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WHAT COMES BEFORE?: UNDERSTANDING SPATIAL FRAMES OF REFERENCE IN IWaidja

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This paper reports on initial findings of an investigation into spatial frame of reference in Iwaidja, an Indigenous Australian language spoken in a multilingual community. It considers spatial language in mathematics where students are being taught and assessed in a language not spoken at home and where their teachers do not speak the students’ first languages. It finds that Iwaidja speakers use different frames of reference to English speakers in small scale space. The meanings and scope of key spatial terms in Iwaidja differ from English in ways that appear to be related to preferred frames of reference. It proposes that teacher awareness of these differences can help in mathematics teaching.

1. INTRODUCTION

Spatial frame of reference is different across languages, a factor that is little understood in and of itself outside the field of cognitive linguistics. It has also not been understood how spatial frame of reference affects mathematics learning. Understanding these differences is critical to improving learning outcomes among Indigenous Australians, who are being taught mathematics in English with unspoken assumptions about spatial thinking. Spatial frame of reference refers to ways of describing the location of one thing with respect to another in a (horizontal) plane (Levinson, 2003). This paper describes some aspects of frame of reference preference in Iwaidja, an Indigenous Australian language spoken mainly in a small remote community in the Northern Territory and its relevance for mathematics teachers of Indigenous language speaking students.

2. CONTEXT/BACKGROUND

Despite an increasing number of Australians from non English-speaking family backgrounds, both Indigenous and immigrant, the Australian education system is focussed towards education in English. Learning English and learning in English are taken to be essential in all learning areas. A statement such as: “The development of Indigenous students’ understanding of Standard Australian English as the language of mathematics is crucial for achieving numeracy proficiency” (Commonwealth of Australia, 2000, p. 30) does not only recognise the important role of language in learning mathematics. Numeracy, which is “the capacity, confidence and disposition to use mathematics” (National Curriculum Board, 2009, p. 5), is conceptualised here as numeracy in English. So strong is the perception that literacy and numeracy need to be achieved in English that in 2009 the Northern Territory Government introduced the Compulsory Teaching in English for the first four hours of each school day Policy (Northern Territory Government , 2009), effectively banning bilingual education. This policy is explicitly directed towards Indigenous students.
In regions of Australia’s Northern Territory such as North West Arnhem Land, multilingualism is an integral part of a society in which people marry someone from a different clan and language group. (Evans, 2009). English is often a third or fourth language. Most of the teachers who go to these remote communities to teach are from the Standard Australian English-speaking monolingual mainstream and may previously never have met an Indigenous person, let alone heard an Indigenous Australian language spoken. Few of them have formal training in English as an Second Language teaching techniques. In their classrooms these teachers encounter multilingual students who accept a need to learn English. These students are already skilled language learners who learn English far faster than their teachers are able to learn any of the local languages. There is usually also a local multilingual assistant teacher who may or may not have had formal training. The role of the assistant teacher varies according to the school and the classroom but one common, very valuable contribution they make is to act as a translator between the teacher and the students.

3. THEORETICAL FRAMEWORK

In terms of language and meaning, this study takes a relativist position that as languages differ from each other, so too do cognitive systems. As Whorf put it, “people act about situations in ways which are like the ways they talk about them” (1956, p.148). This is not to say that that people cannot understand concepts that are not commonly expressed in their language. But how a language commonly expresses things plays a role in what the individual is likely to think and to do. Influential studies in this field include the work of Gay and Cole (1967) which showed how the daily mathematical and linguistic practices of the Kpelle people affect their performance on various mathematical tests compared with English-speaking Americans.

