

Expressing Distance in the Baltic Languages: Remarks on the Use of an Extended RCC

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Abstract. The aim of this paper is to demonstrate how the distance between two objects is expressed in the Baltic languages in a geometric framework. The geometric framework in this research is based on Region Connection Calculus (Randell et al., 1992), representing different spatial relations between two circles depending on the primitive topological relation of connectedness and extended with the operators of distance (near / far) and orientation (left / right, above / below, oblique). The paper summarizes the results of two experiments conducted with 106 Lithuanian and 105 Latvian participants, and provides an interpretation of 15 stimuli with the emphasis on the usage of the terms that express proximity, remoteness and which specify distance. Our results indicate different determining factors for the use of these three groups of terms. Proximity terms clearly depend on the change in distance: as the distance between the circles decreases, the number of proximity terms increases, but the largest number of them is generated for externally connected circles. In addition, the largest number and variety of proximity terms are produced for the horizontal axis, less – for the oblique, and least – for the vertical. The terms indicating remoteness are most compatible with the greatest distance between the circles and with horizontal axes as well. The usage of the distance-specifying phrases, in contrast, does not depend on axis and increase or decrease in distance. The presence of any distance seems to be a determining factor for attempting to express it in certain measurements.

Keywords: distance, near, far, RCC, geometry, the Baltic languages.

1. Introduction

Within static non-angular spatial relations, containment and support have received most attention in linguistic and psycholinguistic research due to several reasons. There has been ample evidence on the polysemy of the terms expressing containment and support attempting to define the determining principles for the usage of these terms in spatial domains, and to explain the meaning extensions into abstract domains (Herskovits, 1986; Navarro, 1998; Feist, 2000, Jamrozik and Gentner, 2011 among others). Another

important question was raised about the importance of geometry vs. function or force-dynamic factors and their impact for the use of containment and support terms. Earlier geometric approaches (e.g., Cooper, 1968; Bennett, 1975) were considered insufficient for explaining all the use-types of prepositions positing a functional approach as more plausible (Vandeloise, 1991, 1994; Coventry et al., 1994; Coventry and Garrod, 2004; cf. Landau, 2017). In addition, containment and support relations have attracted much attention because of the cross-linguistic similarities and variation, which provides evidence that languages may structure spatial domain extremely differently (Bowerman and Pedersen, 1992; Bowerman and Choi, 2003; Levinson and Wilkins, 2006; Gentner and Bowerman, 2009; Landau et al., 2017; Feist and Zhang, 2019).

In comparison to containment and support, proximity has been rather underexamined. Studies in linguistic semantics largely deal with polysemy of proximity adpositions, and the explanatory procedures behind it (e.g., Herskovits, 1986; Vandeloise, 1991; Navarro, 1998, see also Cienki, 1989, Šarić, 2006 for Slavonic languages). Functional geometric framework sees proximity depending on the distance between the objects involved, their size, mobility and environment (small- vs. large-scale) (Coventry and Garrod, 2004), as well as the speed of the speaker and addressee (Vandeloise, 2017). Vandeloise (idem) proposes the notion of accessibility as determining NEAR/FAR prepositions: *near* is used when the Figure is easily accessible to the Ground, but *far from* – vice versa. However, it seems that angular proximity and the choice of certain frames of reference have received more attention (Levinson, 2003; Majid et al., 2004; Levinson and Wilkins, 2006, among others), not to mention demonstratives and proximal-distal distinction, which is under thorough cross-linguistic exploration (Coventry et al., 2008; project of Deictic Communication¹).

Intuitively used relational spatial language has been made more precise in Qualitative Spatial Reasoning formalisms (for an overview cf. Forbus, 2018). These formalisms are usually equipped with a first order language expressing relationships between spatial objects without numerical and measurement-sensitive components.

