) discussion of Merleau-Ponty (1962/2002), who in turn was heavily influenced by Husserl (see especially his 1952/1989, 1973/1997).

raises the question of how perspectival unity is achieved, such that these perspectival structures form a complex whole, rather than a merely disunified set of individually, distinctively structured experiences.

In section 13.4, I consider a variety of accounts: switch accounts, according to which perspectival structures are themselves individually unified, but do not form a complex whole; sensory accounts, according to which egocentric perspectival structures are unified relative to a dominant sensory modality's perspective; transformation accounts, according to which egocentric perspectival structures are unified in virtue of coordinate transformations between spatial representations encoding information in distinct egocentric frames of reference; and ultimate accounts, according to which egocentric perspectival structures are unified in virtue of mutual anchoring relations to an ultimate anchor.

In section 13.5, I will return to the Evansian conception to show that it provides us with a further kind of account—an agentive account—according to which egocentrically structured experiences present the world in relation to a part of a single thing, the body as a dynamic unity.

13.2 Perspectival structures

13.2.1 Egocentric structures

A perspective is an essential feature of any experience that exhibits a perspectival structure, for a perspectival structure is an organization of content determined by a perspective. *Egocentric* perspectival structures are such because their elements are systematically organized within an egocentric frame of reference.

Minimally, an egocentric frame of reference is one in which locations on an axis are individuated relative to a privileged point on that axis. Typically, egocentric frames of reference have multiple orthogonal axes. Points on each axis can be denoted in a coordinate system. For example, a Cartesian coordinate system assigns the number zero to the point at which the axes intersect. A metric would provide intervals of a certain scale, such that changes in value would correspond systematically to changes in position on each axis. The extent to which a value on each axis deviates from the zero-point would thus serve to determine locations in the frame of reference.

There are also a range of familiar egocentric locative expressions. In English, we have static terms such as *nearby*, *far away*, *straight ahead*, *to the left*, or *to the right*; we also have dynamic terms such as *coming closer* or *moving leftward*. These can serve to describe spatial relations in an egocentric frame of reference, where the axes of the reference frame are labelled with canonical terms for egocentric directions such as *leftward*, *upward*, or *forward*.

13.2.2 Limitation structures

Issues concerning the unity of perspective are centrally issues concerning egocentric structure. But another, important kind of perspectival structure that characterizes perceptual experience concerns the ways in which the appearance of objects is determined by the characteristic limitations of one's senses (Martin, 1992; Richardson, 2010). This kind of perspectival structure—call it *limitation structure*—has been the subject matter of much disagreement since at least the seventeenth century, particularly as it figures in the Argument

from Perspectival Variation.³ A key premise of that argument is that, strictly speaking, three-dimensional objects do not appear as such visually. Rather, their shapes and sizes are distorted, as if lines were projected from the objects themselves through an image plane to a single point, as in some form of graphical perspective. Thus, what distinguishes limitation structures from egocentric structures is that the former (but not the latter) involve a particular determination of the apparent sizes and shapes of objects relative to a given perspective, although the extent and nature of this determination has long been controversial.

Thankfully, what is of most relevance to our discussion here is the less controversial (if closely associated) idea of a sensory field. This is roughly the idea, the totality of what can be sensed by a subject in a given modality at a time and can be described by picking out a region of space.⁴ For instance, if the immediate objects of sight were indeed planar, then the visual field would have *only* horizontal and vertical dimensions.⁵ But what is key to our discussion here is not how many dimensions sensory fields possess, but the ways in which they are characteristically bounded on those dimensions. Indeed, it is a familiar idea that the boundaries of the visual field are a consequence of eye position, head morphology, the position and structure of the eyes, etc. In this way, the eyes constitute a perspective determining a limitation structure of a kind, the *human* visual field, one that is rather different from that of, for example, a hammerhead shark. For the same reason, the human visual field is different from the human auditory field in that the former is bounded on the vertical and horizontal planes in ways that the latter is not.⁶

13.2.3 More on egocentric structures

The typical purpose of describing locations in egocentric terms is to capture how they stand not merely in relation to the privileged point that structures the frame of reference. Rather, the purpose is to capture how they stand in relation to a particular object on which the frame of reference is *centred*. We will need to say more about this shortly, but it will suffice for the present to say that a frame of reference is *centred* upon an object when its zero-point falls within an object's boundaries and its axes are aligned with salient structures within the object. For instance, the parts of many creatures (including the human animal) can be regularly divided along horizontal, vertical, and sagittal planes. Running labelled axes along these planes will enable a systematic description of locations in egocentric terms relative to the object in question.