For this study, the choice to focus on spatial language was motivated by a popularly held perception amongst teachers of Indigenous students in the Northern Territory that they have a “strong spatial sense”. But what does this actually mean and how did such an idea originate? There have been various studies of spatial knowledge in Indigenous Australians. Importantly, Laughren (1978) made the observation that cardinal directions, north, south, east and west, form a grammatical category in Warlpiri (a language of Central Australia). She also found that pre-school age children use these directions confidently. Harris (1991) also noted the use of cardinal direction by very young Warlpiri children (under two years old) in small scale space. It appears to be largely from writers such as these, as well as the classroom observations of teachers, that the idea that “Indigenous children have a strong spatial sense” entered the education consciousness. These findings related to Indigenous Australians living in the arid interior of the continent; the situation could be expected to differ for Indigenous children living on the coast (Graham, 1988).
Findings such as Laughren’s, that people think and talk about space differently in different languages, sparked a resurgence of interest in linguistic relativity. This helped stimulate a cross-linguistic investigation into the language of space by the Cognitive Anthropology Research Group [CARG] from the Max Planck Institute of Psycholinguistics (Pederson et al., 1998). Their investigation led to the development of a typology of spatial frames of reference (Levinson, 2003). Frames of reference describe where things are in relation to each other in a horizontal plane.

In this typology, frames of reference can be intrinsic, using features of the objects to relate them (e.g. the man is in front of the tree), relative, using the point of view of the speaker to relate the objects (e.g. the man is to the left of the tree) or absolute, with reference to external landmarks or directions (e.g. the man is to the north of the tree). While many languages, including English and Iwaidja, have all of these frames of references, they vary greatly in the circumstances in which frame of reference will be preferred in which context. In Warlpiri, the use of cardinal directions in small scale space demonstrates a preference for the use of an absolute frame of reference. In English, the absolute is generally only used in describing large scale situations, such as the location of a city but not for describing the location of a cup on a table. For table-top descriptions, the relative frame of reference such as ‘left’ and ‘right’ is preferred in English (Barton, 2009; Levinson, 2003).

This study considers how the cognitive linguistic concept of spatial frame of reference and the variation between languages can inform mathematics teaching and learning. Iwaidja has not been previously described in terms of frame of reference. A coastal language, it was not expected to demonstrate the strong use of absolute system of Warlpiri or some other Australian Indigenous languages (Graham, 1988). However it is often subtle differences in language or thinking which present the greatest challenge to mathematics teachers.

4. THE STUDY

The school that is the focus of this study is small, with five teachers and five assistant teachers. It services a remote community of 300 people and has approximately 65 students enrolled from Preschool to Year 9. High teacher turnover means that there have been over 20 different teachers in the past five years. Some students reach the end of primary school never having had a teacher who stayed for an entire year. The current Early Years teacher is new to the school this year. Professional development occurs both formally and informally. But there is very little curriculum support or training focussed specifically towards the teaching of mathematics and numeracy to students who speak Indigenous languages.

The study is an investigation of spatial language in one of the languages of the community, Iwaidja. It also involves interviewing and observing the teachers and working on lessons. The “Man and Tree” game was chosen to produce data that was comparable with existing data on various languages (see Levinson & Wilkins, 2006). It has been specifically designed to elicit spatial frame of reference usages. A pair of
speakers sit side by side with a barrier between them and a table or a rack of cards in front of them. Each participant has a set of cards that show pictures of a toy man and a toy tree, differing in their spatial arrangement in two ways, in the location of the man with respect to the tree and the orientation of the man with respect to the tree. The “Anne Senghas” version was used, which has 16 cards covering all possible combinations. Since the cards contain the same items, spatial language is required to identify the matching card. The speakers’ frame of reference preferences are made clear through their choice of language. For example an English speaker would be highly likely to say of card R22 (see Figure 1 below), “The man is on the right side” (referring to their own, relative, right). They would be highly unlikely to say “the man is on the north side” (supposing he was).

The game was carried out with four pairs of adult speakers. One speaker, the Director, chose a card at random and described it. The task of the other speaker, the Matcher, was to find the same card. The game was conducted seven times, three pairs of speakers each having a turn at being Director and Matcher, with the fourth pair having only one turn. All sessions were conducted with the speakers facing west. Adults were chosen in order to eliminate developmental and acquisition related factors from the data.

5. FINDINGS

Initial findings in Iwaidja show widespread use of the intrinsic and absolute frames of reference. Absolute directions used included cardinal ones such as wurrying manyij ‘west’, abalkbang manyij ‘east’ and walim ‘south’:

Warrkbi ari wurrying manyij yawakaldakan.
‘The man is standing away on the west side.’ (dvR_101115_2 08:52 CM) - R41

Landmark terms such as nimarrk ‘deep ocean’ and manandi ‘mainland’ were also used:

Bad janad ba warrkbi yawukan nimarrk.
‘But he, that man, is looking away to the deep ocean.’ (dvR_100513 05:43 RN) - R34

Speakers varied in whether they used these absolute terms for where the man was standing in relation to the tree or for which way the man was facing.

