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The intrinsic frame of reference and the Dhivehi ‘FIBO’ system

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Abstract

While geocentric and relative frames of reference have figured prominently in the literature on spatial language and cognition, the intrinsic frame of reference has received relatively little attention. Since Levinson’s (1996; 2003) influential work, various subtypes of the intrinsic frame have been proposed (Danziger 2010; Pederson 2006; Shinohara & Matsunaka 2004). This paper presents a revised classification of the intrinsic frame, distinguishing between three subtypes: a ‘direct’ subtype, an ‘object-centered’ subtype and a ‘figure-anchored’ subtype, with a cross-cutting distinction between ‘function-based’ and ‘shape-based’ systems. In addition, the ‘FIBO’ (front = inner, back = outer) system in Dhivehi is analyzed as an example of a borderline case, with some important features of the intrinsic frame but also some differences, presenting a challenge for existing frame of reference classifications. The rotational properties of these various systems are also considered. The analysis underscores the considerable diversity within intrinsic systems but also points to a closer relationship between intrinsic and extrinsic frames than has previously been appreciated. This may have implications for broader theoretical issues including how frames of reference are acquired, how speech communities come to use different frames and whether patterns of frame use in discourse shape patterns of non-verbal frame use.

Keywords: frames of reference, intrinsic frame of reference, Dhivehi, spatial language, spatial cognition

1 Introduction

The domain of space is central to the relationship between language and cognition – for example, conceptualizations of space form the basis of many conceptual metaphors (e.g., Lakoff & Johnson 2003). One aspect of spatial language and cognition that has attracted considerable interest in recent decades is spatial frames of reference. Frames of reference are systems for representing the location, orientation, or path of one object or person (the 'figure') with respect to another (the 'ground'). Different frames of reference rely on different conceptual 'anchors' – entities from which sets of directions are derived – or vary in how the relevant directions are derived from the anchor (Levinson 2003: 39–53). Much of the literature on frames of reference has focused on comparing geocentric and egocentric frames across languages and in cognition, fueling the debate over linguistic relativity (e.g., Dasen & Mishra 2010; Levinson et al. 2002; Li & Gleitman 2002; Li et al. 2011; Majid et al. 2004). Other work has largely concerned the role of the environment in shaping geocentric frames (e.g., Heegård & Liljegren 2018; Palmer 2015; Palmer et al. 2017, 2018).

Compared to geocentric and (relative) egocentric frames of reference, the intrinsic frame has received relatively little attention, with some notable exceptions (e.g., Bohnemeyer & Tucker 2013; Danziger 2010). This is despite the fact that the intrinsic frame is thought to be the first frame of reference acquired by children (Johnston & Slobin 1979; Levinson 2003: 308; Tanz 1980) and is apparently found in nearly all languages – Levinson (2003: 81) describes it as "close to linguistic bedrock, in that it is near universal", with some languages relying on it almost exclusively. The intrinsic frame also forms the basis for the relative frame, which is represented by much of the same vocabulary (e.g., the terms *front, back, left* and *right* in English). The intrinsic frame of reference should therefore be considered of crucial importance to our understanding of spatial language and cognition.

This paper offers a classification of intrinsic frame of reference subtypes, bringing together some different proposals made in the literature and drawing attention to the theoretical significance of a relatively unknown subtype of the intrinsic frame, which I will call the 'figure-anchored' intrinsic frame. This subtype is shown to have much in common with the relative frame of reference, despite not being anchored to the speaker's viewpoint. In addition, this paper discusses the 'FIBO' (front = inner, back = outer) system in Dhivehi (Indo-Aryan, Maldives), which is more difficult to classify. This system has some key features in common with the intrinsic frame of reference, especially the figure-anchored subtype, but patterns like a landmark-based frame in terms of its rotational properties.

Both the figure-anchored subtype and the Dhivehi FIBO system therefore illustrate some important connections between the intrinsic frame and other frames of reference. These connections, which have not previously been acknowledged, may have some important implications for broader questions relating to frames of reference, such as how children acquire certain frames, how different languages or speech communities may come to employ different frames over time, and whether spatial language influences spatial cognition more generally. While it is beyond the scope of this paper to pursue these broader questions, it is hoped that the analysis presented here will contribute some new pieces to those puzzles and that it will lead to further work on the intrinsic frame.

The paper is divided into five parts. Following this introduction, Section 2 compares different classifications in the literature to show how the intrinsic frame of reference may be demarcated from other frames. Section 3 then identifies various subtypes of the intrinsic frame, with special attention to the figure-anchored subtype. Section 4 illustrates the Dhivehi FIBO system and discusses its relationship with the intrinsic frame as well as with other frames of reference. Section 5 compares the rotational properties of different frames and their subtypes. Section 6 concludes.

2 Frames of reference

Several different classifications of frames of reference have emerged in the literature on spatial language and cognition. Most of the differences between the various classifications relate to issues concerning the intrinsic frame and its boundaries with other frames. Table 1 below shows four influential or representative classifications in the literature, expanding on a similar comparison presented by Bohnemeyer and Tucker (2013: 641):

Table 1: Classifications of frames of reference

Anchor	**Example**	**Psychology**	**Levinson**	**Bennardo**	**MesoSpace**
Viewpoint	(1) *The ball is in front of the chair.* (from the viewer's perspective)	Egocentric or Viewer-Centered	Relative	Relative	Relative
Ground (=SAP[1])	(2) *The ball is in front of me.*		Intrinsic		Direct
Ground (≠SAP)	(3) *The ball is in front of the chair.* (with respect to the chair's own front)	Intrinsic or Object-Centered		Intrinsic	Object-Centered
Landmark (=SAP)	(4) *The ball is toward me from the chair.*	Egocentric or Viewer-Centered		Absolute	Direct or SAP-Landmark
Landmark (≠SAP)	(5) *The ball is toward the door from the chair.*	Geocentric or Environment-centered			Landmark-based
Slope (locally restricted)	(6) *The ball is uphill from the chair.*				Geomorphic
Slope (not locally restricted)	(7) *The ball is north of the chair.*		Absolute		Absolute

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[1] 'SAP' here stands for 'speech act participant' – typically the speaker but sometimes the hearer.

As the first column shows, these four classifications organize frames of reference based on their anchor. The anchor may be a viewpoint, the ground (i.e., the reference object or ‘relatum’), a landmark (i.e., an additional object or location invoked to help calculate a bearing from ground to figure), or what Levinson (2003) calls a ‘slope’ – a kind of natural gradient, axis, or set of axes motivated by environmental features but which does not simply point towards some landmark.

These differences have resulted in different classifications cross-cutting each other in various ways. In much of the psychological literature (e.g., Carlson-Radvansky & Irwin 1993; Li & Gleitman 2002), a crucial distinction relates to whether the anchor is the speaker (‘egocentric’ or ‘viewer-centered’ frames) or something else (‘allocentric’ frames). Allocentric frames are further divisible into intrinsic (or ‘object-centered’) frames and ‘geocentric’ (or ‘environment-centered’) frames depending on whether the frame is anchored to the ground object itself or something external in the environment. This classification is shown in the third column of Table 1 above.

The psychological classification maps rather poorly to the classification developed by Levinson and colleagues for typological purposes (e.g., Levinson 1996; 2003; Levinson & Wilkins 2006; Majid et al. 2004; Pederson et al. 1998), shown in the fourth column of Table 1 above. The Levinsonian system employs a very broad ‘intrinsic’ category that subsumes many kinds of spatial references that are differentiated in other classifications.

On the other hand, Bennardo (2000; 2009) and many other Oceanicists (e.g., François 2004; Palmer 2015: 194–199; Senft 2001: 539–540) use a broad ‘absolute’ category that incorporates at least some kinds of landmark-based references, perhaps due to the importance of the sea and some other environmental landmarks in the directional systems of Oceanic languages. This classification is represented in the fifth column of Table 1.

Danziger (2010) argues for a distinction between ‘direct’ and ‘object-centered’ intrinsic frames on the basis that the speaker or some other speech-act participant serves as anchor (and ground) in examples like (2) but not (3) in Table 1 above. As Danziger observes, this difference is reflected in the rotational properties of the two frames – rotating the speaker falsifies (2) but not (3). In other words, the direct frame is a kind of egocentric frame, but the object-centered frame is not. However, both are distinct from the relative egocentric frame in (1), where the anchor is not the same as the ground. This analysis has been adopted by Bohnemeyer and his colleagues in the ‘Spatial language and cognition in Mesoamerica’ project (e.g., Bohnemeyer 2011; Bohnemeyer & O’Meara 2012;

Bohnemeyer & Tucker 2013), also known as ‘MesoSpace’. The MesoSpace classification, shown in the final column of Table 1, is the most fine-grained of those discussed here, distinguishing between all eight possibilities presented in the table.