I will assume that being egocentrically structured is minimally sufficient for any content to be perspectival. I will also assume that experience has content, and thus that, if its content

³ See, e.g. arguments for sense data presented by Russell (1912/1959, pp. 10–11) and Broad (1927, p. 240), surely inspired by remarks from Locke (e.g. 1690/1997, pp. 143–144) Berkeley (e.g. 1732/2008, p. 21) and Hume (e.g. 1739–1740/2007, p. 56).

⁴ Here we can embrace a point made by Soteriou (2013, pp. 115–119) that, from the fact that one's awareness is constrained to such a region, it does not follow that one is aware of the region itself as some object over and above its contents.

⁵ For discussion of the difficulties of excluding visible depth from one's characterization of visual experience, see Schwitzgebel (2006); Smith (2000). J.J. Gibson's work on occlusion is perhaps the most compelling demonstration of the need for a three-dimensional conception of the visual field (Gibson et al., 1969). For more general discussions of a three-dimensional conception of the visual field, see Clark (1996); Martin (1992).

⁶ A further disanalogy is in the possibility that there may be a coherent notion of a temporal auditory field analogous to the spatial field of vision (Soteriou, 2013). I note also that it is not clear whether there is a notion of a tactile field with anything like the kinds of phenomenological connotation with which philosophers have imbued that notion in the visual case, but see Haggard and Giovagnoli (2011); Serino et al. (2008).

is structured in one of the ways described earlier, then that experience's content is perspectival. The distinction between experience and content is important but, for ease of expression, I will collapse the distinction and speak merely of experiences being perspectival or perspectively structured.

One can express the structural difference that egocentric perspective makes to perceptual experience in the following terms: a subject's perceptual experience is perspectively structured in so far as the world she experiences is presented *from* an egocentric perspective. It should be noted, though, that, as described, an egocentric perspectival structure does not involve any connection between a perspective and the body of the subject (cf. Gregory, 2013, p. 38).

What is right about this, I think, is that being perspectively structured is a property not only possessed by perceptual experiences. It is a property possessed by images (both mental and physical) and by various ways of representing space (both mentally and physically). Indeed, in a broader sense of the notion of a perspective, it characterizes *any* representation that is structured in relation to some privileged entity.

But consideration of these broader connotations ought not to distort our characterization of perceptual experience as perspectival. For when considering perceptual experience, in the central case, what it is for the world to be presented to a subject from a perspective is for it to be presented in relation to the subject's body (see, e.g. Husserl, 1952/1989, p. 166).⁷ Indeed, as will become evident shortly, the problem of the unity of egocentric perspective emerges when considering the specific constraints characterizing the relations between bodies and perspectival structures.

13.2.4 Anchoring and embedding

The notion of *centring* provides only a correspondence between a body and a perspective. This may just as well be coincidental. It fails to capture how the comportment of the subject's body can affect the perspectival structure of her experience. For this we need to introduce the further notions of *anchoring* and *embedding*. To illustrate *anchoring*, take Christopher Peacocke's Buckingham Palace example:

Looking straight ahead at Buckingham Palace is one experience. It is another to look at the palace with one's face still toward it but with one's body turned toward a point on the right. In this second case the palace is experienced as being off to one side from the direction of straight ahead, even if the view remains exactly the same as in the first case. (Peacocke, 1992, p. 62)

In this imagined case, the left–right axis is systematically causally related to one's torso, such that changing its spatial properties (e.g. its orientation) affects one's perspectival experience. In short, that part of the structure is *anchored* to the torso.

The conceptual distinction between *centring* and *anchoring* can be grasped by considering a more fanciful case imagined by P.F. Strawson, in which a multi-bodied subject's experience may be determined by the *location* of one body—call this body *Loco*—and the *orientation* of

⁷ I should also note that I lack the space to even briefly address broader questions concerning whether perceptual experience being perspectively structured is in itself sufficient for it to have *de se* content (Schwenkler, 2014). For discussion of these issues, see Alsmith (2017).

a second body—call this *Oriente*. Thus, while it would be possible for this multi-bodied subject to see whatever would be visible from *Loco*'s location, she cannot see in every direction at once; it is the orientation of *Oriente* that determines her line of sight, and thus the view she experiences at any given time (Strawson, 1959/2003, p. 90). In short, her perspective is centred on *Loco* while it is anchored to *Oriente*.

Clearly this departs drastically from our conception of the perspectival structure of ordinary perceptual experience. For that is typically expressed as a combination of *centring* and *anchoring*, such that one perceives the world *from* the very body that determines the structure of one's experience. To capture what is missing, we need a notion that refers to cases in which a perspective is located within an object that determines the structure of an experience at that location. Call this *embedding*: a perspective is *embedded* within an object when it is located within an object by virtue of its structure (or some part of its structure) being *anchored* to that object. *Embedding* is thus a composite notion that requires both *centring* and *anchoring*.

