Language Specificity of the Principle of Canonical Orientation:
A crosslinguistic experimental study of reference frame use in discourse

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1. Introduction

In this paper I discuss the use of spatial frames of reference by speakers of Yucatec and English as they relate to the Principle of Canonical Orientation (POCO), which states in first approximation that speakers do not use intrinsic frames of reference in describing a ground object that is not canonical orientation. To explore this topic, I revised the design of an existing set of stimuli to elicit frames of reference in discourse with the goal of producing statistically significant findings. Psychologists have presented evidence supporting or refuting the strength of POCO (Levelt 1984, 1996 and Carlson-Radvansky and Irwin 1993, 1994, respectively), but none have presented experimental results that test POCO crosslinguistically. Bohnemeyer and Tucker (2010) present experiments on the use of intrinsic frames by Yucatec speakers based on a limited data set. This study seeks to expand upon those findings, using newly designed stimuli sets to increase the amount of data and perform quantitative analyses. The current study finds that, while both English and Yucatec speakers violate POCO, the use of disaligned intrinsic frames (see §2.5.1) in describing non-canonically positioned grounds is significant in Yucatec speakers (see §4.3.3.2). The current study finds that there are a significant number of violations in Yucatec, though this finding is not surprising given Carlson-Radvansky and Irwin’s findings. However, a comparison of English and Yucatec does not meet significance.

In section 2 of this paper, I present background on spatial frames of reference. I briefly discuss how semantic typology as a field seeks to explore variation in semantic domains across languages. I introduce the methods that have been used for exploring the use of spatial reference frames in discourse, especially the referential communication task as an elicitation tool. In section 2, I also introduce the Principle of Canonical Orientation and the research that has been
performed to date supporting and disconfirming this principle. In section 3, I present the methods I used for this study: the development of the spatial configuration etic grid, the design of the Extended Ball and Chair photo stimuli set, and the participants involved in the study. In section 4, I present the reference frame classification used for coding and analyzing the data, and then I present the results in order to evaluate the new stimuli sets in comparison to previous versions. I then present data analyses and inferential tests to evaluate claims about the Principle of Canonical Orientation and the use of intrinsic frames of reference in describing different spatial configurations. Section 5 contains concluding remarks and prospects for further research.

2. Background

In this section I provide background on spatial frames of reference and their role in the study of semantic typology. Next I present tools for semantic typological elicitation, most importantly for this paper, the tool known as the referential communication task. I review specific versions of the referential communication task that have previously been used to elicit data on the use of spatial frames of reference in discourse. I discuss previous research on the Principle of Canonical Orientation, which I seek to further explore using the data presented in this paper. I also introduce a distinction among different types of intrinsic frames of reference that pertain to the evaluation of the Principle of Canonical Orientation and I argue that the Principle holds for some but not all of these intrinsic frame types.

2.1 Spatial frames of reference
Spatial frames of reference are conceptual coordinate systems that are projected onto FIGURES and GROUNDS (Talmy 2000) in order to locate and orient these objects. Objects may be located and oriented with respect to each other, speech participants, speaker-external landmarks, or absolute coordinate systems. Frames are important for research on linguistic relativity in that they can be observed in language and memory via communicative and recall tasks, respectively. For this reason, spatial frames of reference are an ideal domain of study for semantic typology. Numerous studies on linguistic categorization in domains such as color (e.g., Berlin and Kay 1969), kinship (e.g., Lounsbury 1964), and plants (Berlin, Breedlove, and Raven 1974) have been carried out in the exploration of crosslinguistic variation.

Much research has been performed on the categorization of spatial frames of reference and their use and availability in the world’s languages, and a healthy debate has arisen surrounding the causes of their use and their availability in different linguistic communities. Previous research on spatial frames of reference is discussed below, after a discussion of the tools for studying these linguistically expressed conceptual systems.

2.2  *Semantic typology elicitation tools*

Different types of elicitation may be used to study strategies for expressing a given content. For example, a traditional (though somewhat problematic) method is translation from a contact language into the target language. The method preferred by semantic typologists is the description of non-verbal stimuli in tasks of production, comprehension, or referential communication; this type of elicitation allows semantic typologists to elicit naturalistic language (as opposed to language elicited by a direct translation task) while still restricting the content...
such that data for the desired area of study may be produced. This paper presents data collected using a type of referential communication task, which is further detailed below (§2.3).

### 2.3 Referential communication tasks

In order to study the use of spatial frames of reference in discourse, an elicitation task must be used that limits the content of discussion. Referential communication tasks provide speakers with stimuli that they must describe in order to complete the task, and therefore yield results that allow researchers to observe the pragmatic strategies that speakers use in a given context. The classic setup of this task is a pair of speakers divided by an opaque screen who are charged with selecting and describing stimuli cards in order to make a match. The stimuli cards may display content according to the interest of the researcher. Participants often know this task as a ‘matching game’. (Clark and Wilkes-Gibbes 1990; original design as early as the 1960’s Krauss and Glucksburg).

Referential communication tasks offer many benefits over traditional elicitation techniques. In addition to providing access to speakers’ cognitive processes and discourse strategies, the effective elicitation of natural conversation reduces the risk of eliciting infelicitous expressions; with traditional elicitation, speakers may accept sentences produced by a researcher that they would never naturally utter, especially in the target context with the researcher’s intended meaning. A disadvantage of referential communication tasks is the artificial situation of the task; in normal communication, speakers have access to eye-contact and gestures, but for this type of task they are restricted to using only language for communication. However, this
restraint is necessary in order to elicit maximally explicit references to the semantic domain of interest.

Referential communication tasks have been used by researchers in psycholinguistics and communication to draw conclusions about interlocutors’ mental states, specifically in the arenas of audience design, cognitive processes, and interactional psychology (Clark and Wilkes-Gibbes 1986, *inter alia*). The next section discusses previous research on spatial frames of reference using referential communication tasks.