Of the examples in Table 1 above, I will consider only (2) and (3) to be cases of the intrinsic frame of reference in this paper. This is because in both (2) and (3) the anchor is the ground, even though the ground happens to coincide with the viewer in (2). I will return to this distinction between direct and object-centered intrinsic frames in Section 3. Examples (4) and (5) introduce a landmark (*me* or *the door*) that functions as the anchor of the description, a third entity separate from the figure and ground. Because the anchor here is not the ground itself, but something external to the figure-ground array, (4) and (5) may be distinguished from the intrinsic frame. These are landmark-based frames, with (4) representing an egocentric or SAP-landmark frame and (5) an allocentric landmark-based frame. For similar reasons, examples like (6) may be distinguished from the intrinsic frame because the anchor is not to be found in the figure-ground array but in some conceptual ‘slope’ across the local environment (e.g., an uphill-downhill axis).

3 Subtypes of the intrinsic frame of reference

3.1 Function-based vs. shape-based systems

In English and many other languages, some objects are perceived as having an inherent ‘front’ side based on functional properties such as a sensory apparatus (e.g., the eyes or nose of an animal or the lens of a camera), a canonical direction of motion (e.g., of a vehicle) or a canonical direction of access (e.g., of buildings, cupboards, televisions, etc.). An opposite ‘back’ side may be derived secondarily, along with ‘left’ and ‘right’ sides on a perpendicular axis. ‘Left’ and ‘right’ sides may be determined either in relation to the object’s own front and back, or may be inherited from the left and right sides of the humans who use the object (see Levinson 2003: 41–43, 76–77). For example, the man in Figure 1 below may be described in English as *in front of the car*, and the dog as *to the right of the car*, in a function-based intrinsic frame:

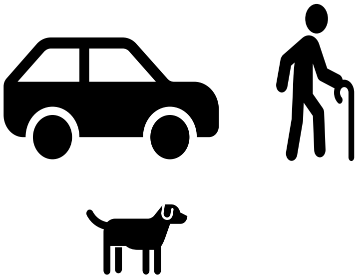

Figure 1: Example of a scene allowing a function-based intrinsic frame of reference in English

Some languages do not (only) assign intrinsic facets based on functional attributes, but instead assign intrinsic facets or parts based on the object's shape. In many of these languages, human body-part terms are productively mapped onto the ground object according to a system of geometric correspondences. Such systems have been widely reported for Mesoamerican languages including the Mayan languages Tzeltal (Brown 2006; Levinson 1994), Tzotzil (de Léon 1993) and Yucatec (Bohnemeyer & Tucker 2013). Figure 2 below shows an example from Yucatec (adapted from Bohnemeyer & Tucker 2013: 644) in which body-part terms are assigned to parts of a knife based on its geometry:

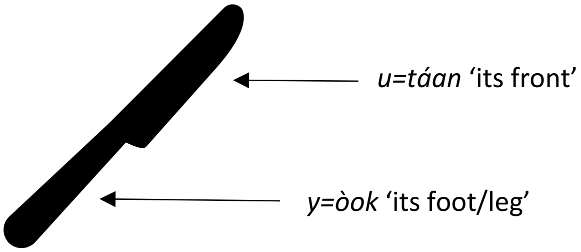

Figure 2: Shape-based assignment of intrinsic parts in Yucatec

Which body-part terms are recruited, and how they are mapped to the parts or facets of various objects, is largely language-specific. But such systems have two key properties in common: (i) they are based on geometry, rather than function (e.g., for Yucatec speakers, the 'leg' of a knife is not based on function – it cannot stand – but on its shape); and (ii) they are independent of any external viewpoint or absolute axis (i.e., they are truly intrinsic systems). The latter property entails that if 'top' and 'bottom' sides are assigned on the basis of gravity rather than geometry (as in Ayoquesco Zapotec, for example – see MacLaury 1989), such that the object's sides get re-labelled when the object is flipped over, then the language in fact has an absolute system on the vertical axis rather than a truly intrinsic system.[2]

It is possible for a language to employ both a shape-based intrinsic system and a function-based one. An example is Bashkir (Turkic, Russia; Nikitina 2018), which has a shape-based system assigning the ‘front’ to the most prominent geometric part of an object but also uses a typical function-based system. For an object such as a chair, where the most prominent part happens to correspond to the functional ‘back’ (i.e., the part where a human’s back would be), descriptions involving terms for ‘front’, ‘back’, ‘left’ or ‘right’ are ambiguous between a shape-based interpretation and a function-based one (with a third reading according to the relative frame also possible). This is illustrated in Figure 3 below:

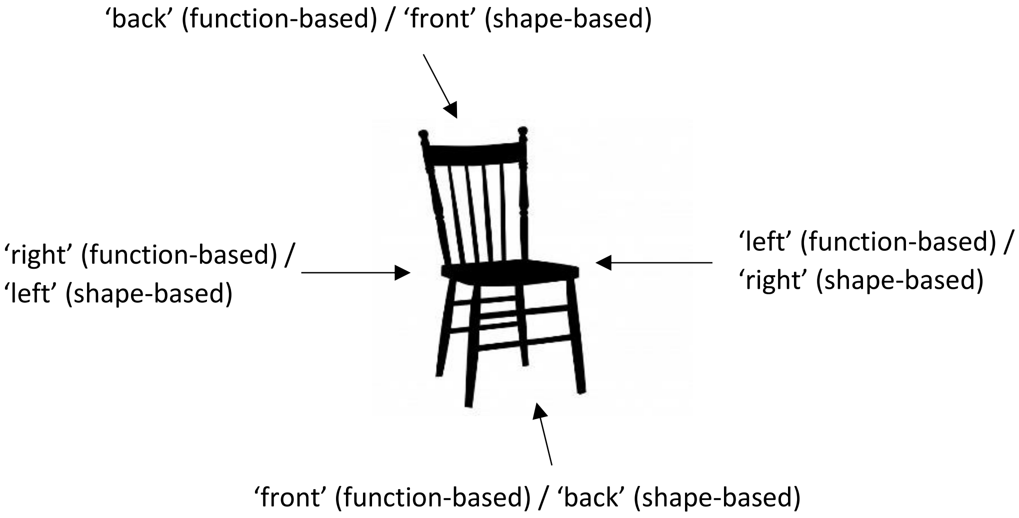

Figure 3: Competing intrinsic systems in Bashkir

3.2 The identity of the anchor

3.2.1 Direct vs. object-centered systems

A further distinction within the intrinsic frame of reference may be made based on the identity of the anchor. As discussed in Section 2, in most classifications the intrinsic frame is defined as a

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[2] Cf. Levinson’s (2003: 78–79) analysis of the Zapotec system as a third kind of intrinsic system alongside the better-known shape-based and function-based types.

frame that uses the ground as anchor. This means that of the examples in Table 1 in Section 2 above, only (2) and (3) (illustrated below in Figures 4 and 5 respectively) use the intrinsic frame:

Figure 4: Direct intrinsic frame –'The ball is in front of me'

Figure 5: A scene permitting an object-centered intrinsic frame – 'The ball is in front of the chair'

The difference between the direct intrinsic frame and the object-centered intrinsic frame, as proposed by Danziger (2010) and as discussed in Section 2 above, is that while the anchor is the ground in both cases, it is the speaker (or a speech-act participant) in the direct intrinsic frame but an object in the object-centered intrinsic frame. Figure 4 thus illustrates the direct intrinsic frame, where the speaker is the anchor and ground. Figure 5 shows a scene for which an object-centered intrinsic frame is possible, where an object (in this case, a chair) serves as the anchor and ground.

3.2.2 Figure-anchored systems

If the intrinsic frame must have the ground as anchor, then the direct and object-centered subtypes would seem to exhaust the possibilities. However, some languages appear to use the *figure* as the anchor of certain spatial descriptions, a possibility not considered by the classifications considered thus far. This strategy is sometimes considered to represent a special case of the intrinsic frame, known as 'figure-aligned' (Shinohara & Matsunaka 2004), 'ascribed intrinsic' (Pederson 2006: 427–428), 'ascribed orientation' (Edmonds-Wathen 2012: 185–186) or 'quasi-intrinsic' (Gaby, Blythe & Stoakes 2016). As Shinohara and Matsunaka (2004) observe, this strategy may be regarded as an intrinsic frame because it is neither relative nor geocentric and because it depends on the orientation of one of the objects being described (i.e., an object in the figure-ground array). Shinohara and Matsunaka therefore propose that the intrinsic frame should be regarded as a frame anchored on *either* the figure or the ground, amending previous definitions in the literature. In addition, as I will show in Section 5, descriptions anchored in the figure share a crucial rotational property – constancy under rotation of the figure-ground array – with other intrinsic frames but not with relative or geocentric frames.