Region connection calculus (RCC; Randell et al., 1992; Cohn et al., 1997) is one of the most prominent frameworks of qualitative spatial reasoning, assuming a set of core topological relations that can be used for expressing a variety of relational spatial information. There are several advantages of the RCC if compared to other spatial formalisms (for an overview regarding qualitative spatial reasoning and the languages of qualitative formal representation cf. Forbus, 2018): (1) RCC assumes region as the main spatial primitive (instead of a point or point-sets); this enables a cognitively adequate way of expressing space, because in everyday situations, we are confronted with spatially extended objects or regions instead of points that are mathematical abstractions and cannot be found in the physical world; (2) RCC contains all necessary relations for representing topological variations in the physical world of human interactions. However, two objections are worth keeping in mind: (3.1) although RCC relations are necessary for representing space, they are not sufficient as some crucial and frequently used spatial (e.g., geometric) relations are still lacking in the set of classical RCC (e.g., distance, orientation, and convexity operators are unavoidable in most relational reasoning situations); (3.2) the RCC cannot explain the functional dependencies between everyday objects (e.g., relations of support and containment cannot be straightforwardly

¹ <http://www.dcomm.eu>.

represented in the RCC). Taking into account objections 3.1 and 3.2, RCC should be enriched both geometrically and functionally.

There have been several attempts to apply extended and modified versions of RCC to natural language analysis (e.g., Mani and Pustejovsky, 2012; Rodrigues et al., 2017; Vasardani et al., 2017). Although there is work on the subject in English, the Baltic languages have received only some attention in this respect (Žilinskaitė-Šinkūnienė et al., 2019a, Škilters et al., submitted, Škilters et al., MS.). Having extended RCC framework with the primitives of distance, size, orientation and partial occlusion, we have analyzed the expressions of the relations of containment and support as well as the determining factors underlying these expressions (Žilinskaitė-Šinkūnienė et al., 2019a). We have found that axial information and external connectedness are the most prominent factors which are interpreted rather similarly in both Lithuanian and Latvian. In addition, we have also examined how containment and support are expressed in typical spatial routines, using the set of stimuli with everyday objects. The results of the latter research show a large intra-linguistic and cross-linguistic variation (Žilinskaitė-Šinkūnienė et al., 2019b, cf. Bowerman and Pedersen, 1992; Bowerman and Choi, 2003; Levinson and Wilkins, 2006; Gentner and Bowerman, 2009; Landau et al., 2017). If the results of our two studies are compared, we observe that in the RCC+F framework participants concentrate more on orientational or positional properties of the spatial relation, whereas the same spatial relation between everyday objects is expressed by the means presupposing their functional interaction (e.g., support prepositions) or avoiding terms that geometrically refer to the inner region (such as inside, middle, center for containment).

In our current study, we are focusing on the distance operator (expressed in primitives FAR and NEAR); we aim to clarify the usage of proximity terms in the Baltic languages within an extended RCC framework (RCC+F). It mainly focuses on the following questions: (a) which proximity terms are employed; (b) is there a difference between the use of these terms and what properties sanction and constrain the occurrence of them.