2.4 *Eliciting spatial frames of reference in discourse*

The Cognitive Anthropology research group (later the Language and Cognition Group, of the Max Planck Institutes for Psycholinguistics) adopted the task as a main method of exploring variation in cognitive function between populations. One task designed specifically to elicit relation descriptions was the Men and Tree task, a picture-to-picture matching task featuring configurations of a toy man and toy tree (Levinson et al. 2002; Pederson et al. 1998). Figure 1 shows the set-up of this matching task, where a director selects a picture from a set of stimuli photos and describes it so that the matcher may select the same picture from their own set. As mentioned above, the screen between speakers prevents shared attention or gesture so that only language may be used to complete the task.
Several problems with the Men and Tree picture stimuli were discovered, most notably that the configurations deviate from the semantic prototype of locative descriptions, which features a figure and ground (which prototypically is the larger, less movable, and less animate object in the scene). Also, the figure in Men and Tree (the man) has salient intrinsic axes (i.e. FRONT, BACK, SIDES), whereas the ground object (the tree) does not. Men and Tree therefore forces the speaker to make a choice to either use an intrinsic, atypical description with the man as ground, or use a prototypical description in an extrinsic frame. Terrill and Burenhult (2008) have shown that speakers of languages that don’t make a great deal of use of extrinsic frames often go with the former strategy. Another issue with the Men and Tree task is that the stimuli consist of pictures of toy objects, which causes difficulties for participants’ interpretation of scale, and further contributes to the atypicality of the ground.

In an attempt to resolve the above-mentioned problems with Men and Tree, the Ball and Chair picture stimuli were developed by the MesoSpace Project in 2008. The MesoSpace Project, funded through NSF (BCS-0723694, BCS-1053123), explores the use of spatial frames
of reference and meronyms in 25 languages in Mesoamerica and beyond. The Ball and Chair picture stimuli feature different spatial configurations of a real chair and a soccer ball. The figure (the ball) is smaller than the chair and has no intrinsic axes so that it is easily selected as the figure. The ground object (the chair) is larger and has intrinsic axes so that it may be referenced as the ground object and used to locate the ball. Figure 2 shows an example of the Ball and Chair picture stimuli.

![Ball and Chair picture](image)

**Figure 2.** Ball and Chair picture 3.9

The original Ball and Chair task consists of four sets of 12 pictures (shown in Appendix A). At the time of the current study, the task had been piloted with English-speaking American university students, and run with 13 Mesoamerican languages, 2 indigenous control languages in Mexico and Nicaragua, and 3 varieties of Spanish. Notable publications of the results from Ball and Chair include a special issue of *Language Sciences* (2011) and an article in the proceedings of the Fifth Conference on Indigenous Languages of Latin America (2012), as well as numerous presentations.

Bohnemeyer and Tucker (2010) show that Yucatec speakers make frequent use of ground objects’ axes, using intrinsic frames even when the ground object is not in canonical orientation.
English speakers also do this, though not to nearly the same extent\(^1\). This finding is an interesting violation of current research claims that such use of intrinsic frames does not occur.

2.5 *The Principle of Canonical Orientation*

The Principle of Canonical Orientation (POCO) states that “[f]or the intrinsic system to refer to a relatum’s intrinsic dimension, that dimension must be in canonical position with respect to the perceptual frame of orientation of the referent.” (Levelt 1996: 92). In this description, ‘relatum’ refers to the ground object, and ‘referent’ refers to the figure (ibid.: 89). The ‘intrinsic system’ is the set of axes projected from the ground object itself. The intrinsic axes contrast to axes projected from the speaker or axes from absolute systems such as vertical gravity or cardinal directions. Figure 3 shows the axes of the ground object in Ball and Chair. The use of these axes to locate the figure is considered a use of an intrinsic frame.

![Figure 3. The intrinsic axes of the ground object (Ball and Chair picture 4.4)](image)

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\(^1\) English speakers have been shown to strongly prefer the use of relative, and, more generally, egocentric frames.
Levél further states that:

“[t]he top-down dimension of the relatum is in canonical position if it coincides with the vertical dimension of the referent’s perceptual frame. The left-right and front-back dimensions of the relatum are in canonical orientation if and only if they are in a plane that is perpendicular to the vertical in the referent’s perceptual frame.” (ibid.: 94)

By this definition, a ground object such as the chair in figure 3 is in a non-canonical orientation, since the chair’s intrinsic up-down axis is disaligned with the frame of absolute gravity. A description of figure 3 such as (1) is an example of a use of an intrinsic frame that is disaligned from a vertical frame that is aligned with the perspective of the speaker.

(1) The ball is under the chair.

It is exactly this type of description that POCO proscribes. Levél explains that when frames are disaligned, one may gain dominance, thereby preempting others (ibid.: 89). He notes that, “if in a scene canonical orientation does not hold, the intrinsic system is evaded by the standard average European (SAE) language use; it is preempted by the [relative] or by the absolute system.” (ibid.: 94). In a footnote Levél addresses how POCO may hold in other languages, citing Levinson’s work on Tzeltal speakers’ use of intrinsic frames. However, he seems to dismiss the POCO violations claimed by Levinson based on the Tzeltal intrinsic system’s “connotation of verticality.” (ibid.: 105).

Carlson-Radvansky and Irwin’s (1993) experiments show that English speakers use an intrinsic frame even when the verticality of the observer and ground object are misaligned,

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2 Levél refers to the “referent’s perceptual frame” to limit the scene to that of the figure. His discussion of this issue is in response to challenges made by Garnham (1989), which are not relevant to the discussion here.
therefore violating POCO. They performed experiments with vertical stimuli that allow the observation of the effects of each type of frame in isolation. The results show that the selection of vertical relators depends on the cumulative applicability of the three types of frames that Carlson-Radvansky and Irwin distinguished.