Of the different labels in the literature, Shinohara and Matsunaka's (2004) term 'figure-aligned' best captures the fact that the figure's orientation is crucial in these systems, which map the figure's facets onto the ground. However, as I will show below, there are different kinds of mappings from figure to ground, such that the ground is not always perceived as sharing the same orientation as the figure – that is, the figure and ground are not necessarily 'aligned'. I will therefore call these kinds of systems 'figure-anchored' intrinsic frames to capture the fact that the figure functions as the anchor of the system, without implying that the figure and ground are aligned.

Figure-anchored systems are not well documented in the literature on frames of reference, and there has been very little analysis of their mechanics or their relationship with other frames. They are not mentioned in Levinson's (1996; 2003) influential work, nor are they represented in any of the classifications discussed in Section 2 above. Perhaps the earliest report of such a system was for Tamil (Pederson 1993: 304–305), though Pederson did not explicitly classify it as a kind of intrinsic frame until later (Pederson 2006: 427–428). According to Pederson, for a scene like the one in Figure 6 below, some Tamil speakers describe the horse as *pinnale* 'behind' the tree:

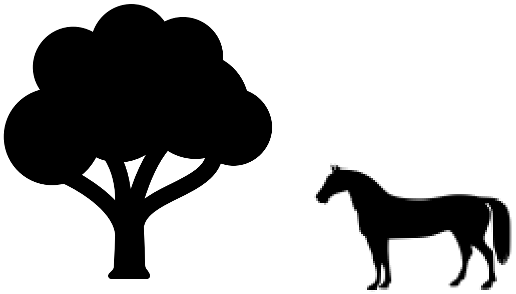

Figure 6: A scene permitting a figure-anchored intrinsic frame in Tamil – 'The horse is behind the tree'

The intrinsic facets of the figure (here, a horse) are mapped or transposed onto the ground object (the tree). The basis of this mapping appears to be a construal of the ground as facing the same way as the figure (and perhaps moving in the same direction). Once the mapping has been made, it is possible to describe the location of the figure with respect to the ground's newly assigned facets – e.g., once the tree is perceived as having a back or behind, it is possible to describe the horse as 'behind' the tree. Since the figure's orientation is the source of the mapping, the figure is the anchor of the system.

Shinohara and Matsunaka (2004) report a similar system in Japanese. In an experiment conducted with 49 native speakers of Japanese, Shinohara and Matsunaka found that participants predominantly used the relative frame of reference to represent the relationship between the figure (a wooden block or a model car) and the ground (a wooden block).[3] However, for scenes where the figure was the model car (i.e., a figure with intrinsic facets), nearly a third of responses used a figure-anchored system. For example, when the car was on the near side from the participant's perspective and facing to the right of screen (as in Figure 7 below), some participants selected *migi* 'right', such that the description read 'the car is to the right of the block':[4]

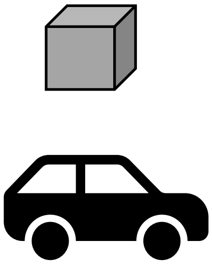

Figure 7: A scene permitting a figure-anchored intrinsic frame in Japanese – 'The car is to the right of the block'

Since the block does not have its own right side, and the car is not to the block's right from the viewer's perspective, this kind of description involves neither an object-centered intrinsic frame nor a relative frame. As Shinohara and Matsunaka (2004: 275) observe, "[i]t is the figure that provides the primary coordinate system that is mapped onto the ground", i.e., the figure is the anchor for the description. Like in the Tamil case described earlier, this mapping seems possible only because the figure has an intrinsic orientation while the ground does not. An interesting difference, however, is that while Pederson (1993; 2006) identifies a figure-anchored usage of the

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[3] On a computer, participants viewed 12 photos of scenes with these items in various positions and orientations. Participants were presented with a Japanese sentence on the screen with a blank space where they could select one of four options, e.g., 'The car is in ( ) of the block'. The four options offered were *mae* 'front', *ushiro* 'back', *migi* 'right' and *hidari* 'left'.

[4] See Shinohara and Matsunaka (2004) for the photos used in the original experiment. Figure 7 is an adaptation of Picture 9 in their study.

Tamil word *pinnale* 'behind', Shinohara and Matsunaka (2004) identify figure-anchored usages of the Japanese terms *migi* 'right' and *hidari* 'left'. Because of the configurations of the objects in Shinohara and Matsunaka's study, it is not known whether Japanese speakers also use terms for 'front' and 'back' in a figure-anchored way. Pederson (pers. comm.) reports that in Tamil, the use of the figure-anchored system is not restricted to the 'behind' relator but may also be used for 'front' and to a lesser extent for 'left' and 'right' terms.

Figure-anchored systems have also been identified more recently in a few languages and language varieties of northern Australia. According to Edmonds-Wathen (2011; 2012: 150–155), Iwaidja speakers playing the 'Man & Tree' photo-matching game (Ann Senghas version: Senghas 2000; see also Terrill & Burenhult 2008) assign a front or back to the tree based on the orientation of the toy man.[5] The same strategy is used by some Kunwinjku-speaking children as well as by children speaking Aboriginal English (Edmonds-Wathen 2012: 215, 219–221). In Figure 8 below, for example, the man can be described in Iwaidja as *warrwak* 'behind'; in Figure 9, he can be described as *wurdaka* 'in front':

Figure 8: A scene permitting a figure-anchored frame in Iwaidja – 'The man is behind'

Figure 9: Another scene permitting a figure-anchored frame in Iwaidja – 'The man is in front'

The use of *warrwak* 'behind' for the scene in Figure 8 is similar to the Tamil use of *pinnale* 'behind' described earlier. The use of a term meaning 'front' (*wurdaka*) for the scene in Figure 9, however, is different from the Tamil and Japanese examples illustrated earlier, which did not involve words meaning 'front'. Taken together, the examples considered thus far show that the figure-anchored

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[5] The Senghas version is based on an earlier 'Men and Tree' game developed by Levinson et al. (1992).

frame applies to ‘front’, ‘back’, ‘left’ and ‘right’ terms in different languages. However, based on the limited data available, it appears that the system is more likely to apply to ‘front’ and ‘back’ terms than to ‘left’ and ‘right’ terms. This may reflect the functional and geometric salience of the fronts and backs of objects (or people, animals, etc.) in comparison with their lefts and rights.

As a subtype of the intrinsic frame, how does the figure-anchored strategy relate to the direct and object-centered intrinsic subtypes? As shown above, it is not anchored on the ground, and in this respect it is unlike both the direct and object-centered subtypes of the intrinsic frame. However, the examples of figure-anchored descriptions presented thus far were all allocentric (i.e., non-egocentric), and in this respect they are like the object-centered subtype but not like the direct subtype. In theory, it would be possible for the figure to be the speaker in a figure-anchored description (e.g., if a speaker says *I am behind the horse* in a context where she is facing the horse, regardless of the horse’s orientation), but such a description could equally be analyzed as a relative frame projecting the speaker’s orientation onto the ground. These possibilities are shown in Table 2 below.

Table 2: Subtypes of the intrinsic frame of reference based on identity of the anchor

	Anchor ≠ Speaker (Allocentric)	**Anchor = Speaker (Egocentric)**
Anchor = Ground	Object-centered	Direct
Anchor = Figure	Figure-anchored	Ambiguous (Figure-anchored or Relative)

3.2.3 Figure-anchored vs. relative systems

It is important to observe that the figure-anchored systems described above are distinct from the ‘aligned’ or ‘translational’ relative frame found in Hausa, Tongan and some other languages (Bennardo 2000; Hill 1982; Levinson 2003: 84–89). The translational relative frame is a subtype of the relative frame of reference, but figure-anchored systems are not. In the translational relative frame (see Figure 10 below), the ‘front’ is the far side of the ground from the viewer’s perspective and the ‘back’ is the near side – i.e., the viewer’s facets are projected onto the ground via a process of geometric translation. In the ‘reflectional’ relative frame used in English and many other languages, however, the ‘front’ is the near side of the ground and the ‘back’ is the far side – i.e., the viewer’s facets are mapped onto the ground via geometric reflection. In the ‘rotational’ relative frame the viewer’s facets are mapped onto the ground via a 180° rotation, such that the ‘front’ and ‘back’ are the same as for the reflectional system, but the ‘left’ and ‘right’ of the ground are not aligned with the viewer’s. These subtypes of the relative frame are exemplified in Figure 10:

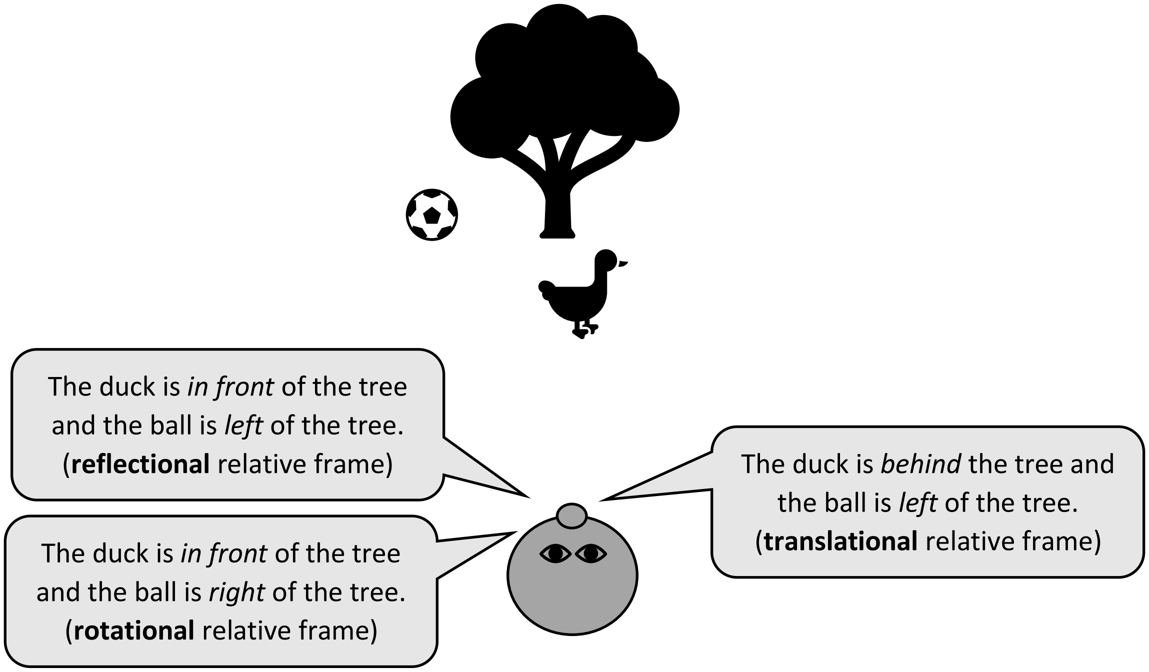

Figure 10: Subtypes of the relative frame of reference

All subtypes of the relative frame are anchored to a viewpoint (usually the speaker’s) that is separate from the figure and ground. In contrast, figure-anchored systems are anchored to the figure and are completely independent of the speaker’s viewpoint. If the viewer walks around the scene, or rotates the entire scene as a unit, a description in any subtype of the relative frame is falsified (Levinson 2003: 50–53), but would remain constant in a figure-anchored system.

Although figure-anchored usages are distinct from relative frames, they are sometimes compatible with relative interpretations. For example, in their account of frames of reference in Murrinhpatha (Southern Daly, northern Australia), Gaby, Blythe and Stoakes (2016; pers. comm.) note that for the scene in Figure 11 below, some speakers describe the man as *kumparra* 'in front' (and the tree as *tirduk* 'behind'):

Figure 11: A scene permitting a description ambiguous between a figure-anchored frame and a translational relative frame – 'The man in front'

Here, the description of the tree as *tirduk* 'behind' may be analyzed as an object-centered intrinsic frame – the figure (the tree) is located with respect to the ground's (the toy man's) intrinsic back. But the description of the man as *kumparra* 'in front' is ambiguous between the figure-anchored intrinsic frame and the 'translational' relative frame. That is, the man may be 'in front' of the tree either because intrinsic facets have been mapped from the figure to the ground such that the tree is now perceived as having a 'front', or because the man is on the far side of the tree from the speaker's perspective. The ambiguity arises because the term *kumparra* 'front' denotes a side on the sagittal (front-back) axis and the objects in the scene are arranged along this axis; the examples of the figure-anchored frame discussed earlier involved either a transverse (left-right) axis term with a sagittal arrangement of objects (e.g., Japanese) or a sagittal axis term with a transverse arrangement of objects (e.g., Tamil, Iwaidja), and so were not ambiguous with the relative frame.

According to Gaby, Blythe and Stoakes (2016), the same Murrinhpatha speakers use the same description (i.e., 'the man in front, the tree behind') for the photo in Figure 12 below, where the toy man is on the near side of the tree but facing the viewer:

Figure 12: A scene permitting a description ambiguous between a figure-anchored frame and a reflectional relative frame – 'The man in front'

In Figure 12, the description of the man as 'in front' is compatible with a figure-anchored analysis, if the man's facets have been mapped onto the tree such that the tree's front is towards the man. However, it is also compatible with a reflectional relative analysis – recall that in the reflectional relative system, the front of the ground is the near side from the viewer's perspective. Given that the same speakers use this description for both Figure 11 and Figure 12, it might be more parsimonious to assume that a single, figure-anchored strategy is at work in both cases, rather than two different relative frames, especially given that the relative frame is otherwise marginal in Murrinhpatha. Gaby, Blythe and Stoakes (2016) therefore analyze such examples as figure-anchored (or 'quasi-intrinsic' in their terminology). On the other hand, it is known that some languages use both the translational and reflectional variants of the relative frame (e.g., Tongan, Bennardo 2000), and so the relative frame analysis cannot be definitively rejected.

In the examples of the figure-anchored system considered above, a tree or some other 'unfeatured' ground is construed as facing the same way the figure is facing. However, it is also possible for the two items to be construed as facing opposite directions. According to Gaby, Blythe and Stoakes (2016; pers. comm.), in photos where the man is facing the tree (e.g., Figure 8 above or Figure 13 below), some Murrinhpatha speakers describe the man and tree as *dirrimninthanubatjdim* 'looking at each other'.

Figure 13: A scene in which the man and tree may be construed as 'looking at each other'

Although a tree does not have an intrinsic face and so cannot literally ‘look’, this kind of description implicitly identifies the ‘front’ of the tree as the side closest to the man’s front. Edmonds-Wathen (2012: 155–156) reports the same phenomenon in Iwaidja, and observes that Iwaidja speakers also sometimes describe the man and tree as *ngirrunmin* ‘back to back’ in scenes where the man’s back is to the tree (e.g., Figures 9, 11 and 12 above). In such cases, the ‘back’ of the tree is construed as the side closest to the man’s back. These descriptions of the man and tree ‘looking at each other’ or being ‘back to back’ are descriptions of the orientations of the man and tree, rather than descriptions of their locations. However, such examples illustrate that when the intrinsic facets of one entity in a scene are mapped onto another object, the mapping does not always occur in a way that results in the two entities sharing the same orientation.[6]

The different possible mappings from viewer to ground in the relative frame of reference are well established in the literature (e.g., Hill 1982; Bennardo 2000; Levinson 2003), but it is interesting to observe the parallels between these mapping types and the figure-to-ground mappings involved in figure-anchored systems. In relative and figure-anchored systems alike, facets are mapped onto the ground from the anchor – this means from the viewpoint in the relative frame and from the figure in the figure-anchored system. And in both kinds of system, it is possible to map facets in a ‘translational’ way (such that the anchor and the ground are construed as facing the same way), or in a ‘reflectional’ or perhaps ‘rotational’ way (such that the anchor and the ground are construed

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[6] In principle at least, this kind of non-aligned mapping could occur in locative descriptions too – for example, ‘the man is behind the tree’ might mean ‘the man has his back to the tree’ – though to the best of my knowledge this system is not attested in any languages.

as facing different ways). These possibilities are shown for front-back axis terms in Figures 14 and 15 below:

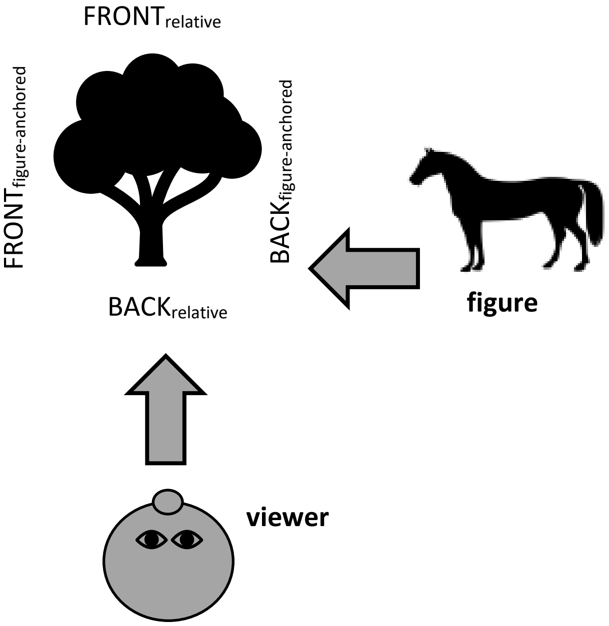

Figure 14: Translational mapping of facets from viewer to ground (relative frame) and from figure to ground (figure-anchored frame)