2. The experiment

2.1. Stimuli

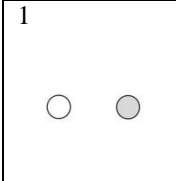
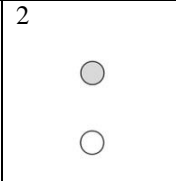
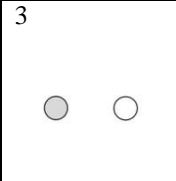
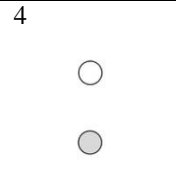
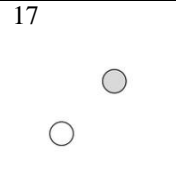
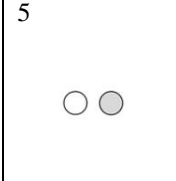
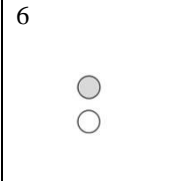
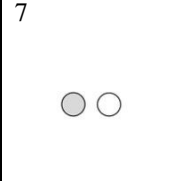
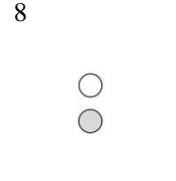
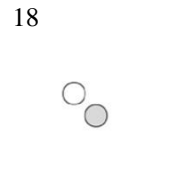
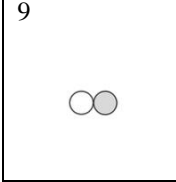
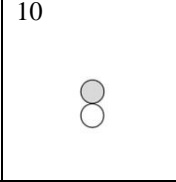
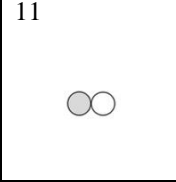
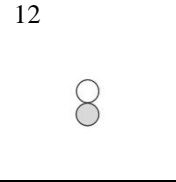
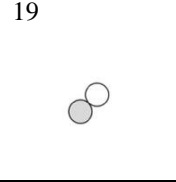
In order to test the usage of the proximity relations and proximity terms in RCC framework, we used an extended version of the RCC, namely, RCC+F (Škilters et al., MS). RCC deals with basic topological relations between two regions and is based on a primitive topological relation of connectedness (*C*). From this relation, the rest of classical RCC relations are derived: disconnectedness (*DC*), external connectedness (*EC*), partial overlap (*PO*), tangential proper-part (*TPP*) and inverse relation of tangential proper-part (*TPPi*), non-tangential proper-part (*NTPP*) and inverse relation of non-tangential proper-part (*NTPPi*). In our approach (which is a part of RCC+F), RCC was extended with orientational, distance, and size primitives, such as partial occlusion, orientation (left, right, above, below, oblique), and distance (near / far), and size (small / large). The stimuli used in this paper are summarized in Table 1.

Table 1. Stimuli labels and variables analyzed in this paper

RCC	ORIENTATION							DIS-TANCE
	left	right	above	below	45° right above	45° left below	45° right below	
DC	7	5	6	8			18	Close
DC	3	1	2	4	17			Far
EC	11	9	10	12		19		–

Each stimulus is characterized by an RCC relation (*DC* or *EC*), orientation (horizontal, vertical, or oblique axial alignment) and distance (near and far in the cases when the circles are disconnected). The numbers in the Table 1 reflect the original numeration of the stimuli as it was during the experiment. The actual stimuli are given in Table 2. Each stimulus depicts a spatial scene which consists of two circles: the dark one (the Figure) and the light one (the Ground). The terms are used as in (Talmy, 2000): the Figure is the central element that has to be located, whereas the Ground is the reference object enabling to locate the Figure.

Table 2. Stimuli for analysis

1	2	3	4	17
				
5	6	7	8	18
				
9	10	11	12	19
				

2.2. Task design and procedure

An in-group (repeated measures) experiment was conducted in two formats: a paper-and-pencil task (henceforth – p-task) and an electronic task created with QuestionProTM tool (henceforth – e-task). Both tasks consisted of the same stimuli set containing 31 stimuli. Each stimulus represented two circles: the light and the dark one, provided in a randomized order to each participant. Each stimuli set was preceded by a short

instruction introducing the task and was followed by a demographic questionnaire containing questions about gender, age, nationality, native tongue, foreign language skills, level and field of education, occupation, place where a participant has spent most of her/his life, hobbies and handedness. Under each stimulus was the question “Where is the dark circle?”, and the participants were tasked with describing the location of the dark circle in relation to the light one. We chose a partially open-ended production task (Carlson and Hill, 2003), where the beginning of the response was already given (*The dark circle...*). The average time to complete the electronic task was approximately 14 minutes for both Lithuanian and Latvian participants. All the results were manually coded in Excel and analyzed using descriptive statistics tools. Statistical t-test was conducted by software SPSS Statistics 22.

2.3. The participants

The p-task was carried out by 45 Lithuanian and 45 Latvian native speakers and the e-task – by 61 Lithuanian and 60 Latvian participants. Male / female distribution was almost equally balanced for the e-task (51% women and 49% men for LT and 52% women and 48% men for LV) but there were more male participants for the p-task (44% women and 56% men for LT and 30% women and 70% men for LV).