Three of eight configurations that Carlson-Radvansky and Irwin presented to participants are relevant for the discussion of POCO. In situation (a), the ball appears above the chair in absolute, relative or "deictic", and intrinsic frames. The observer and the chair are in a canonical orientation (i.e. standing upright), with the ball in the air above the chair. In this case, 95 percent of participants said that the ball was ‘above’ the chair. In situation (b), the ball is above the chair in absolute and relative frames, but not intrinsic frames. The observer is in canonical orientation, but the chair is in a non-canonical position (i.e. on its side), and the ball is in the air above the chair. The percentage of ‘above’ descriptions drops to 63%. Situation (g) shows the ball ‘above’ the seat only intrinsically, not in an absolute or relative frame. The observer is in canonical position, the chair is in a non-canonical position and the ball is on the floor at the top of the chair. 30% of participants said that the ball was ‘above’ the chair in this situation. Carlson-Radvansky and Irwin call these type (g) descriptions a use of a disaligned intrinsic frame, which is a situation that POCO excluded.

2.5.1 The disaligned intrinsic

The results from Carlson-Radvansky and Irwin’s (1993) experiments reveal that POCO is not an absolute restriction, but only a tendency. Therefore, it is not the case that vertical relators never occur with disaligned intrinsic frames, only that uses of the aligned and disaligned absolute vertical are much more common than uses of the disaligned intrinsic. The results that were
obtained in the production studies in 1993 were confirmed in 1994 experiments on comprehension of vertical relators. The effects of cumulative uses of frames were investigated via acceptability judgments and reaction times; they found that reaction times were longer in trials where ‘above’ is used to refer to disaligned frames.

As discussed above in §2.4, Bohnemeyer and Tucker (2010) suggest that, based on the Yucatec data produced from the Ball and Chair task, the POCO violable constraint may be language-specific. To further explore this topic and more conclusively demonstrate the violability of POCO via quantitative analysis, more data is needed. The research presented here supports Carlson-Radvansky and Irwin’s findings that English speakers do use the disaligned intrinsic, though not significantly. Further, this paper expands on Carlson-Radvansky and Irwin’s research by presenting evidence of significant use of disaligned intrinsic frames in a language other than English.

2.5.2 The dynamic intrinsic

In addition to the disaligned intrinsic frame type, this research has noted additional uses of intrinsic frames made by both English and Yucatec speakers in describing the location of the ball with respect to a non-canonically positioned chair. This intrinsic does not use a vertical relator and so is not a violation of POCO. Therefore, this frame type is not discussed beyond the current section, but the phenomenon is worthy of discussion here and further investigation in the future. In descriptions where uses of disaligned intrinsic frames might occur (e.g. the chair is in non-canonical orientation, and the ball is intrinsically ‘above’ or ‘below’ the chair, as shown in figure 4), English and Yucatec speakers used horizontal instead of vertical relators, suggesting a dynamic interpretation of the scene.
In pictures such as 5.8 (shown in figure 4), speakers locate the ball with horizontal relators such as ‘in front of’. However, the region designated as the front of a canonically positioned chair is submerged into the floor. Therefore, speakers must either reassigning axes for the differently positioned chair (which would be unusual) or they are interpreting the scene dynamically. Other evidence from discourse suggests that speakers view scenes of the non-canonically oriented chairs as results of dynamic events rather than as static situations. They describe the disposition of the chair as having undergone a change from a starting position; for example, English speakers describe the chair as ‘tipped over’, ‘fallen forward’, ‘pushed on the ground’, ‘if you pushed the chair forward it’d be facing towards you’, and even (one orientation description) ‘if it was standing upright it would be facing left’. Brief review of Yucatec data reveals similar descriptions, (2) for example, which was uttered in locating the ball in picture 7.6, where the chair is face down towards the left of the photo, and the ball is located beneath the backrest, toward the seat.

(2) \text{chan=táan-il ti’}\text{DIM=front-REL PREP ‘(the ball is) in front of (the chair)’ (Yucatec 2011 pilot; MTM 7.6)}
Such dynamic interpretations are interesting, but clearly do not make use of a vertical relator to use the intrinsic in violating POCO, and as such they are excluded from the analyses presented in this paper.

3. Methods

The primary aim in designing additional Ball and Chair stimuli is to increase the number of critical items that might afford descriptions that violate POCO – essentially, pictures of chairs in non-canonical orientation. Another three sets of 12 Ball and Chair pictures were designed to serve as an extension of the original Ball and Chair.

3.1 Etic grid design: Ball and Chair revisited

The design of the new stimuli was motivated by a desire for an unskewed, fully-instantiated etic grid of spatial configurations of figure and ground. The extent of the etic grid was limited to a reasonable number of cells (lest an unmanageable amount of data be produced), as the Ball and Chair task is time-consuming for participants to perform and for researchers to transcribe and code. More than seven sets of pictures would take more than two hours for participants to complete and would unduly tax (and potentially bore) them.

Therefore, the etic grid used for design of these stimuli is limited to 48 possible configurations, consisting of six locations of the figure with respect to the ground (‘above’, ‘under’, ‘front’, ‘back’, ‘left’, and ‘right’ of the chair), and eight orientations of the chair (standing and face-down in non-canonical position, facing the front, back, right, and left of the
scene). Etic grids are commonly used in semantic typology in guiding stimulus design. They serve to provide all possible instantiations within a given domain so that speakers’ conceptual categories may be discovered. Table 1 below shows the etic grid used to guide this project’s stimulus design; shaded cells represent the configurations instantiated in the original Ball and Chair stimuli sets.

<table>
<thead>
<tr>
<th>Location of Ball wrt Chair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above</td>
</tr>
<tr>
<td>Right</td>
</tr>
<tr>
<td>Left</td>
</tr>
<tr>
<td>Front</td>
</tr>
<tr>
<td>Back</td>
</tr>
</tbody>
</table>

Table 1. Etic grid of possible Ball and Chair spatial configurations

Note that no picture instantiates configurations where the chair is in non-canonical position.