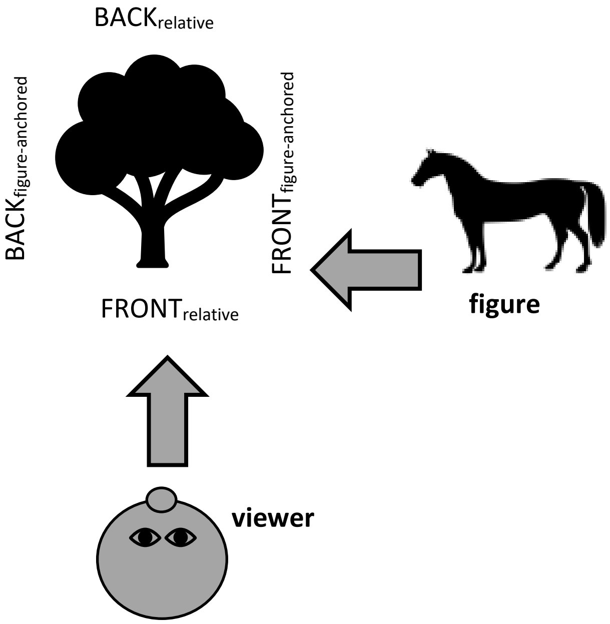

Figure 15: Reflectional/rotational mapping of facets from viewer to ground (relative frame) and from figure to ground (figure-anchored frame)

The translational figure-anchored mapping is the type of mapping involved in the Tamil, Iwaidja and Murrinhpatha locative descriptions presented earlier. It is also the type of mapping involved in the figure-anchored examples from Japanese, except that in Shinohara and Matsunaka's (2004) stimuli, the figure always has its left or right towards the ground, and so it is the figure's left and right that is translationally mapped onto the ground, rather than its front and back.

Reflectional or rotational mappings in the figure-anchored frame have not been reported for locative descriptions in any languages, as far as I am aware. However, as some of the Murrinhpatha and Iwaidja examples demonstrate, reflectional or rotational mappings are involved in some orientation descriptions, where two items in a scene are construed as 'facing each other' or 'back to back'. Note that in such examples, it is not possible to distinguish between reflectional and rotational mappings because both systems result in the relevant facets being in the same places – in Figure 15 above, for example, reflecting the horse's facets onto the tree results in the tree's 'front' being towards the horse, and mapping the horse's facets onto the tree by a 180° rotation obtains the same result.[7]

4 'Front' and 'back' in Dhivehi

4.1 The Dhivehi 'FIBO' system

I now turn to the use of 'front' and 'back' terms in Dhivehi (Indo-Aryan, Maldives). After briefly discussing some more familiar intrinsic and relative uses of these terms, I will show that Dhivehi has an additional system that cannot straightforwardly be classified as one of the intrinsic or relative systems discussed in previous sections. This system, which I will call 'FIBO' ('front = inner, back = outer') is to my knowledge not attested in any other language and has not been reported in the literature except in Lum (2018). The data presented here was collected during my

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[7] This contrasts with the relative frame, where because the anchor (i.e., viewer) is separate from the figure and ground, it is possible to distinguish between reflectional and rotational mappings on the basis of a figure object located to the 'left' or 'right' of the ground from the viewer's perspective (e.g., the ball in Figure 10 earlier) – i.e., there is an L-shaped configuration of anchor, ground and figure. But in a figure-anchored system, there are only two relevant entities – the figure (functioning as anchor) and the ground – and so there can be no such L-shaped configuration.

own fieldwork in Laamu Atoll and Addu Atoll in the Maldives, during visits in 2013-2015 (see also Lum 2018).[8]

The Dhivehi nouns *kurimati* ‘front’, *fahat̊* ‘back, rear’, *furagas* ‘back (esp. of an animate)’, *vāt̊* ‘left hand’ and *kanāt̊* ‘right hand’ refer to body parts but may also be used in (function-based) object-centered and direct intrinsic frames, like similar terms in many other languages. They are additionally used by some speakers in the relative frame of reference (Lum 2018).

There is, however, another way of using ‘front’ and ‘back’ terms in Dhivehi – the ‘FIBO’ system (Front = Inner, Back = Outer). This system may be used when the ground object forms one part of a broader ring-shaped configuration of objects. The inner side of the ground object (that is, the side closer to the center of the cluster) is construed as its ‘front’, while the outer side is construed as its ‘back’. Thus in a route description task (Lum 2018: 261-267), Dhivehi speakers commonly used ‘front’ and ‘back’ terms for the inner and outer sides (respectively) of various objects near the edge of the gameboard – the red blocks, toy fences, and toy flowers in Figure 16 below. The grey dotted line (not part of the actual array) in Figure 16 represents the imagined ring formed by the red blocks, the fences, and the flowers. The black ovals and the text boxes within them identify the ‘fronts’ and ‘backs’ of the various objects in the configuration according to this system – for example, the ‘fronts’ of both sets of fences are towards the yellow hill in the center of the board.

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[8] Australian Research Council Discovery Project Grant DP120102701.

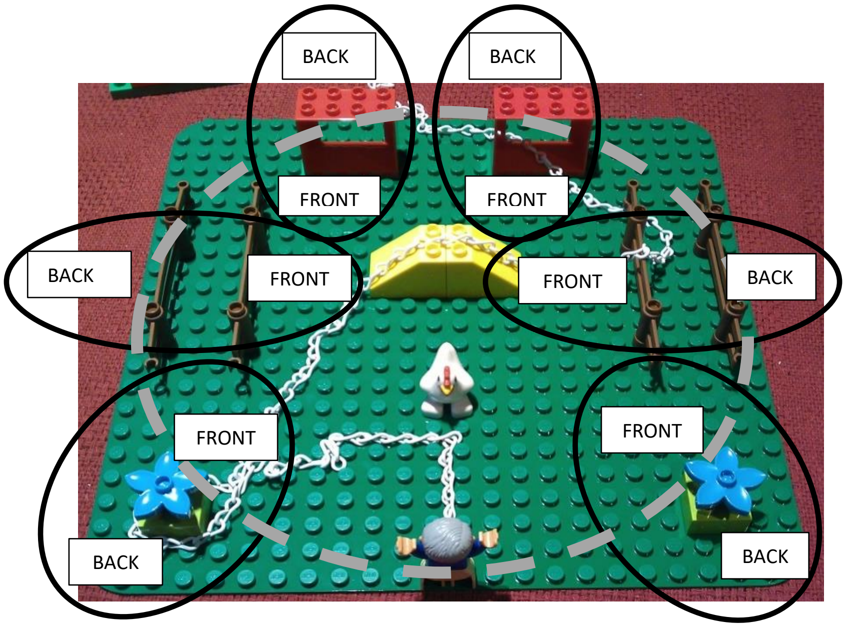

Figure 16: Assignment of 'front' and 'back' terms by Dhivehi speakers in a route description task

It is important to note that according to native speakers, the FIBO system can only be used when there is a cluster of unfeatured objects that (roughly) form a ring-like cluster, such as in Figure 16 above, or a circular formation of trees, bottles, balls or other unfeatured objects. The system does not apply to clusters of featured entities like people or furniture (since the function-based fronts and backs of these objects take precedence) nor to single ring-shaped objects like hoops or bracelets.

Since Dhivehi 'front' and 'back' terms can also be used in intrinsic and relative frames, as discussed above, and because the route description task is dynamic (with participants moving the figurine along as they describe the path through the scene), uses of such terms in this task are usually ambiguous between multiple interpretations. However, when the same speaker (or pair of speakers) uses 'front' and 'back' terms more than once in the task, in relation to different objects in the scene, it is often possible to observe a pattern emerge. I will illustrate this below with an example from two speakers from Fonadhoo, Laamu Atoll. In Figure 17 below, participant AY1 (right) is directing participant MA2 (left) to move the figurine around the outer side of a toy flower in one corner of the scene.

Figure 17: Participants AY1 (director, right) and MA2 (matcher, left) moving the figurine around a toy flower in a route description task

At this point in the task, AY1 tells MA2 that the route (marked out by the white chain on AY1's gameboard) passes by the flower but does not specify on which side. MA2 asks if AY1 means by the 'back' of the flower:[9]

(9) AY1 (Director):
goho *malu* *kairin̊* *lā=fa*
go.IMP flower.GEN near.ABL put.CVB=SUC
'Go by passing near the flower'
DIV_RD_LF_20131125_2_4_AY1_MA2_NE; 0:19

(10) MA2 (Matcher):
malu ***furagahun̊*** *?*
flower.GEN **back.ABL**
'By the **back** of the flower?'
DIV_RD_LF_20131125_2_4_AY1_MA2_NE; 0:22

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[9] Abbreviations: ABL = ablative; CVB = converb; DAT = dative; FUT = future; GEN = genitive; IMP = imperative; INF = infinitive; PROG = progressive; PST = past; SUC = successive; TAG = question tag. Note that in some of the examples, the Dhivehi ablative case indicates motion by or alongside something, as indicated in the translations. Its other functions include motion away from a source as well as an instrumental function.