The age distribution of the participants is given in Figure 1. The age distribution of Latvians was similar in both tasks (p-task/e-task) – younger than 25: 41%/30%; 25–34: 23%/27%; 35–44: 16%/23%; 45–54: 9%/8% and older than 55: 11%/12%). The sample of Lithuanian participants has a different age-distribution: the p-task was filled by 73% participants under age of 25, 7% participants were in the age group 25–34; 11% and 9% were in the age groups 35–44 and over 55. The e-task was filled by 15% of participants younger than 25, while most participants were in the age groups 25–34 (44%) and 35–44 (31%), while 10% were older than 55.

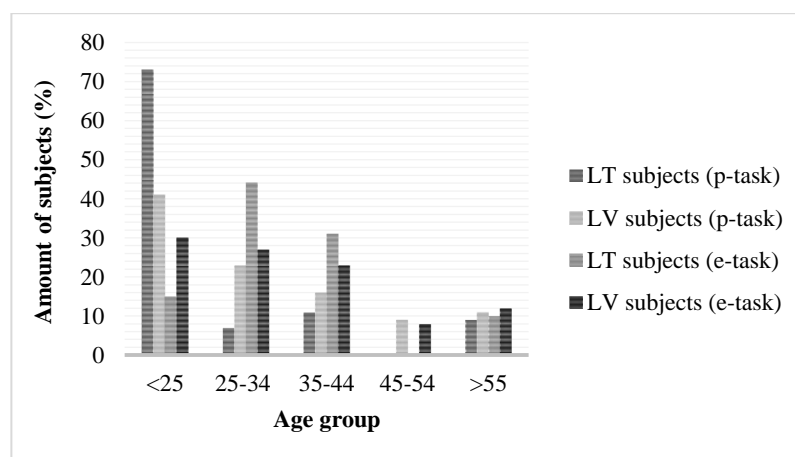


Figure 1. The age distribution (%) of LT and LV participants for both tasks

Almost all of the participants were native speakers of the language in which they filled in the questionnaire. In both tasks, 2 Lithuanian and 3 Latvian participants

indicated Russian as their mother tongue. 1 LV participant noted Yiddish as their mother tongue in the p-task, but in the e-task, other languages as native were indicated by 1 Lithuanian and 2 Latvian participants. 91% of both Lithuanians and Latvians reported English as the first most well-spoken foreign language and 56% Lithuanians and 72% of Latvians indicated Russian as the second one.

The p-task was made up of 36% Lithuanian and 37% Latvian participants with higher education, LT 62% / LV 32% with secondary school education, 2% LT and 20% LV with vocational secondary education and 11% Latvian participants with primary school education. Most of the participants in the paper task were from the fields of exact sciences, whereas humanities and social sciences were represented by 18% Lithuanian and 34% Latvian participants.

Most of the participants that completed the e-task were with higher education (Lithuanians 74%, Latvians 75%). 21% of Lithuanians and 15% of Latvians had secondary school education, 3% Lithuanians and 7% Latvians – vocational secondary education. Humanities and social sciences were reported the most frequent fields of education for both Lithuanians (72%) and Latvians (60%), the rest indicated engineering, natural sciences, medical, agriculture or other fields.

The demographic part of the e-task ended with the question about handedness: there were 95% right-handed and 5% left-handed Lithuanian participants as opposed to 92% right-handed and 8% left-handed Latvian participants.

3. Results and discussion

3.1. Data

We further describe the data of each language and compare the results between Latvian and Lithuanian taking into account the format differences (i.e., p-task and e-task). We analyze how stimuli differing in axis (horizontal / vertical / oblique) and distance (when the circles are externally connected or disconnected and located far or close from each other) induce differences in descriptions. The data are organized in 3 tables according to the axis.

3.1.1. Results for the horizontal axis

When specifying the location of the dark circle on the horizontal axis, the participants of both languages usually employ the relative frame of reference locating the dark circle on the right or left side of the light circle (see Table 3). The absolute frame of reference is also chosen, namely the location of the dark circle, which is described using cardinal directions: it is located to the East or the West of the light circle. The results of the p-task of Lithuanian participants show that this strategy is not frequent – it occurs in 7% of the cases for every of the horizontal axis stimulus. However, responding to the e-task, the absolute frame of reference was almost never used. The same must be said of Latvian data in both tasks: the means of absolute frame of reference never exceed 5%.