13.3 The problem

13.3.1 The complex structure of visual perspective

With these basic ideas on the table, we can begin to express the problem that will occupy us in the pages to follow. In the Buckingham Palace example, describing the perspective in question as *anchored* to the torso captures the fact that the structure of the (imagined) experience changes as a consequence of the rotation of the torso. But it leaves open the question of whether the perspective is *embedded* within the torso. In simpler terms, would one perceive the palace *from* the torso?

One core element to the problem here is that the body is not a structureless lump. It is an articulated object with parts that are each to some extent independently mobile, and thus capable of varying degrees of alignment, complicating the question of their contribution to the egocentric structure of our experience. Thus, what might seem odd about the idea of *seeing from the torso* is that there is another candidate body-part from which one visually perceives—namely, one's *head*—for the head causally affects the structure of one's experience in broadly the same respects. To paraphrase Peacocke: it is one experience to look at an object in front of one's face; it is rather another to look at that object when it is off to the side of one's face.

This brings out another core element of the problem—namely, the intuition that we possess a *single* perceptual perspective upon the world, such that our perspectively structured experience is unified in relation to that perspective. This intuition seems especially problematic when also considering the perspectival structure of sensory modalities other than vision, as will shortly become clear. But the problem has some bite when considering vision alone. Indeed, one can imagine a subject with one's head and torso misaligned, with a visible object placed at 15° relative to her torso and –15° relative to her head. Her visual experience of the object might equally well be characterized as being 'to the right' and 'to the left'.⁸ Yet, on

⁸ Indeed, tests of intuition concerning this kind of scenario in a perspective-taking task have repeatedly demonstrated that individuals' spatial judgements are influenced by both the avatar's torso position and head position, with clear individual differences in the weightings assigned to each body-part (Alsmith, Ferrè, & Longo, 2017; Longo, Alsmith, & Ferrè, 2020).

the assumption that her experience of the object is unified in relation to a single perspective, it cannot seem to her to be in both directions at once.

In more general terms, given the complexity of the egocentric structure of perceptual experience, in virtue of what is that structure unified? This is the problem of the unity of perspectival experience, and it will form the focus of the remaining discussion.

13.3.2 The complex structure of auditory and haptic perspective

Discussions of perspective in both psychology and philosophy have generally focused on the specific case of visual perspective. This reflects a broader trend of disproportionate focus on vision in the study of perception, only partially justified by the dominance of the visual sense upon others (Stokes & Biggs, 2014). But we should not be held captive by the visual when thinking about perspectival phenomena in general. And although it is possible to express the problem of the unity of perspectival experience when considering sight alone, it is more acute when one considers the non-visual senses. For both auditory and tactual experience present their objects in an egocentrically structured manner.⁹ Moreover, each provides clear examples of intramodal complexity in their egocentric structure.

It is in haptic perception that we can most easily discern tactual experience as egocentrically structured.¹⁰ Take a simple case, such as feeling an object in one hand that extends beyond one's grip. The feel of the object would be structured relative to a perspective embedded within the hand. Parts of the object would be perceived from the hand, in the sense that the perspective of the egocentric frame of reference would be centred within the hand (e.g. within the palm, according to one's grip). And at least part of the overall egocentric structure would be causally dependent upon salient structures within the hand. These need not be labelled in canonical egocentric terms (e.g. it might suffice to label a direction as *thumbwards*). As one manipulates the object, pushing part of it *thumbwards*, bringing another part of it towards the centre of one's grip, one's overall experience of the object changes, in a manner organized according to its egocentric structure.

Haptic perception can involve a variety of egocentric structures (Oldfield & Phillips, 1983) depending on the purpose of a given task (Millar, 2008, chapters 2 and 5), and even how long it lasts (Zuidhoek et al., 2003). This might seem in tension with the fact that philosophers sometimes describe the perspectival structure of tactual experience as if it were simple (e.g. Evans, 1982; Gregory, 2013; Nichols & Horgan, 2015). But this is largely, I suspect, to facilitate ease of expression: it is useful sometimes to describe the structure of a part of a subject's tactual experience in isolation. This should not mask the complexity of a subject's typical tactual experience when taken as a whole. For instance, pushing a piece of furniture into the corner of a room might involve perspectives embedded within one's hands and feet, and perhaps anchored to one's hips and torso.

⁹ Not all would be inclined to agree with such claims in full generality. For instance, Strawson writes that 'such expressions as "to the left of", "spatially above", "nearer", "farther" have no intrinsically auditory significance' (Strawson, 1959/2003, p. 65). But, as O'Callaghan (2010) points out, this does not sit easily with empirical research on spatial hearing. And even if we admit that Strawson's sound world would be a 'no-space world', it should not push us to the conclusion that, in our world, auditory experience does not have egocentric structure (see, e.g. Mershon & King, 1975). With respect to touch, some might reject the description of this form of perceptual experience as perspectivally structured, because they believe that '[nothing] in the tactual sphere corresponds to the fact of optical perspective' (Blumenfeld, 1937, p. 56). But here we should be careful not to deny that touch is egocentrically structured because it does not have the kind of *limitation structure* exhibited by another modality.