After a few exchanges not involving ‘front’ or ‘back’ terms, MA2 again asks if the route goes by the ‘back’ of the flower, which AY1 subsequently confirms:

(11) MA2 (Matcher):

malu	***furagahun̊***	*lai=gen̊*	*goho*	*vaṣ̌ā_lān̊_vū*	*dō ?*
flower.GEN	**back.ABL**	put.CVB=SUC	go.CVB	circle.CVB_put.INF_be.PST	TAG

‘After passing by the **back** of the flower I have to go around [it], yeah?’
DIV_RD_LF_20131125_2_4_AY1_MA2_NE; 0:33

(12) AY1 (Director):

hmm
yeah

‘Yeah.’
DIV_RD_LF_20131125_2_4_AY1_MA2_NE; 0:34

No object-centered intrinsic interpretation is possible because flowers (including the toy flower used for the task) are not perceived by Dhivehi speakers as having inherent fronts or backs. Later in the same task, the route passes by the near side (from the speakers’ viewpoint) of one of the red square-shaped objects, shown in Figure 18 below. In describing this part of the route, however, AY1 tells MA2 to go *kurumattun̊* ‘by the front’ of this red object:

Figure 18: Passing 'by the front' of a red object in a route description task

(13) AY1 (Director):

rat̊	*eccu*	***kurumattun̊***	*lā=fa*	*dānū*
red	thing.GEN	**front.ABL**	put.CVB=SUC	go.FUT.PROG

‘[You] will be going by passing by the **front** of the red thing.’
DIV_RD_LF_20131125_2_4_AY1_MA2_NE; 1:37

Again, no object-centered intrinsic interpretation is possible for (13) as the square-shaped objects in the scene are not regarded as having inherent fronts or backs, according to my consultants. But if AY1 and MA2 are using *furagahun̊* ‘by the back’ and *kurumattun̊* ‘by the front’ in a relative way, they are not using the same relative frame subtype consistently throughout the task – (10) and (11) are compatible with a translational relative frame but (13) with a reflectional relative frame. The matcher, MA2, seems to understand AY1’s instructions as she is able to move her own figurine along the correct path. However, if the two speakers are using the FIBO system, then their use of ‘front’ and ‘back’ terms in the task is consistent – the route passes by the ‘back’ or outer side of the flower but by the ‘front’ or inner side of the red block.

The FIBO analysis is further supported by the use of ‘front’ and ‘back’ terms by the same speakers when describing a different route through the same scene, where they refer to the far or outer side of the red blocks as the ‘back’. In addition, they refer to the outer side of one of the brown fences as the ‘back’ of the fence. This use of *furagahun̊* ‘by the back’ in relation to the fence is not compatible with either a reflectional or translational relative frame, since the location being described is to the left of the fence from the participants’ perspective. This is shown in Figure 19 and example (14) below (note that for this route, MA2 was director):

Figure 19: Passing 'by the back' of a fence in a route description task

(14) MA2 (Director):

koṣ̌uga^{n}*ḍu*	***furagahun̊***	*lai=gen̊*
fence.GEN	**back.ABL**	put.CVB=SUC

hama	*uman̊*	*got-aṣ̌*	*umān̊_vū*
just	come.INF	way-DAT	come.INF_be.PST

'[You] have to come just straight [lit. 'to the coming way'] passing by the **back** of the fence.'

DIV_RD_LF_20131125_2_3_MA2_AY1_NE; 1:41

While the FIBO system seems the best analysis for the use of 'front' and 'back' terms by many participants in the route description task, it is difficult to quantify how common this system is in this task in comparison to relative or intrinsic frames. As demonstrated above, many individual descriptions are ambiguous between multiple frames or frame subtypes. Where a participant uses 'front' or 'back' terms only once, or multiple times but always in relation to the same object, it is often impossible to tell whether they used the FIBO system or not.

In order to investigate the prevalence of the FIBO system in (Laamu) Dhivehi, a separate task was designed in which participants were asked (in Dhivehi) to place a green block 'in front of' or 'behind' various blue blocks in a ring-shaped configuration (see Lum 2018: 267-281), as shown in Figure 20 below.[10] Each participant made at least four placements, two in response to an 'in front' instruction, and two in response to a 'behind' instruction, with additional placements requested of participants who produced ambiguous or mixed results.

Figure 20: A participant placing a block in the Object Placement Task

Based on their placements, each participant was coded as using FIBO, a relative frame (translational or reflectional/rotational), or another system as their dominant strategy. Participants were also coded for the level of consistency in their dominant strategy – either perfectly consistent or else showing some inconsistency (i.e., most but not all placements followed the same strategy). As Table 3 below shows, the predominant interpretation of 'front' and 'back' terms in this experiment was in line with the FIBO system.

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[10] As discussed in Lum (2018), the ring-shaped configuration was one condition within a broader experiment that tested participants' interpretations of various spatial terms. However, none of the preceding conditions involved configurations that could conceivably prime participants to adopt a FIBO interpretation – if anything, some of the earlier conditions (which tested for preference of relative frame subtype) might have primed some participants to adopt a relative frame interpretation in the ring-shaped configuration condition. Thus, the results possibly understate how widespread the FIBO interpretation is among Dhivehi speakers.

Table 3: Dhivehi speakers' interpretations of 'front' and 'back' terms for a ring-shaped configuration in the Object Placement Task

Dominant strategy		**Consistency**	**Participants (n=52)**
FIBO		consistent	24 (46.2%)
		inconsistent	7 (13.5%)
			Total FIBO: ***31 (59.6%)***
Relative	translational	consistent	12 (23.1%)
		inconsistent	3 (5.8%)
	reflectional/rotational	consistent	1 (1.9%)
		inconsistent	1 (1.9%)
			Total Relative: ***17 (36.5%)***
Other		consistent	3 (5.8%)
		inconsistent	1 (1.9%)
			Total Other: ***4 (7.7%)***

4.2 Classifying 'FIBO'

It is clear that the FIBO system is common among Dhivehi speakers, but which frame of reference does this system involve? Firstly, it should be observed that the use of 'front' and 'back' terms in the FIBO system is not consistent with respect to any geocentric axis in the wider environment – e.g., if the participants face north during the route description task described earlier, the 'back' of the red blocks is to the north of those blocks but the 'back' of the left-hand side fence is to the west of that fence. FIBO is therefore not an absolute system and appears not to be any kind of geocentric system given the absence of any external anchor such as an environmental axis or landmark.

However, since FIBO is organized around a focal point at the center of the configuration, the system does show a resemblance to certain landmark-based systems. In the same way that 'mountainward' points towards the mountain regardless of which side of the mountain one is on, an object's 'front' in the FIBO system is always the side towards the center of the configuration. As I will show in Section 5, this is reflected in the rotational properties of the FIBO system. Of course, the difference between FIBO and typical landmark-based systems is that FIBO does not involve an actual landmark – the center of the configuration acts as the anchor of the system but is not explicitly referred to and may not even be a tangible object (i.e., it may be empty space).

FIBO is not an egocentric system because the system operates independently of the speaker's location or viewpoint. For example, the 'front' of one of the sets of fences in the route description task corresponds with the speaker's right, but the 'front' of the other set of fences corresponds with the speaker's left; also, the fronts of the objects do not change if the viewer walks around the table and looks at the scene from a different angle.

In terms of the intrinsic frame subtypes identified in Section 3, FIBO cannot be regarded as either a function-based or shape-based intrinsic frame, because the relevant objects have 'fronts' and 'backs' that are indistinguishable in terms of their functional and geometric properties – e.g., for the toy blocks used in the Object Placement Task, there is no particular side of a block that is functionally salient or that has a different shape to other sides of the same block. FIBO also cannot be identified with the direct subtype, the object-centered subtype or the figure-anchored subtype, because FIBO descriptions are not anchored in the speaker, the ground object itself, or the figure's orientation.

The FIBO system presumably derives from a construal in which unfeatured objects in ring-shaped clusters are assumed to be facing inwards to the center of the configuration. This construal may be related to the fact that when featured objects (or people, animals, etc.) are in a ring-shaped formation, their fronts typically face inwards. For example, furniture and appliances inside a room tend to face inwards (for ease of access) rather than towards the walls, and a group of people in conversation normally face each other rather than outwards – this facilitates the return of gaze and the construction of a space to which participants have shared access (cf. the F-formation system described by Kendon 1990). This orientation is illustrated in Figure 21 below.