While the original Ball and Chair did contain pictures of chairs in non-canonical position (as shown below in figure 5), the positioning of such chairs is irregular to the point that they would not fit within this etic grid.

**Figure 5.** Non-canonical orientation chairs of original Ball and Chair stimuli set
These configurations led themselves to ambiguities which make analysis of speakers’ strategies more difficult. Instead of relying on the irregular configurations present in the original Ball and Chair sets (the 12 pictures shown in figure 5), I designed another three sets of photos that included the 24 non-canonically positioned chairs needed to test for POCO. The analyses presented in this study are based on a subset of these newly designed photos.

3.2 Extended Ball and Chair

Three sets of twelve pictures were created to instantiate the 34 non-instantiated cells of the etic grid (see table 1); combined with 14 pictures from the original four sets of Ball and Chair stimuli, all 48 cells of the etic grid are then represented by one picture each. With seven sets of 12 pictures, 84 photos have been described: 48 instantiate configurations from the etic grid, and 36 do not. These 36 are excluded from the analyses presented in this study; in the study of the effect of POCO, they are essentially treated as fillers (in a non-technical sense). The pictures designed for the English pilot study are shown in Appendix B.

3.3 Participants

Two versions of the extended Ball and Chair stimuli were piloted with two populations. The first pilot was run in April 2011 with English speaking university students recruited from Linguistics courses. 27 dyads of these speakers performed the task, of which eight dyads were of monolingual English speakers. Of these, data from five dyads were coded and analyzed. In July 2011, the second pilot was run with Yucatec speakers using different photographs that were
designed to better control for background and ball descriptions. Five pairs of Yucatec speakers were recorded, and their data coded and analyzed for frame usage.

The original four Ball and Chair picture sets were piloted with 10 dyads of UB students in 2008. Of these, data from five were coded for analysis, however, only three dyads are strictly monolingual\(^3\). These students were not available to perform the task with the new stimuli, so different university students were recruited. The same Yucatec-speaking participants who performed the task in 2008 with the original picture set performed the task in 2011 with the new stimuli\(^4\).

4. **Results**

4.1 **Data Processing**

Descriptions of each picture were broken down into propositions describing (i) Orientation of the Chair, (ii) Location of the Ball with respect to the Chair, and (iii) Location of the Ball in the Picture. Propositions describing Ball with respect to Chair were then analyzed and coded for the frame type they employed.

The frame of reference classification used distinguishes nine categories of types: relative (REL), direct (DIR), intrinsic (INT), landmark-based, absolute, disaligned vertical (VERT),

\(^3\) Dyad 1 consisted of a bilingual Spanish speaker who directed for the entirety of the task, and was directing to a native Japanese speaker. Dyad 5 consisted of a bilingual Spanish speaker who did not start speaking English until age 10. Dyad 5 alternated between sets according to the protocol and his partner was a monolingual English speaker.

\(^4\) Questions have been raised about a training effect with re-using participants. When the final version of the extended Ball and Chair picture set was run with the same Yucatec speakers in 2012 (see §4.3.3.2), a strong training effect was indeed observed. However, in order to perform quantitative analysis over the seven sets of photos, it was desirable to collect data from the same participants.
intrinsic-vertical aligned (IV), intrinsic-relative aligned (IR), and topological⁵ (TOPO).

Landmark-based and absolute frame types were collapsed into a geocentric category (GEO), since absolute is not a frame type preferred by English or Yucatec speakers. The classification blends the classifications traditionally used by psychologists and linguists, as shown in figure 6 below. It also recognizes configurations where intrinsic frames align with relative frames (with horizontal relators) and vertical frames (with vertical relators). In cases where an intrinsic frame type is aligned with a relative one, the axes of the ground object (the chair) are aligned with those of the speaker, such that a proposition describing the location of the ball uses both relative and intrinsic frames. For example, (3) describes the location of the ball both to the chair’s intrinsic right and the speaker’s right.

(3) The ball is to the right of the chair.

<table>
<thead>
<tr>
<th>Classification based on anchor (e.g. Carlson-Radvansky and Irwin 1993; Wassmann and Dasen 1998; Li and Gleitman 2002; inter alia)</th>
<th>Classification by anchor and origin of axes (Levinson 1996, 2003; Pederson 1993; Danziger 2010; Bohnemeyer and O’Meara 2012; inter alia)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ego-centric</strong></td>
<td>relative (Levinson 1996)</td>
</tr>
<tr>
<td>anchor = body of an observer</td>
<td></td>
</tr>
<tr>
<td>ground ≠ anchor</td>
<td></td>
</tr>
<tr>
<td>axes projected (translated and/or reflected)</td>
<td></td>
</tr>
<tr>
<td><em>The ball is to the right of the chair.</em></td>
<td></td>
</tr>
<tr>
<td>egocentric intrinsic (‘direct’ in Danziger 2010)</td>
<td></td>
</tr>
<tr>
<td>anchor = body of an observer</td>
<td></td>
</tr>
<tr>
<td>ground = anchor</td>
<td></td>
</tr>
<tr>
<td>axes extended (without projection or abstraction)</td>
<td></td>
</tr>
<tr>
<td><em>The ball is in front of me.</em></td>
<td></td>
</tr>
<tr>
<td><strong>allocentric intrinsic</strong></td>
<td>object-centered (Carlson-Radvansky and Irwin 1993)</td>
</tr>
<tr>
<td>anchor ≠ body of an observer</td>
<td></td>
</tr>
<tr>
<td>ground = anchor</td>
<td></td>
</tr>
<tr>
<td>axes extended (without projection or abstraction)</td>
<td></td>
</tr>
<tr>
<td><em>The ball is in front of the chair.</em></td>
<td></td>
</tr>
<tr>
<td><strong>geocentric</strong></td>
<td>landmark-based (‘projected’ in Mishra et al. 2003; ‘head-anchored’ in Bohnemeyer and O’Meara 2012)</td>
</tr>
<tr>
<td>anchor = environmental entity/feature</td>
<td></td>
</tr>
</tbody>
</table>

⁵ Topological descriptions are free of any reference frame, but are tallied as “type” or absence of reference frame.
The ball is mountainward of the chair.