¹⁰ See, though, Parsons and Shimojo (1987) for work on egocentric structures in passive touch.

As introspectively obvious as the complexity of haptic perceptual experience might seem, so it might seem equally obvious that the structure of auditory experience is simple. However, work on spatial hearing suggests otherwise, in so far as a subject may hear sounds in relation to distinct auditory perspectives as a function of the spatial position of each sound's source.

Neelon, Brungart, & Simpson (2004) studied the egocentric structure of hearing by adapting methods originally designed to study the location of the estimated 'egocentre' in binocular vision. These methods, first developed by W.C. Wells and E. Hering in the eighteenth and nineteenth centuries, respectively, essentially involve adjusting a line (along a rotating rod, or an imagined axis between two or more points) until it is judged by the participant to be pointing directly at herself. By conducting the task at a series of radial directions and extending the line in each judgement to pass through the observer, an examiner could determine the participant's estimated egocentre as the point of their intersection (Howard & Templeton, 1966; for a historical and methodological review, see Ono, 1981). Using an auditory form of this task, Neelon et al. (2004) found a systematic direction-dependent shift for the estimated position of the auditory egocentre. For sound sources $\pm 30^\circ$ from midline, the pattern of responses clearly indicated an egocentre located towards the front of the head. Responses to more lateral sources (beyond a region roughly $\pm 60^\circ$ about the midline) indicated an egocentre located further back, roughly at the centre of the interaural axis—that is, just between the ears.

13.3.3 Split perspectives

It will be useful to have a device for expressing the problem in its various guises simultaneously. For that purpose, I offer the case of *Split*, a subject whose total perceptual experience is of a virtual world. This virtual world is a conjunction of perfect visual, auditory, and tactual worlds, each of which is a facsimile of a world genuinely perceptible through these sensory modalities. *Split's* perceptual experience is structured by perspectives embedded within and anchored to three humanoid virtual bodies. There is no topological connection between the virtual parts of each of *Split's* bodies. And each is independently mobile. *Audio*, from which she hears the audible properties of an auditory world, is thus a distinct body from *Visuo*, from which she sees the visible properties of a visual world, and *Tactuo* is a third body, from which she feels the tangible properties of a tactual world.

Assume further that *Split's* auditory experience is entirely structured by the shape and position of *Audio's* head, within which *Split's* interaural and interocular perspectives are embedded. *Split's* visual experience is causally connected to a different body—*Visuo*—and has a similarly complex relation to that body. For it is structured both by the shape and position of *Visuo's* head, within which *Split's* visual perspective is embedded, but also *Visuo's* torso, to which the left-right axis of her visual experience is anchored, as in Peacocke's Buckingham Palace example above. *Split's* tactual experience presents potentially the most complexity, with potentially as many anchoring and embedding relations as there are parts of *Tactuo's* body engaged in haptically perceiving the tangible properties of the world. But as noted above, we can simplify the situation somewhat by considering only the part of *Split's* tactual experience structured according to a perspective embedded within the hand.

The purpose of the example here is, of course, not to show that this strange subject's experience is anything like ours. Rather, the purpose is to provide a case in which parts of our experience, which are usually intimately connected, are separate, so that we can better examine how they come to be unified. *Split* is thus precisely the model of a subject whose

experience is not unified according to a single, multimodal perspective. Note that this disunity is not a consequence of *Split*'s bodies occupying different positions. Indeed, we could assume a mapping between the visual, audible, and tactual worlds. And as her bodies are virtual, *Split* is able to situate them such that they simultaneously fill exactly the same volume of virtual space. For ease of reference, let's call this version of *Split* '*Split-juxtaposed*'. Even though, broadly speaking, *Split-juxtaposed* visually, auditorily, and tactually experiences from a single place, she does so in very different ways from three different bodies.

What exactly, then, is it about *Split*'s multiple embodiment in virtue of which her experience is disunified? Put differently, what kind of relation would be required between her three sensory bodies, such that her experience of the world would be unified according to a single egocentric perspective?

Before moving on to consider a variety of responses to the problem expressed here, it is worth saying a little to clarify its relation to issues concerning the unity of consciousness between the senses. Indeed, raising the bare question of how 'a unitary picture of the world' in the form of 'one egocentric space' is built up from egocentrically structured experience in different modalities—as per Evans' remarks at the start—might suggest that the problem is really one of how modality-specific perspectival structures are united.