Table 3. Results for the horizontal axis stimuli, %

Conceptual categories	Language	1		5		9		3		7		11	
		○ ●		○○		○○		● ○		● ○		○○	
		<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>
RIGHT ²	LT	82	84	84	80	82	77						
	LV	89	83	89	80	73	77					2	
LEFT	LT							87	80	93	82	76	74
	LV					7		87	85	84	88	76	73
EAST	LT	7	2	7	3	7	-						
	LV	2	5	-	5	-	3						
WEST	LT							7	2	7	-	7	3
	LV							-	3	2	3	2	3
NEAR	LT	4	12	9	19	22	33	4	12	10	20	30	39
<i>šalia</i> 'next to'		2%	2%	7%	8%	13	21	4%	2%	4%	7%	20%	21%
<i>greta</i> 'beside'			2%		2%	2%	5%		3%		8%	2%	6%
<i>prie</i> 'near'			2%		2%		3%		2%		2%	4%	11%
<i>prie pat</i> 'right at'						7%	2%					4%	
<i>šone</i> 'at the side'			3%										
<i>kartu</i> 'together'					2%								
<i>netoli</i> 'not far'		2%	3%	2%	5%				3%	4%	3%		
<i>arti, arčiau</i> 'close, closer'							2%		2%	2%			
NEAR	LV	9	3	15	5	35	31	9	7	13	5	35	30
<i>blakus</i> 'next to'		7%	3%	11	3%	33	27	9%	5%	11	5%	33%	28%
<i>līdzās</i> 'beside'					2%		2%						2%
<i>cieši klāt</i> 'tightly at'							2%						
<i>pie</i> 'near'						2%						2%	
<i>netālu</i> 'not far'		2%							2%				
<i>tuvu</i> 'close'				4%						2%			
FAR	LT	18	13	2	2	-	-	13	13	2	-	-	-
<i>tolī / toliāu</i> 'far, farther'		18	11	2%	2%			11	11	2%			
<i>atskirai</i> 'separately'								2%					
<i>atokiai</i> 'rather far from'			2%						2%				
FAR	LV	9	8	4	3	-	-	13	4	2	3	-	-
<i>atstatus</i> 'apart'		9%		4%				9%		2%			
<i>tālu, tālumā</i> 'far'			8%		3%			4%	2%		3%		
<i>nostāk</i> 'away from'									2%				
distance-specifying phrases	LT	13	7	13	2	-	-	11	3	9	2	-	-
	LV	7	10	7	15	-	-	9	15	4	12	-	-
non-top-verbs	LT	56	15	42	16	29	7	58	21	53	18	29	5
	LV	22	20	40	20	27	22	42	22	38	23	31	17
top-verbs	LT	2	-	2	-	40	28	2	-	2	-	42	20
	LV	2	5	-	10	27	25	2	-	5	24	25	

² Capitalized lexemes in the tables denote the conceptual component regardless of its linguistic form. For example, location on the right side in Lithuanian is expressed using a wide range of functional variants: *dešinėj(e)* (*pusėje*) [LOC] 'on the right (side)', *į dešinę* (*puse*) 'to the right (side)', *iš dešinės* (*pusės*) 'from the right side', *po dešine* (*puse*) 'on the right (side)', *dešiniau* [ADV] 'more to the right', *dešinėn* [ILL] 'to the right', predicative construction *tamsus apskritimas yra dešinytis* 'the dark circle is the right one'.