**geomorphic** (‘contextual’ in Jackendoff 1996: 17)
- anchor = environmental entity/feature
- ground ≠ anchor
- axes projected
  
  *The ball is downriver of the chair.*

**absolute** (Levinson 1996; ‘geographical’ in Jackendoff 1996)
- anchor = environmental entity/feature
- ground ≠ anchor
- axes abstracted from geomorphic or landmark-based system
  
  *The ball is downriver of the chair.*

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**Figure 6.** Frame of Reference classification

The intrinsic frame type is aligned with the vertical frame type in all instances where the chair is in canonical position (i.e. standing upright). When propositions such as (4) describe a configuration such as picture 5.2 in figure 7, the speaker is making use of the ground object’s intrinsic axes as well as the vertical axes of gravity. But when (4) describes a configuration such as figure 7, the speaker is making use of a disaligned vertical frame. Similarly, such a proposition describing a configuration such as in picture 5.8 in figure 7 would be a use of a disaligned intrinsic. It is these uses of disaligned intrinsic frames that are POCO violations, and is analyzed in detail in §4.3.

(4)  The ball is above the chair.

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**Figure 7.** Distinguishing different types of frame alignment
4.2 Evaluating the stimuli design

In this section I present comparisons of data sets to evaluate the stimuli design.

4.2.1 English data: Original Ball and Chair set vs. Extended Ball and Chair set

A comparison of the frames used by English speakers in the original Ball and Chair pilot and the extended Ball and Chair pilot is shown in figure 8. This comparison includes propositions locating the ball with respect to the chair. In describing the extended set, participants used fewer intrinsic frames and topological descriptions. They also used significantly more disaligned vertical frames in describing pictures of the extended set, though this may be an artifact of the increased number of non-canonically positioned chairs. Other than the difference in disaligned vertical, no differences proved significant (see Table 1 in Appendix C). These results are as expected.

Figure 8. Comparison of English original Ball and Chair sets and Extended Ball and Chair sets (Location of Ball wrt. Chair)
4.2.2  *English data: Original Ball and Chair set vs. Etic grid set*

A guiding factor in the design of the extended Ball and Chair pictures was to complement the original Ball and Chair pictures in order to create an etic grid of potential spatial configurations where every cell is instantiated, as discussed in §3.2. We may compare the data from the four original Ball and Chair sets to the data produced in descriptions of only the pictures of the etic grid, as shown in figure 9 below. The etic grid set consists of 14 pictures from the original Ball and Chair set and 34 pictures from the newly designed extended Ball and Chair set. Together these 48 pictures instantiate the 48 different spatial configurations of the etic grid shown in table 1 (§3.1). Other than a difference in disaligned vertical, as discussed above in §4.2.1, we do not expect significant differences between the sets for English speakers.

For English speakers, there are about the same raw number of propositions between the sets (250 vs. 235), but there are significantly fewer topological descriptions, and very significantly more vertical uses (see table 2, Appendix C). The increase in the vertical is expected given the increase in the number of pictures featuring chairs in non-canonical position.

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6 We do however expect a significant increase in the intrinsic for Yucatec speakers. See §4.3.1 for results.
Figure 9. Comparison of English original Ball and Chair sets and Etic Grid Set (Location of Ball wrt. Chair)

4.2.3 English data: Canonically vs. Non-canonically oriented chairs

Within the Etic grid data set, we may compare frame usage in describing configurations with chairs in canonical position and non-canonical position, as shown in figure 10 below. Note that the complementary results for disaligned vertical and intrinsic/vertical are an artifact of the design of the stimuli; vertical relators describing the location of the ball with respect to canonically oriented chairs necessarily use aligned intrinsic-vertical frames, whereas the same relators locating the ball with respect to non-canonically oriented chairs make use of a purely gravitational (vertical) frame. It is therefore not possible to felicitously use intrinsic-vertical frames in describing a non-canonically oriented chair, nor is it possible to use a disaligned vertical in describing a canonically oriented chair. Other than this stark contrast, no other significant differences in frame use occur between chair dispositions, as expected (see Appendix C, table 3).
4.3 Evaluating the language-specificity of POCO

Now that we’ve discussed the stimuli design, we may move on to testing the hypothesis of whether POCO is language-specific. If we believe POCO, we expect that Yucatec speakers predictably violate POCO, whereas English speakers do not. I first present a full comparison of the English pilot data set and the 2011 Yucatec pilot\(^7\), then analyze the use of disaligned intrinsic frames in target photos.

4.3.1 English vs. Yucatec: Summary

Figure 11 below shows the frame use in the English Etic Grid set and the 2011 Yucatec Etic Grid set. As explained in §4.2.2, the Etic Grid set consists of 14 photos from the original Ball and

\(^7\) As discussed in §3.3, different photo sets were used as stimuli for the different pilots, in the hopes of eliminating distractors found within the stimuli used for the English pilot. However, the configurations of ball and chair are identical between the stimuli sets, so we may proceed with a comparison, noting where the use of different photos may have had an effect.
Chair sets (collected for Yucatec in 2008) and 34 pictures from the newly designed extended Ball and Chair set (the pilot version collected for Yucatec in 2011). We expect English speakers to rely more heavily on relative frames than Yucatec speakers, and for Yucatec speakers to rely more heavily on intrinsic frames. Quantitative analysis using fisher exact tests shows that English speakers use relative and intrinsic-vertical aligned frames significantly more than Yucatec speakers, whereas Yucatec speakers use geocentric, direct, and topological strategies significantly more than English speakers.