If this were right, then what *Split*'s experience would lack is what Ayers calls an 'integrated sensory field', in which there are not 'several sets of apparent directions' corresponding to each sensory modality and associated or identified with one another, but rather a single multimodal field 'of which we are aware in different but essentially integrated ways' (Ayers, 1993, p. 164). But, as I hope to have shown in sections 13.3.1–13.3.2, the problem plausibly runs deeper: for each sensory modality might itself present multiple 'apparent directions', raising again the question of how the complex structure of each modality is unified relative to a single perspective.¹¹

13.4 Accounts of perspectival unity

13.4.1 Switching accounts

Despite the problem at hand being distinct from questions concerning unity relations between the senses, one might take inspiration from a certain approach to the latter in giving an account of the former. It is commonly assumed that a subject's perceptual experience at a time can be multisensory, in that it may consist in multiple modality-specific experiences (or modality-specific contents). But while it is true that perceptual processing is highly multisensory, as Spence & Bayne (2014) note, it is difficult to shake the sceptical view that 'all such cross-modal interactions take place "below" (or perhaps "prior to") the level of awareness' (p. 107). Moreover, it is possible that *switches* between modality experiences might occur at a temporal scale beneath our capacity for introspective discrimination—all of which makes it hard to find dispositive evidence that perceptual experience is multisensory in the relevant respect, and to rule out the alternative unisensory view that 'a subject's awareness of

¹¹ This could be more precisely expressed by creating further separations within *Split*'s embodiment, such that each of her bodies was qualified not only with reference to a sensory modality but also to a certain egocentric organization of the contents of her experience from that body in that modality. But this would, I think, increase the difficulty in imagining the case in ways that would not really justify the precision we might gain.

the world involves frequent and rapid alternations (or switches) between different modalities (ibid., p. 102).

The unisensory view suggests a similar approach to the Gordian knot of perspectival unity. For it is clear that much of the force of the problem is in the assumption that the egocentric structure of perceptual experience is complex. But, if this is taken to imply that this complexity is a feature of the egocentric structure of one's perceptual experience at a time (or, better, within a specious present), the empirical justification for this assumption might seem rather weak. It hardly rules out the alternative possibility that the structure of one's perceptual experience is never complex in this way. Building upon this, one might pursue an account according to which our experience at any given time is only ever simple. Any appearance of complexity—and thus any basis for any substantive problem of perspectival unity—would then be explained as a consequence of rapid switching between perspectives.

There is, of course, a clear respect in which this kind of account is consistent with the idea that there is just 'one egocentric space'—or, more elaborately, the idea that a subject's experience is synchronically unified relative to a single perspective. For there is just a single perspective from which the subject experiences the world at a time.

I do not at this point have any knock-down argument against a switching account. But given the similarity between this account and the dispute between the unisensory and multisensory views of perceptual experience, the grounds on which the account should be evaluated ought to be correspondingly similar. Thus, the extent to which one will find a switching account compelling depends on whether there are convincing cases of experiences that could not occur when considering a single perspectival structure alone.¹² In our discussion thus far, the key cases would then be the visual experience of an object placed equidistant from the midlines of a misaligned head and torso (see the elaboration on Peacocke's Buckingham Palace example in section 13.3.1) and the auditory experience of an object placed around $\pm 60^\circ$ from the midline, where head and torso are aligned (see the discussion of Neelon et al., 2004, in section 13.3.2).

13.4.2 Sensory accounts

One explanation of Neelon et al.'s (2004) results is especially worth examining because it suggests the general shape of what one might call a sensory account of the unity of perspectival experience. Using similar methods to Neelon et al. (2004), Sukemiya, Nakamizo, & Ono (2008) tested sighted, late-blind and congenitally blind subjects. They found that the estimated auditory egocentres for sighted and late-blind subjects were near the midpoint of the interocular axis, similar to Neelon et al.'s finding for frontally located auditory stimuli, whereas the egocentre for the congenitally blind was near the midpoint of the interaural axis, similar to Neelon et al.'s laterally located stimuli. Such a 'concordance of the locations of the visual and auditory egocentres', as Sukemiya et al. (2008) write, would thus eliminate any potential 'cross-modal mismatch between the visual and auditory directions of an audiovisual object' (p. 1549).

There are two sets of facts here that might suggest an approach to the problem at hand. An auditory egocentre is located at the site of a visual egocentre, and this only obtains auditory

¹² For corresponding issues concerning multisensory perceptual experience, see the discussion of multisensory objects in Spence & Bayne (2014, p. 117, ff.??), the discussion of novel intersensory features in O'Callaghan (2017, pp. 181–186) and generative multisensory integration in Briscoe (2016, pp. 124–127).

stimuli that fall within the boundaries of the visual field in sighted subjects, or where those boundaries are for late-blind subjects. These are just what one would expect if the egocentric structure of sight were dominant, such that it served to unify the structure of one's perceptual experience in other modalities. That is, to the extent that objects and events perceived in non-visual modalities fall within the scope of the subject's (previous) visual field, the egocentric structure of her auditory experience will be dominated by her visual perspective. Generalizing this approach, one might say that the perspectival structure of a subject's experience is unified, in so far as the spatial contents of experience in each modality adopt the structure of her visual perspective.