The speakers also made frequent use of the intrinsic facets of the objects being described and combined this with information linked to the cardinal directions and local landmarks. Body parts of the man were used to describe his orientation to the tree, such as rukung kirrwarda ‘he gave it his back’ i.e. he has his back to it.

Speakers also referred to the direction of his gaze, e.g. arrungbayan ‘he's looking at us’. Maruj ‘left’ and nurlinurli ‘right’ were also used to project the speaker’s left and right onto the scene in a relative manner, but this strategy was infrequent and did not appear to be successful when used.
A pair of terms that was used frequently and by all speakers was *wurdaka* ‘in front’ and *warrwak* ‘behind’. These terms revealed some of the subtle differences in concepts between Iwaidja and English. In both English and Iwaidja, these terms can have both intrinsic and relative uses. In Iwaidja, the intrinsic sense is more likely to be used than the relative, whereas in English the relative sense is more frequently preferred.

In R11, *wurdaka* ‘in front’ can apply to the tree *arlirr*, and *warrwak* ‘behind’ to the man *warrkbi*:

> *Janad warrwak, arlirr arlirr wurdaka, janad warrwak arlirr.*
> ‘He is behind, the tree is standing in front, he is standing behind.’ (dvR_100512 AB)

This is similar to how these terms are used in English in a the same context. In this case the intrinsic and the relative senses both hold, and reinforce each other. These terms were used by every speaker in describing this card.

More surprising (to an English speaker) was the use of these terms about R22:

> *Wurdaka arlirr, bingkan warrwak ba warrkbi.*
> ‘The tree is in front, the man comes behind.’ (dvR_100522 38:38 MM)

In this case only the intrinsic sense of the terms holds. This card was described using these terms by four speakers. In English, this would be unlikely, and the terms would need to be qualified, e.g. ‘the tree is in front of the man from the man’s perspective’.

A situation like that shown in R31, where the relative and intrinsic senses of the terms contradict each other is also interesting. As in English, the relative sense can be used in Iwaidja:

> *Arlirr arlirr wurdaka, warrkbi arlirr warrwak angmunqurlkarrjiny.*
> ‘The tree is in front, the man is behind, looking at the ground.’ (dvR_100522 42:19 MM)

However, it is also possible to use the intrinsic sense:

> *Warrkbi wurdaka lda arlirr warrwak.*
> ‘The man is in front and the tree is behind.’ (dvR_100513 45:02 RG)

This would not be possible in English. So while the relative senses of these terms can apply in Iwaidja in the same contexts as in English, the intrinsic senses can apply in contexts which English does not permit, sometimes contradicting the relative sense. This is summarised in Table 1.
Table 1: Possible descriptions of cards in Iwaidja and English

<table>
<thead>
<tr>
<th>Card:</th>
<th>R11</th>
<th>R22</th>
<th>R31</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frame of reference</td>
<td>Can say</td>
<td>Frame of reference</td>
</tr>
<tr>
<td>Arlirr wurdaka</td>
<td>intrinsic and relative</td>
<td>yes</td>
<td>intrinsic</td>
</tr>
<tr>
<td>Tree in front</td>
<td>-</td>
<td>yes</td>
<td>-</td>
</tr>
<tr>
<td>Warrkbi wurdaka</td>
<td>-</td>
<td>no</td>
<td>-</td>
</tr>
<tr>
<td>Man in front</td>
<td>-</td>
<td>no</td>
<td>-</td>
</tr>
</tbody>
</table>

Some cards were described using only what Terrill and Burenhult (2008) describe as orientation, through a combination of the absolute direction of the man’s gaze and the man’s orientation with respect to the tree indicated by the use of wurdaka and warrwak. For example, adding the statement warrkbi angbayan abalkbang manyij ‘the man is looking east’ to the phrase used earlier, arlirr wurdaka, warrkbi warrwak, ‘the tree is in front, the man is behind’, effectively disambiguates card R11 from the other cards where the man is facing the tree. This calls into question an analysis based on a distinction between ‘facing’ and ‘standing’ information.