A surprising result is the roughly equivalent percentage of usage of intrinsic frames in both populations. It was expected that Yucatec speakers would more strongly prefer intrinsic frames than English speakers, as has been observed in previous research. It was also expected that English speakers would show a depressed usage of intrinsic frames as compared to Yucatec speakers, given the number of non-canonically oriented grounds in this data set. As discussed in §2.5.1, Yucatec speakers are expected to use the intrinsic despite POCO’s claim that intrinsic frames may not be used non-canonically oriented ground objects.

![Figure 11. Frames used to describe Etic grid stimuli in 2011 English and Yucatec pilots](image)
The unexpected results for intrinsic frame usage are most likely due to the interpretability of the stimuli. While the Yucatec speakers saw the same configurations as the English speakers, they performed the task using a different set of pilot pictures. New stimuli photos were developed in the summer of 2011 due to issues that became apparent in the analysis of the English pilot data (see picture 7.4 in figure 12). The English pilot photos featured decorative tile flooring which speakers made use of in their descriptions. The tile, as well as shadows in the photos, were used as additional grounds with respect to which speakers located the ball. Thirdly, the ball used in the photo had two different colored sides, providing it intrinsic axes which speakers could use to orient it. All of these details loosened the restrictions of the task and complicated coding, so another set of photos with the same spatial configurations were made.

**Figure 12.** Examples of photos from the 2011 English and Yucatec pilots

Another set of photos were taken in Buffalo and featured a soccer ball (like the original Ball and Chair sets) and chair on a green lawn with green vines in the background (see picture 6.2 in figure 12). These pictures were then piloted with Yucatec speakers by Bohnemeyer in summer 2011. He transcribed and analyzed the descriptions for frame use, while I performed comparative quantitative analyses. Bohnemeyer’s analysis of the Yucatec pilot data revealed
issues with the green background stimuli photos as well. The angle of the shot made interpretation of the chair difficult, as speakers could not reliably determine the front-back orientation of the chair. For example, in attempting to interpret the facing direction of the chair in picture 6.2 (figure 12), only about half of an American colloquium audience succeeded. Yucatec speakers viewing these photos may have dealt with this difficulty by shifting away from frames that make use of the ground’s axes, apparently shifting to perspective-free descriptions, as evidenced by the significant use of topological propositions.

4.3.2 Uses of the disaligned intrinsic

To find POCO violations and compare them in the 2011 English and Yucatec populations, I isolated the critical stimuli (13 photos of the 36 that were piloted in the newly designed extended Ball and Chair set), in which the configurations afford descriptions where vertical relators may be used with a disaligned intrinsic frame of reference, as in figure 13. Essentially, these critical stimuli include only pictures where the chair is in non-canonical position (fallen face-down), with the ball intrinsically ABOVE or BELOW with respect to the chair.

Figure 13. Ball and Chair Picture 5.8
Across the five dyads per language that were coded and analyzed, there were 65 potential disaligned intrinsic uses (i.e. a total of 65 critical items were described). In the 2011 pilot, Yucatec speakers used intrinsic frames in describing 17 of the critical pictures, whereas English speakers used intrinsic frames for 10 pictures. After dynamic and vector-based intrinsic uses (see §2.5.2) were excluded from analysis, these numbers reduce to five and one for Yucatec and English, respectively. Given previous research and the results presented by Bohnemeyer and Tucker (2010), we would expect English speakers to use the intrinsic significantly less frequently, if at all.

4.3.3 Quantitative analysis
Quantitative analysis is based upon a comparison of POCO violations against a lack of violations from within the set of items that afforded POCO violations. Out of 65 stimuli (13 per dyad), how many photos were described with a disaligned intrinsic frame?

4.3.3.1 English significance
I tested whether English speakers significantly differ from what POCO predicts (i.e. that there are no violations) using a fisher exact test, and found no significance (see Appendix C, table 5). This confirms that English does not predictably violate POCO.

4.3.3.2 Yucatec significance
After examination of the 2011 Yucatec descriptions of the target photos, only 5 of the 17 intrinsic uses were found to be unambiguous uses of a disaligned intrinsic frame (this excludes
the alternate uses of the intrinsic, as discussed in §2.5.2). This result (p=0.05771) is almost significant, but misses the mark slightly (see Appendix C, table 6).

A discussed in §4.3.1, Bohnemeyer found that participants had trouble interpreting the stimuli run in 2011, and in 2012 returned to the field with finalized stimuli. In response to this stimuli set, participants made 23 uses of an intrinsic frame in describing the target photos. Seven are uses of the up/down axis such that a disaligned intrinsic frame is being used (i.e. violating POCO). I found significance for this (p=0.01318) (see Appendix C, table 7). We can therefore conclude that, given interpretable stimuli, we can predict that Yucatec speakers use the ground object’s vertical axes to locate a figure, even when that ground object is not in canonical orientation.

4.3.4 Significance of use between languages

Beyond testing whether POCO holds in individual languages, I wanted to see if this stimuli set could shed light on whether two languages differ in their probability of committing POCO violations. Unfortunately, no comparison between English and the two different Yucatec data sets yielded significant results.

Very few uses of a disaligned intrinsic were made in describing the target photos in the 2011 Yucatec pilot, and so there is no significant difference between the English pilot and the 2011 Yucatec pilot (see Appendix C, table 8).