The shortcoming of this approach demonstrates the difficulties inherent to any solution to the problem that appeals to the perspectival structure of a sensory modality as a means of unifying others. As noted in section 13.2.2, each sensory modality involves distinctively bounded sensory fields, partly due to the characteristics of the sense organs themselves and partly their bodily position. For the unity of perspectival structure to be merely a matter of one sense dominating the others, that unity will be constrained to the possible overlap between their respective fields. Accordingly, for any such approach, the 'in so far as' qualifier will be essential in describing the experience of any creature whose sensory fields across their modalities do not wholly overlap. The case of audiovisual perspectival unity in virtue of visual perspective makes this especially clear, with at most a third of the auditory field's 360° horizon being thus unified.

13.4.3 Transformation accounts

It may have entered the reader's thoughts (especially given the present volume) that, if there is a problem of perspectival unity at all, it is only made more acute when considering peripersonal spatial representation—for one of the most carefully and repeatedly documented facts concerning peripersonal spatial representation is that it involves integrating sensory information in frames of reference structured around various body-parts. Early important work in this area used single neuron recording in macaque monkeys to reveal both cortical and subcortical neural populations with multisensory receptive fields. For instance, cells that responded to tactile stimulation on a part of the hand (Rizzolatti et al., 1981a) would also respond to visible objects close to the hand and only poorly for visual stimuli at a greater distance (Rizzolatti et al., 1981b). Cells have been documented with similar visuotactile receptive fields for the surface and surrounding regions of various body-parts, such as the head, neck, and trunk (Fogassi et al., 1996; Graziano & Gross, 1993), with some cells exhibiting responses to not only visual and tactile, but also auditory stimuli (Graziano, Reiss, & Gross, 1999).

The embedding of these multisensory receptive fields is demonstrated in various ways. If a body-part for which a cell has a tactile receptive field is moved, the field within which the cell will be responsive to visible objects will shift accordingly. For instance, a cell might have a tactile receptive field for the dorsal surface of the forearm and a visual receptive field for the adjacent region above. When the arm moves, the cell's response again increases or decreases as a function of the visible object's distance from the arm; when the arm is moved out of sight, the cell ceases responding to visual stimuli altogether, even though the retinal location of the stimuli are unchanged. In short, these cells respond to multisensory stimuli in egocentrically structured frames of reference embedded in particular body-parts.

Similar results have been found in the study of human spatial attention, in both neurologically normal subjects (Spence, Pavani, & Driver, 1998, 2004) and those suffering from visuotactile and audiotactile extinction (di Pellegrino, Làdavas, & Farnè, 1997; Farnè & Làdavas, 2002). Taken together, this work suggests that the brain systematically integrates tactile information, concerning the superficial surface and/or orientation of a particular body-part, with visual and auditory information concerning the space surrounding that part, in egocentric frames of reference the perspectives of which are embedded within that part.

Robert Briscoe's comments on the relevance of this research for egocentric structure of perceptual experience are worth quoting at length:

This subpersonal representational arrangement seems to be reflected at the personal level [...] I may perceive, e.g., that the object is closer to my right hand than to my left hand, or above my waist, or below my chin, etc. Such body-relative spatial information [...] is part of the content of a visual experience of an object and is reflected in its phenomenology. (Briscoe, 2009, pp. 425–426)

We are capable of such a broad range of egocentrically structured perceptual experiences, he claims, in virtue of our proprioceptive awareness of our body-parts. As he puts it: 'my visual experience of an object may convey information about its location relative to any part of my body (seen or unseen) of which I am proprioceptively aware' (*ibid.*, p. 425).

It is arguable that proprioception can play this role, because it is critical in solving a problem faced by the brain, so to speak, which is very similar (and closely related) to that which we have called the problem of perspectival unity: how is it that neural structures are able to integrate sensory information, if that information is encoded in such a great variety of egocentric frames of reference? In essence this is a coordinate transformation problem—a problem of mapping coordinates from one frame of reference to another. Achieving such a mapping requires some means of identifying locations specified in one frame with locations specified in another (Clark, 2010; Driver & Spence, 1998). Part of the solution to this problem may be that these various sources of information are integrated in virtue of being combined with proprioceptive information concerning the body-parts within which the egocentric structures are embedded. If proprioception provides information about positions of body-parts relative to one another, this information can be used to achieve coordinate transformations between egocentric frames of reference (Briscoe, 2019, section 6).