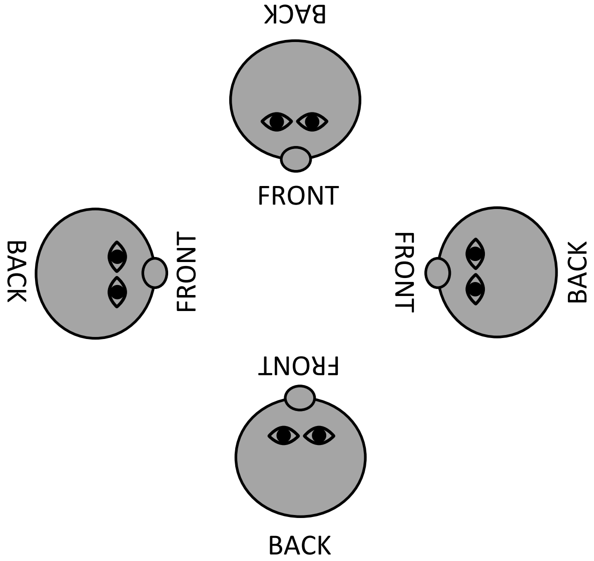

Figure 21: Typical orientation of featured objects or people in a ring-shaped configuration

If this explanation is correct, then the FIBO system is related to intrinsic frames, even if is not itself a true intrinsic system. This is because FIBO assigns front and back sides based on the objects' presumed functional orientation: inwards to the center of the cluster. The anchoring of the system in a construed orientation resembles the figure-anchored intrinsic frame as well as the relative frame. Crucially, however, the model for the construal is different in these various systems. Whereas the figure's orientation provides a model in the figure-anchored frame and the viewer's orientation provides a model in relative frames, the canonical orientation shown in Figure 21 above offers a model for the assignment of fronts and backs in the FIBO system.

5 Rotational properties

As discussed in Section 2, classifications of frames of reference are based on the nature of the anchor. In order to illustrate the relationships between frames and their anchors, and to show how frames differ from one another, many authors have observed that different frames have different rotational properties (e.g., Danziger 2010: 174–176; Levinson 2003: 51–53; Palmer 2015: 204–209). Although this earlier work has identified the rotational properties of the main frames of reference, and of direct vs. object-centered intrinsic frames (Danziger 2010), here I add to existing analyses by considering the rotational properties of the figure-anchored and FIBO systems. These rotational properties are summarized in Table 4 below. The first three tests are well established in the literature (e.g., Levinson 2003: 51–53). The 'rotation of anchor' test is a relatively recent addition that distinguishes between landmark-based and absolute frames (Bohnemeyer & O'Meara 2012).

Table 4: Summary of rotational properties

		Constant under:			
		Rotation of viewer	**Rotation of ground**	**Rotation of figure-ground array**	**Rotation of anchor**
	Landmark-based	Yes	Yes	No	Yes
	Absolute	Yes	Yes	No	No
	Relative	No	Yes	No	No
Intrinsic	**Direct**	No	No	Yes	No
	Object-centered	Yes	No	Yes	No
	Figure-anchored	Yes	Yes	Yes	No
	FIBO	Yes	Yes	No	Yes

As the table shows, both the direct and object-centered intrinsic frames can be distinguished from other frames by their sensitivity to the rotation of the ground. For example, if the ball is at the intrinsic front of the chair, spinning the chair around (on the spot) would mean the ball is no longer 'in front' of the chair. In addition, these intrinsic subtypes remain constant under rotation of the entire figure-ground array – e.g., if the ball and chair are picked up and rotated as a unit while maintaining their orientation with respect to one another. These properties reflect the anchoring of direct and object-centered intrinsic frames in the ground object rather than an external entity.

In the figure-anchored system, however, the anchor is the figure rather than the ground, and so descriptions are constant under rotation of the ground. Consider again the Tamil example in which the horse is described as 'behind' the tree as long as it is facing the tree. If the tree could be rotated on the same spot, with the horse staying still, the description would remain true (see Figure 22 below). This distinguishes the figure-anchored subtype from other intrinsic frames. However, all subtypes of the intrinsic frame including the figure-anchored subtype remain constant under rotation of the figure-ground array – e.g., the horse is still ‘behind’ the tree if the whole array is rotated as a unit (see Figure 23 below).

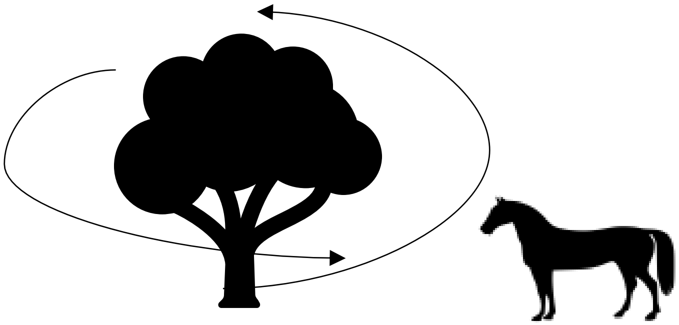

Figure 22: Constancy under rotation of the ground: in the figure-anchored system, a horse facing a tree is regarded as 'behind' the tree even if the tree is rotated.

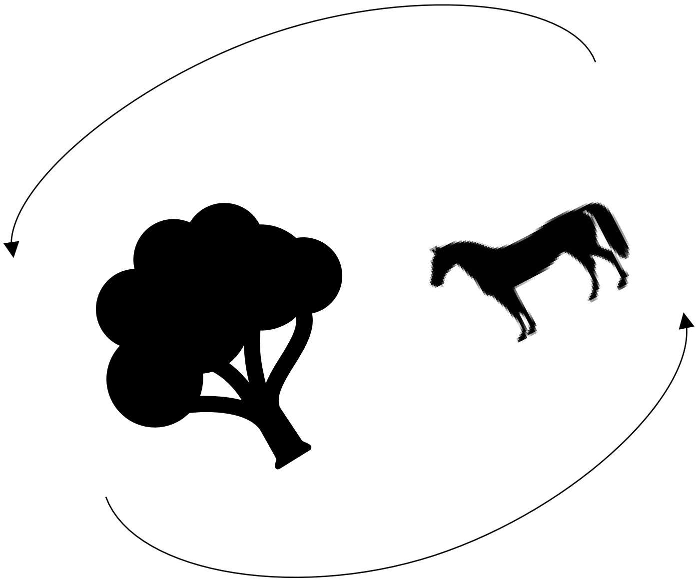

Figure 23: Constancy under rotation of the figure-ground array: in the figure-anchored system, a horse facing a tree is still 'behind' the tree if the horse and tree are picked up and rotated as a unit.

Like the figure-anchored system and non-intrinsic systems, the FIBO system is constant under rotation of the ground – e.g., the ball is ‘in front’ of the orange flower in Figure 24 below even if the orange flower is rotated on the spot:

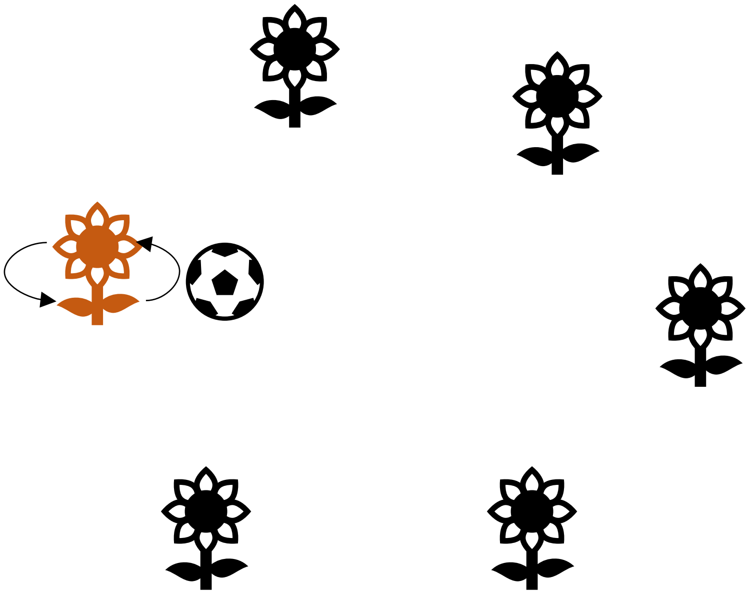

Figure 24: Constancy under rotation of the ground in the FIBO system: the ball is still 'in front' of the orange flower even if that flower is rotated.