The difference between the English pilot and the 2012 Yucatec collection approaches significance (p=0.06194), but unfortunately is not strong enough (see Appendix C, table 9). Perhaps with more data, or less ambiguity in the results, a significant finding could be reached.
5. **Conclusion**

This paper has presented data from a revised design of the Ball and Chair referential communication task, used in the study of spatial frames of reference in discourse in the project ‘Spatial language and cognition in Mesoamerica’. The goal of the revision was to provide further data for the exploration of the constraint on the use of vertical relators in expressing intrinsic frames, a constraint Levelt has termed “the Principle of Canonical Orientation” (POCO). The study presented here is the first known experimental research on POCO violability in a language other than English. As discussed in section 4.3.3, inferential statistical analysis shows that Yucatec speakers significantly use ground objects’ vertical axes to locate figures, even when the ground object is not in canonical orientation. In contrast, the same analysis of English speakers’ data finds no significance.

This study has also yielded greater understanding of the types of uses of intrinsic frames across languages, resulting in a more fine-grained classification of spatial frames of reference. As presented in section 2.5, intrinsic frames may be used when aligned with the axes of gravity (vertical frames), the observer (relative frames), or disaligned from these frame types. Further, analysis of the discourse data produced by English and Yucatec speakers shows use of a newly discovered dynamic intrinsic frame type (§2.5.2). The use of frames of reference in combination with types of scene interpretation (e.g. static vs. dynamic) was not originally a focus of this research but is ripe for further study.

Finally, although the pilot of the extended Ball and Chair picture sets did not yield a significant difference in POCO violations between the two languages of study, further research is currently underway using the finalized version of the picture stimuli. In the second phase of the
MesoSpace Project, ‘Spatial language and cognition beyond Mesoamerica’, the new stimuli are being used to collect further data on frame use in discourse from several languages of the first phase. In the future, the analyses presented here will be applied to the data collected from those other languages, with the hopes of producing significant results. Additionally, Ball and Chair data is currently being analyzed to explore potential causes of POCO violations in the different languages of the sample, comparing rates of meronym use and overall preference for intrinsic frame use with POCO violability (Tucker et al., to be presented 2013).
References


Appendix A: Original Ball and Chair task, Sets 1-4
Appendix B: Extended Ball and Chair task, Sets 5-7 (English Pilot photos)
Appendix C: Print-outs of R computations

Table 1. Analyses of significance for English original Ball and Chair set vs. extended Ball and Chair set (Fig. 8)

<table>
<thead>
<tr>
<th>Vertical:</th>
<th></th>
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<tr>
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</tbody>
</table>

Vertical:

```r
> vert <- matrix(c(10, 240, 26, 145), nrow=2)
> vert
 [,1]  [,2]
[1,]   10   26
[2,] 240  145
> fisher.test(vert)
Fisher's Exact Test for Count Data

data:  vert
p-value = 7.129e-05
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 
0.09738101 0.51728832
sample estimates:
  odds ratio
        0.23319
```

Intrinsic:

```r
> int <- matrix(c(49, 201, 22, 149), nrow=2)
> int
 [,1]  [,2]
[1,]   49   22
[2,] 201  149
> fisher.test(int)
Fisher's Exact Test for Count Data

data:  int
p-value = 0.08467
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 
0.9313289 2.9966527
sample estimates:
  odds ratio
       1.649158
```

Topological:

```r
> topo <- matrix(c(50, 200, 23, 148), nrow=2)
> topo
 [,1]  [,2]
[1,]   50   23
[2,] 200  148
> fisher.test(topo)
Fisher's Exact Test for Count Data

data:  topo
p-value = 0.08924
alternative hypothesis: true odds ratio is not equal to 1
```
Relative:

```r
> rel <- matrix(c(102, 148, 62, 109), nrow = 2)
> rel
 [,1] [,2]
[1,] 102  62
[2,] 148 109
> fisher.test(rel)
```

Fisher's Exact Test for Count Data

```
data: rel
p-value = 0.3614
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.7962214 1.8485040
sample estimates:
odds ratio
1.211084
```

Intrinsic-Relative aligned:

```r
> IR <- matrix(c(15, 235, 19, 152), nrow = 2)
> IR
 [,1] [,2]
[1,]  15  19
[2,] 235 152
> fisher.test(IR)
```

Fisher's Exact Test for Count Data

```
data: IR
p-value = 0.06899
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.2340659 1.0987418
sample estimates:
odds ratio
0.5114712
```

Table 2. Analyses of significance for English original Ball and Chair set vs. final Etic Grid set (Fig. 9)

Topological:

```r
> topo <- matrix(c(50, 200, 30, 205), nrow = 2)
> topo
 [,1] [,2]
[1,]  50  30
[2,] 200 205
> fisher.test(topo)
```

Fisher's Exact Test for Count Data

```
data: topo
p-value = 0.1178
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.4601211 2.7326286
sample estimates:
odds ratio
1.526513
```
data: topo
p-value = 0.03728
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 1.017356 2.901300
sample estimates:
   odds ratio
   1.706445

Vertical:
> vert<- matrix(c(10,240,26,209),nrow=2)
> vert
   [,1] [,2]
[1,]  10   26
[2,] 240  209
> fisher.test(vert)

Fisher's Exact Test for Count Data

data: vert
p-value = 0.003142
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 0.1409772 0.7398676
sample estimates:
   odds ratio
   0.335659

Intrinsic/Vertical aligned:
> IV<- matrix(c(22,228,33,202),nrow=2)
> IV
   [,1] [,2]
[1,]  22   33
[2,] 228  202
> fisher.test(IV)

Fisher's Exact Test for Count Data

data: IV
p-value = 0.08512
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 0.3172019 1.0837473
sample estimates:
   odds ratio
   0.5912914

Relative:
> rel<- matrix(c(102,148,85,150),nrow=2)
> rel
   [,1] [,2]
[1,]  102   85
[2,] 148  150
> fisher.test(rel)
Table 3. Analyses of significance for Canonical vs. Non-canonically oriented chairs in English Etic Grid set (Fig. 10)

**Intrinsic:**

```r
> Int<- matrix(c(24,97,15,99),nrow=2)
> int
[,1] [,2]
[1,] 24  15
[2,] 97  99
> fisher.test(int)

Fisher's Exact Test for Count Data

data: int
p-value = 0.2194
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 0.7675423 3.5567751
sample estimates:
odds ratio 1.629595
```