Let us assume (as is eminently plausible) that coordinate transformation can serve to integrate information from distinct egocentric frames of reference. Would this then be sufficient to solve the problem of perspectival unity? It is not at all obvious that it would be sufficient on its own, precisely because it might be that coordinate transformation is achieved 'on the fly', using a flexible mechanism for integrating information in any frame available to the system (Pouget, Deneve, & Duhamel, 2002). This would then be compatible with a form of partial unity, such that various egocentric structures may be unified with one another (pairwise, for instance) without each structure being unified with every other (*cf.* Bayne, 2010, pp. 36–45).

13.4.4 Ultimate accounts

Ultimate accounts supplement the bare notion of coordinate transformation with the notion of an ultimate frame of reference anchored to a particular body-part. Thus, on such accounts,

all the egocentric frames of reference comprising the complex structure of a subject's egocentric perspectival experience are mapped onto a single, ultimate frame.

There are independent motivations for such an ultimate frame being anchored to the head or to the torso. A great number of spatially informative sensory organs are found in the head: the eyes, ears, and the vestibular labyrinth. As Sherrington noted, the latter is a particularly significant source of spatial information, in that the vestibular system 'maintains not merely a limb in flexion or extension, but a posture of the whole animal in regard to gravitation' (Sherrington, 1907, p. 480). But, morphologically speaking, the head is not the most major body-part and it is one of the most mobile. By contrast, the torso is the most major body-part and the least mobile, making it perhaps the most stable anchor for the construction of a consistent egocentric representation (Blanke, 2012; Grush, 2000).

It is not clear on what grounds we should evaluate these two possibilities. We should question the need to make such a choice, for it is not at all obvious that opting for one over the other would be optimal. Each presents a robust means by which cognitive systems might perform coordinate transformations between reference frames available to the system. Depending on the current needs of the system, a head-embedded frame might serve best, for instance, where a task ultimately requires comparison of visual and vestibular information (Ionta et al., 2011; Pfeiffer et al., 2013); in other circumstances, a torso-embedded frame might be the optimal choice (Serino et al., 2015).

Indeed, it is evident that cognitive systems exhibit a great deal of flexibility in their use of spatial information (Millar, 2008). They are able to use hybrid frames involving combinations of body-part anchored frames (e.g. Carrozzo & Lacquaniti, 1994) and idiosyncratic frames for transformation between body-part anchored frames (e.g. Chang & Snyder, 2010; Gazzaniga, Ledoux, & Wilson, 1977). Such flexibility seems a virtue. It only seems a vice when placed in an inappropriate context of trying to find a single, spatially unified representation for all purposes.

13.5 Agency and perspectival unity

13.5.1 Agency and egocentricity

What I hope to have shown in the course of this chapter is that it is not a trivial matter how a subject can 'build up a unitary picture' from the multiple ways in which her perceptual experience of the world is egocentrically structured, such that she experiences 'one egocentric space' (Evans, 1982, p. 160). In this final section, I now hope to fulfil the other aim stated at the start, to show how this matter is addressed by the Evansian conception of egocentricity, according to which being in possession of '[egocentrically structured] perceptual information at least partly consists in being disposed to do various things' (Evans, 1985, p. 383).

We can develop an agentive account of perspectival unity from this basic idea and its elaboration in the writings of, for example, José Luis Bermúdez (1998, 2005), Bill Brewer (1992, 1993), Robert Briscoe (2009, 2019), and Christopher Peacocke (1986, 1992), for it follows from this that each of a subject's egocentrically structured experiences will have as a common constraint the agentive capacity of the subject. Moreover, each will represent objects and events with respect to a perspective embedded in a part of the very same whole, within the body as a dynamic unity. We do not suffer the disunity of *Split's* experience, not

merely because of the integration of the information encoded within and between our sensory systems, but rather as a consequence of their integration with our capacities for bodily action.

13.5.2 The agentive unity of egocentric perspective

Many theorists who are broadly sympathetic to the Evansian conception show some degree of sensitivity, at least, to the idea that there might be some issue. For instance, Peacocke writes: 'Actually, in the specification of the representational content of some human experiences, one would need to consider several such systems of origins and axes, and to specify the spatial relations of these systems to one another' (1992, p. 63). These remarks—and similar ones made by proponents of an intimate connection between egocentrically structured perception and action (see, e.g. Bermúdez, 1998, pp. 140–142; Briscoe, 2009, pp. 424–426; 2019, section 6) are somewhat brief. But what they suggest is roughly that, to the extent that there is a problem here, it can be resolved by establishing spatial relations between egocentric structures.