But unlike true intrinsic frames, FIBO is not constant under rotation of the figure-ground array – as shown in Figure 25 below, rotating the figure and ground as a unit (i.e., as though one were rotating a platform stuck to the bottom of both the figure and the ground) would mean that the figure is no longer towards the center of the ring-shaped configuration and therefore no longer on the ‘front’ side of the ground:

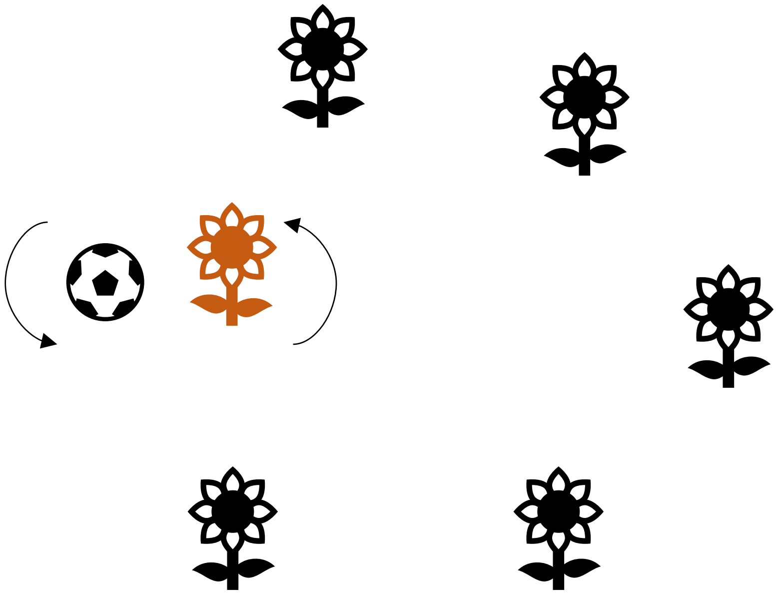

Figure 25: Lack of constancy under rotation of the figure-ground array in the FIBO system: if the ball and orange flower are rotated as a unit, the ball is no longer 'in front' of the orange flower.

The ‘rotation of anchor’ test is a little more abstract. The anchor of the FIBO system is the center of the ring-shaped cluster of which the ground is a part, but this central point may often be empty space. Still, if one were to imagine ‘rotating’ this central point on the spot, ‘front’ and ‘back’ relations in the FIBO system would be unaffected. To grasp this test more easily, let us suppose that instead of empty space, there is a pole at the center of the configuration as shown in Figure 26 below. If this pole is rotated, the ball remains ‘in front’ of the orange flower, as it is still on the side towards the center of the configuration (i.e., towards the central pole). This suggests that unlike intrinsic frames, FIBO is constant under rotation of the anchor.

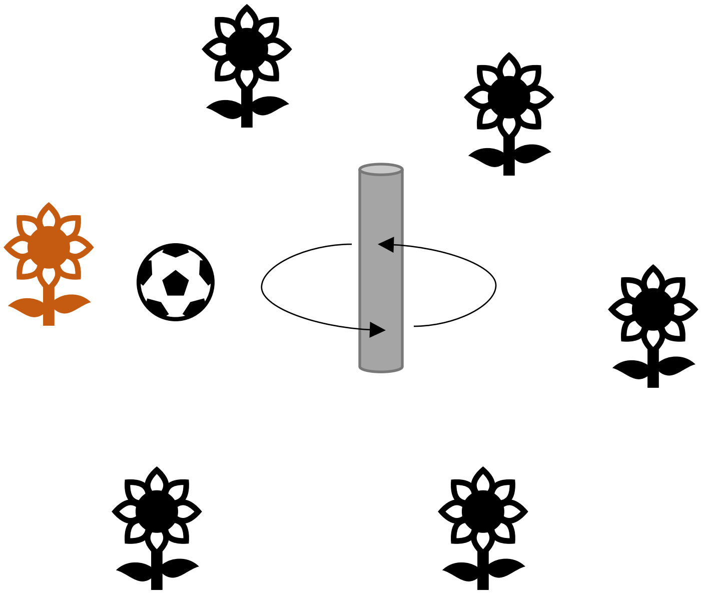

Figure 26: Constancy under rotation of the anchor in the FIBO system: the ball is still 'in front' of the orange flower even if the cluster's central point undergoes rotation.

As shown in Table 4 earlier, the FIBO system in fact patterns like landmark-based frames, showing constancy under rotation of the viewer, ground or anchor, but not under rotation of the figure-ground array. This makes sense if we consider how the system operates. As discussed in Section 4, the center of the configuration in effect functions as a covert landmark that determines the 'front' and 'back' of every item encircling it. The 'front' of an item is the side closer to this focal point, and the 'back' is the side further away. Even though the focal point is not overtly expressed, FIBO has the same rotational properties as more explicit landmark-based systems (e.g., 'towards the city' vs. 'away from the city'), which show the same radial pattern of directions.

6 Conclusions and further discussion

This paper has offered a classification of the intrinsic frame of reference based on two parameters: (i) the kinds of properties underpinning the assignment of intrinsic facets; and (ii) the identity of the anchor. The first parameter distinguishes function-based from shape-based intrinsic systems, and the second distinguishes between direct, object-centered and figure-anchored subtypes.

The figure-anchored subtype appears to be unusual cross-linguistically. Although anchored on the figure rather than the ground, it was shown that the figure-anchored system is still an intrinsic frame because it depends on the orientation of an object in the figure-ground array and because it is not sensitive to the rotation of the figure-ground array as a unit. It differs from other intrinsic frames in that it is not sensitive to the rotation of the ground alone. The figure-anchored subtype of the intrinsic frame is of some theoretical interest, not only for its anchor but also for its mapping of coordinates from anchor to ground. It was demonstrated that in the small number of languages known to use a figure-anchored strategy, a translational system of mapping is used, though some orientation descriptions in certain languages may employ reflectional mapping. A remaining question is why figure-anchored systems appear to favor translational mapping when relative frames in the world's languages commonly involve reflectional mapping.

This paper has also presented the Dhivehi FIBO system and has shown that FIBO shares some important properties with intrinsic frames – in particular, it is independent of the viewer and of the broader environment. FIBO is similar to the figure-anchored intrinsic frame in that it is not anchored in the ground object itself (and so is not sensitive to rotation of the ground) and in that it assigns intrinsic facets to the ground based on the ground's position within a configuration of objects. The configuration invites a particular construal of the ground's orientation, and in this respect FIBO may also be compared with relative frames. However, because the anchor is the center of a ring-shaped configuration of objects, rather than the figure or viewer, FIBO exhibits the same rotational properties as landmark-based systems, despite the absence of a tangible landmark. FIBO therefore appears to be a borderline case in frame of reference typology, further highlighting the considerable cross-linguistic diversity in spatial language identified by earlier research (e.g., Levinson & Wilkins 2006).

Considered together, both the figure-anchored and FIBO systems therefore depend on certain underlying spatial cognitive operations – in particular, processes of reflection and translation and the mapping of spatial coordinates across different but analogous configurations – for their assignment of 'front' and 'back' terms, illustrating a close relationship between spatial cognition and spatial language. This finding may have implications for broader issues concerning frames of reference in language and cognition, such as the linguistic relativity debate. Are there effects of language on thought for speakers of languages that use these (near-)intrinsic systems? Some studies on non-verbal spatial cognition have been conducted for such languages (Edmonds-Wathen 2012; Gaby, Blythe & Stoakes 2016; Lum 2018; Pederson 1995), but they have focused on extrinsic frame preference (i.e., relative egocentric vs. geocentric frames) rather than exploring whether or how the figure-anchored or FIBO systems might be reflected in non-verbal spatial behavior. This could be a valuable topic to explore in future work on these spatial systems.

Finally, this paper has pointed to a closer relationship between intrinsic and extrinsic frames than has generally been appreciated in the literature. This may have a bearing on questions relating to acquisition (e.g., how do children acquire frames of reference and in which order do they acquire them?) as well as to questions about typology and language change (e.g., how are different frames and frame subtypes distributed across the world's languages and why do some speech communities shift their frame use over time?).

While it is not possible to answer such questions here, the analysis presented in this paper may offer some clues. For example, because the figure-anchored system involves the 'mapping' of front and back facets, it is conceivable that it could help to facilitate the acquisition of a fully-fledged relative system. Children are known to acquire relative frames much later than direct or object-centered intrinsic frames (Johnston & Slobin 1979; Levinson 2003: 308; Tanz 1980), but little is known about exactly how children make this jump. While the direct frame may represent a kind of bridging context in that it is both egocentric and intrinsic, it does not involve the mapping operations required for the relative frame, whereas the figure-anchored system does. It may therefore be revealing to look for figure-anchored usages in children's spatial discourse and to see how this relates to the development of other intrinsic systems and of the relative frame. On the other hand, it is worth noting that in some languages like Murrinhpatha (as discussed in Section 3), figure-anchored usages appear in adult speech even though no relative system is linguistically available, and so clearly the presence of a figure-anchored system does not entail the acquisition of a relative frame by the same speaker or even in the same language. Meanwhile, nothing is known about the acquisition of the Dhivehi FIBO system or about the acquisition of Dhivehi 'front' and 'back' terms more generally – any future work on this subject may offer a unique insight into how children acquire such terms in a language with multiple frames of reference and frame subtypes.

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Data availability statement

The datasets analysed during the current study are available in the Pacific and Regional Archive for Digital Sources in Endangered Cultures (PARADISEC) and may be accessed via the following persistent web link: http://catalog.paradisec.org.au/repository/JL5.

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