6. DISCUSSION

It is quite common for teachers to have difficulty teaching the English concepts of ‘before’ and ‘after’ in relation to numbers e.g. “What number comes after 6?” and “What number comes before 6?” The terms for ‘before’ or ‘after’ are known to differ in Australian Indigenous languages. Graham (1988) gives the example that, “it was found in one language that a word was being used for ‘after’ (e.g. What comes after 3?) that was related to the speaker's point of view. Thus, the word could be translated back into English as ‘before’, ‘after’, ‘previously’, ‘following’, etc., depending on the context.” (Graham, 1988, p.129). In Warlpiri, the concepts are linked to size as well as time, with ‘before’ associated with largeness, since a child born ‘before’ will be larger than one born ‘after’, as will a tree that started growing ‘before’. Thus a larger number such as 6 will be seen to come ‘before’ the smaller number 5 (Mary Laughren, personal communication, 11 March 2011).

In Iwaidja, these terms also have temporal meanings. Temporally, warrwak means ‘later’ and can be used as a conjunction in the sense of ‘then (next)’. A better translation might be ‘following’. Spatially, wurdaka and warrwak have in Iwaidja a stronger sense of directionality and perhaps implicit movement than their English equivalents ‘in front’ and ‘behind’.

One of the Early Years teachers at the school interviewed for this study related the difficulty she experienced in teaching these concepts of ‘before’ and ‘after’. She said the first attempt “was a disaster when I did it because the children just played around and were talking to each other, totally bored because they had no idea what I was talking about.” She then spent six weeks teaching these concepts to her class,
focussing on real events in the students’ lives, such as “What did you do before you came to school today?” Asked about how she then made the links between that and the number line, she said, “I don’t think they really got that bit. I don’t think they really clicked onto that concept.”

Graham (1988) points out that a failure to appreciate the subtle differences in concepts between languages can lead teachers to underrate their students’ intelligence. It is quite common to teach the English concepts ‘in front’ and ‘behind’ in an Early Years classroom using similar toys. A teacher asking a student to place the man ‘behind’ the tree would be anticipating an outcome like R11, where the tree is between the speaker and the man. Any outcome where the tree is between the speaker and the man would be accepted, regardless of the facing direction of the man. A student translating ‘in front’ and ‘behind’ into *warrwak* and *wurdaka* could place the man as in R22, facing the tree, but to the side from a relative viewpoint. The teacher would be likely to say that this was wrong. However, an understanding that *warrwak* and *wurdaka* can be used in this manner will help the teacher to explain to the student that they are talking about ‘behind’ from the perspective of the student and the teacher, not from that of the man, and that in English these terms do not have the same range of meanings as in Iwaidja. The teacher is only able to be explicit about differences between the Indigenous view and the Western one when the teacher is themself aware of the differences.

When talking about numbers and the number line, the temporal and spatial senses of these terms are extended metaphorically. Understanding what is actually quite an abstract sense of these words may be further complicated by the children assigning to these words a semantic scope that doesn’t match with their meanings in Standard Australian English but with those of a related term in their home language.

### 7. CONCLUSION

This preliminary analysis shows some of the ways that Iwaidja spatial terminology and use of frames of reference differ from English. The next stage of the project is to determine to what extent children in the community are using this type of language. This is not straightforward as language shift and change appear to be occurring. As it is not possible at this time to plan a teaching program in Iwaidja (Edmonds-Wathen, 2010), applying this knowledge in the school in mathematics lessons could take the form of using the English equivalents of terms that the students are familiar with, such as east and west, in lessons involving directions and locations, delaying the introduction of relative terms such as left and right until the use in English of the other terms is consolidated. It might also involve being more explicit about the subtle differences between terms such as ‘in front’ and *wurdaka*, and ‘behind’ and *warrwak*. While this project can explore only a tiny part of the differences between the mathematical language of Iwaidja and English, concrete examples such as these can help teachers to appreciate the spatial strengths of their students, and appreciate some of the subtle differences in their mathematical worldviews.
REFERENCES