In the last section, we considered three kinds of account that did just that. Sensory accounts establish spatial relations by means of overlap in sensory fields, transformation accounts by means of coordinate transformation, and ultimate accounts by means of an ultimate frame of reference serving as a universal for such transformations. I have argued that each of these kinds of accounts is insufficient to resolve the problem at hand, but there is a sense in which each picks out one of the many means by which egocentric structures can be related. Indeed, *pace* the denial of synchronic perspectival unity, there may also be a lesson to be learned from switching accounts. For whether or not we do experience the world from multiple perspectives at a time, it is certainly plausible that, even as a general rule, our attentional focus may be such that a single egocentric structure may be more prominent than the others.

An agentive account serves to supplement the bare idea of spatially relating egocentric structures by providing a means for all such structures to be unified in their relation to a single agent. What the other accounts provide is a further specification of the particular forms that the complex egocentric structure of a subject's experience might take and some of the mechanisms that might be involved. Thus, a subject's experience may be unified according to a single perspective, such that one particular egocentric structure within a particular modality shapes the focus of her engagement with the world. Nevertheless, this structure might be synchronically unified with several others in virtue of coordinate transformations supported by a common anchor.

13.5.3 Evidence for action-orientated peripersonal representations

In closing, I want to illustrate a little further how the agentive account manages the contrast between *Split* and ordinary subjects, by appealing to the well-established action-orientated function of peripersonal representations.

As di Pellegrino and Ladavas write, peripersonal spatial representations are 'probably best described as multisensory-motor interfaces, which serve to encode the location of nearby sensory stimuli to generate suitable motor acts' (2015, p. 131). Evidence for the action-orientated function of peripersonal spatial representation abounds. Visuotactile integration

has been shown to be sensitive to the functional range of action effectors located in the relevant regions (Làdavas, 2002; Làdavas & Serino, 2008). Indeed, this is of key behavioural significance, precisely because that range determines the system's physical contact with objects of interest (de Vignemont, this volume). This has been demonstrated by extending the functional range of effectors through the active use of a tool such as a rake or hockey stick. Using single neuron recordings, Iriki, Tanaka, & Iwamura (1996) found that cells with visuotactile receptive fields surrounding the hand were sensitive to visual stimuli presented around the distal end of an actively used tool, held in that hand. Similarly, cross-modal extinction effects have been found at the tip of an actively used tool (Farnè, Bonifazi, & Làdavas, 2005; Farnè & Làdavas, 2000). And visual distracters placed at the tip of an actively used tool had a cross-modal congruency effect similar to visual distracters from LEDs on subjects' hands (Holmes, Calvert, & Spence, 2007).

These 'multi-sensory motor interfaces' are also affected by a range of basic features of visual or auditory stimuli, such as direction and velocity, but also more complex features such as positive or negative valence (Bufacchi & Iannetti, 2018). The latter suggests a broadly useful way of classifying the action-orientated functions of peripersonal spatial representations into appetitive and defensive functions (de Vignemont & Iannetti, 2015), although I agree with the caveat noted by Klein (this volume) that it is only in limit cases that we can easily individuate actions on these bases, because so many of our actions involve acting carefully to fulfil our needs.

13.5.4 Split agentive perspectives

How might possessing this further property of peripersonal spatial representation (*viz.* being action-orientated) affect *Split's* case? Assume that it would be possible to integrate the sensory systems of *Visuo*, *Audio*, and *Tactuo*, such that they formed action-orientated multisensory representations of the space surrounding the corresponding parts of each body. The integration on the sensory side of the interface would necessitate that the motor outputs would affect all *Split's* bodies simultaneously. This is perhaps almost inconceivable, because it would be a remarkably dysfunctional mechanism for *Split*. And the situation is no better for *Split-juxtaposed*. What, for instance, would be the appropriate action in a case in which *Visuo* is presented with a positively valued visual stimulus and *Audio* is presented with a negatively valued auditory stimulus in the same apparent direction?

The trouble here is that *Split's* bodies, even when juxtaposed, do not form a part of the same physical whole in the facsimile-physics of her virtual worlds. They occupy the same location, but this is not in virtue of their unity: it is merely in virtue of a mapping between her visual, auditory, and tactual worlds. Consequently, the connections between *Split's* complexly structured perspectival experience and her actions would involve individually establishing how things are with respect to the body with which she acts. The only way in which *Split's* or *Split-juxtaposed's* situation would be workable would be to sever the direct connection between the multisensory representation and action inherent in peripersonal spatial representation. In this way, she would be able to flexibly distinguish between, for example, what her visual world afforded to *Visuo* and what her auditory world afforded to *Audio*.

But this is precisely the difference that makes the difference in our case for, in our case, there is no distinction between the body with which we act on the basis of what we see, hear, or feel. Each of the ways in which we experience the world perspectively is unified in virtue of its structural connection to a single thing, the one and only body with which we directly

act. This, I think, is the best way of making sense of Evans' dictum: 'There is only one egocentric space, because there is only one behavioural space' (Evans, 1982, p. 160).

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