**Relative:**

```r
> rel<- matrix(c(38,83,47,67),nrow=2)
> rel
[,1] [,2]
[1,] 38  47
[2,] 83  67
> fisher.test(rel)

Fisher's Exact Test for Count Data

data: rel
p-value = 0.1357
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval: 0.3686536 1.1537296
sample estimates:
odds ratio 0.653864
```

Table 4: Analysis of significance for English vs. 2011 Yucatec pilots (Fig. 11)

**Relative:**

```r
> rel<- matrix(c(85,150,65,312),nrow=2)
> rel
[,1] [,2]
[1,] 85  65
[2,] 150 312
```
Fisher's Exact Test for Count Data

data: rel
g- \text{value} = 2.342e-07
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
1.832813 4.038858
sample estimates:
odds ratio
2.715239

Topological:
> topo <- matrix(c(30, 205, 95, 282), nrow=2)
> topo
[,1] [,2]
[1,] 30 95
[2,] 205 282
> fisher.test(topo)
Fisher's Exact Test for Count Data
data: topo
g- \text{value} = 0.000192
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.2677548 0.6910965
sample estimates:
odds ratio
0.4349575

Geocentric:
> geo <- matrix(c(2, 233, 33, 344), nrow=2)
> geo
[,1] [,2]
[1,] 2 33
[2,] 233 344
> fisher.test(geo)
Fisher's Exact Test for Count Data
data: geo
g- \text{value} = 8.732e-06
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.01032722 0.35655430
sample estimates:
odds ratio
0.08968812

Intrinsic/Vertical aligned:
> IV <- matrix(c(33, 202, 22, 355), nrow=2)
> IV

> fisher.test(IV)
Fisher's Exact Test for Count Data

data:  IV
p-value = 0.0007557
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
  1.444504 4.878037
sample estimates:
  odds ratio
  2.631741

Intrinsic/Relative aligned:
> IR<- matrix(c(19,216,48,329),nrow=2)
> IR
 [,1] [,2]
[1,] 19  48
[2,] 216 329
> fisher.test(IR)
Fisher's Exact Test for Count Data

data:  IR
p-value = 0.0837
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
  0.3255856 1.0793850
sample estimates:
  odds ratio
  0.6033862

Direct:
> dir<- matrix(c(1,234,17,360),nrow=2)
> dir
 [,1] [,2]
[1,]  1  17
[2,] 234 360
> fisher.test(dir)
Fisher's Exact Test for Count Data

data:  dir
p-value = 0.002443
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
  0.002160666 0.586606913
sample estimates:
  odds ratio
  0.09070557

Vertical:
```r
> vert <- matrix(c(26, 209, 32, 345), nrow = 2)
> vert

[,1] [ ,2]
[1,] 26   32
[2,] 209 345
> fisher.test(vert)

Fisher's Exact Test for Count Data

data: vert
p-value = 0.3214
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.7446211 2.3948690
sample estimates:
odds ratio
1.340518

Table 5. Analysis of English POCO violations

> EngViol <- matrix(c(0, 65, 1, 64), nrow = 2)
> EngViol

[,1] [,2]
[1,] 0   1
[2,] 65 64
> fisher.test(EngViol)

Fisher's Exact Test for Count Data

data: EngViol
p-value = 1
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.00000 39.00055
sample estimates:
odds ratio
0

Table 6. Analysis of 2011 Yucatec pilot POCO violations

> YucViol <- matrix(c(5, 60, 0, 65), nrow = 2)
> YucViol

[,1] [,2]
[1,] 5   0
[2,] 60 65
> fisher.test(YucViol)

Fisher's Exact Test for Count Data

data: YucViol
p-value = 0.05771
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
0.9449695       Inf
sample estimates:
odds ratio
Inf
```
Table 7. Analysis of 2012 Yucatec POCO violations

```r
> YucViol <- matrix(c(7,58,0,65),nrow=2)
> YucViol
[1,]  7  0
[2,] 58 65
> fisher.test(YucViol)
```

Fisher's Exact Test for Count Data

```
data:  YucViol
p-value = 0.01318
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
  1.52713     Inf
sample estimates:
odds ratio
          Inf
```

<table>
<thead>
<tr>
<th>Table 8. Analysis of English and 2011 Yucatec pilot POCO violations</th>
</tr>
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<tbody>
<tr>
<td>&gt; QPViol &lt;- matrix(c(5,60,1,64),nrow=2)</td>
</tr>
<tr>
<td>&gt; QPViol</td>
</tr>
<tr>
<td>[,1] [,2]</td>
</tr>
<tr>
<td>[1,] 5 1</td>
</tr>
<tr>
<td>[2,] 60 64</td>
</tr>
<tr>
<td>&gt; fisher.test(QPViol)</td>
</tr>
</tbody>
</table>

Fisher's Exact Test for Count Data

```
data:  QPViol
p-value = 0.2078
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
  0.5668702 255.7876451
sample estimates:
odds ratio
  5.274827
```

<table>
<thead>
<tr>
<th>Table 9. Analysis of English and 2012 Yucatec POCO violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; QPViol &lt;- matrix(c(7,58,1,64),nrow=2)</td>
</tr>
<tr>
<td>&gt; QPViol</td>
</tr>
<tr>
<td>[,1] [,2]</td>
</tr>
<tr>
<td>[1,] 7 1</td>
</tr>
<tr>
<td>[2,] 58 64</td>
</tr>
<tr>
<td>&gt; fisher.test(QPViol)</td>
</tr>
</tbody>
</table>

Fisher's Exact Test for Count Data

```
data:  QPViol
p-value = 0.06194
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
  0.9345125 352.830843
sample estimates:
```


<table>
<thead>
<tr>
<th>odds ratio</th>
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</thead>
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