As the distance between the two circles throughout the stimuli decreases (stimuli 1 > 5 > 9 and 3 > 7 > 11), the number of NEAR-terms for Lithuanian increases: respectively, 4% > 9% > 22% and 4% > 10% > 30% for p-task and 12% > 19% > 33% and 12% > 20% > 39% for e-task. In the NEAR group, LT *šalia* and *greta* are the most common: they both indicate proximal location, but the former is used more often in standard Lithuanian. A larger amount of LT *prie* (11%) occurs only for the stimulus 11 in e-task. LT *prie* in combination with the particle *pat*, namely, *prie pat* ‘right at’, is found for stimuli 9 and 11 and infer the connectedness of the circles. Conversely, *netoli* ‘not far away’ is found only for the stimuli with disconnected circles regardless the distance between them (1 and 3 with larger distance / 5 and 7 with smaller distance). Adverbs *arti* ‘close’, *arčiau* ‘closer’ occur for all three types of stimuli, however, very sporadically.

In Latvian, we see a similar but a slightly less homogenous situation in usage of NEAR-terms: the closer the circles are, the more NEAR-terms are used (with a minor exception for stimuli 3 and 7 of the e-task). The adposition *blakus* seems to be the central marker of proximity. Interestingly, the adverb *netālu* ‘not far’ is used only for stimuli 1 and 3, but *tuvu* ‘close to’ – for 5 and 7 indicating that the former adverb allows larger distance than the latter. *līdzās* ‘next to, beside’, *pie* ‘near, at’ and *cieši klāt* ‘tightly at’ are used for externally connected circles mostly. Adverb *cieši* ‘fast, tightly’ in combination with *klāt* indicates connectedness. Additionally, stimuli 9 and 11 are sporadically expressed employing the phrase *tiešā kontaktā* ‘in direct contact’.

FAR-terms occur most frequently for stimuli 1 and 3, and their number decreases for stimuli 5 and 7. Farness for stimuli 1 and 3 is described using LT *toli* ‘far’, *toliau* ‘farther’ and adverbs *atskirai* ‘separately’ and *atokiai* ‘remotely’ (18%/13% and 13%/13%), but stimuli 5 and 7 have a few cases of *toli* ‘far’. Latvian employs somewhat different FAR-terms for the p-task and e-task: the former has only *atstatus* ‘at a distance, apart, away’ while the latter has *tālu*, *tālumā* ‘far’ and *nostāk* ‘away, aside’: they all occur 9%/8% for stimulus 1 and 13%/4% for stimulus 3.

In addition to the NEAR and FAR categories, there is also a separate label “distance-specifying phrases” in the Table 3. It stands for the cases when subjects specify the distance between the circles using numerical or semi-numerical expressions. Both languages employ very similar strategies: the subjects spell out the distance using numbers, geometric measurements, such as radius, diameters, centimeters, lexemes LT *pusė*, LV *pusē* ‘half’, etc. There are also responses stating that the distance exists, but no precise description is provided, e.g., LT *per atstumą* ‘in distance’, *tam tikru atstumu* ‘in certain distance’, *skiriamas tarpo* ‘separated by gap’, LV *attālumā* ‘in distance’, *ar atstarpi* ‘with distance’, *ir distance* ‘there is distance’. The rationale behind such a separate group of terms lies in its difference from the categories NEAR and FAR. Even though distance-specifying phrases are used for the disconnected circles only (stimuli 1 and 3, 5 and 7), and thus presuppose remoteness (as the category FAR), the description of the remoteness usually does not explicitly entail nearness or farness, but instead it states that the distance is present or estimates it, cf.:

Latvian

- (1) *Virzienā pa labi no neiekrāsotā apļa, aptuveni tādā attālumā, kas ir divas reizes lielāks par neiekrāsotā apļa diametru.* (stimulus 1)

‘In the direction to the right from the unpainted circle, at about twice the distance of the diameter of the unpainted circle.’

- (2) *Pa kreisi no gaišā, apmēram divu aplu attālumā.* (stimulus 3)
‘To the left of the light, about two circles away.’
- (3) *Pa labi nelielā attālumā.* (stimulus 5)
‘A short distance to the right.’
- (4) *Pa kreisi no otra un ar ~1/2 apļa diametra lielu atstarpi.* (stimulus 7)
‘To the left from the other circle and with the distance of ~1/2 circle diameter.’

In addition to all the spatial means described above, verbs also highly contribute to the expression of spatial information. The responses in both languages include various verbs, and for this analysis, the verbs are divided into two groups: non-topological and topological verbs. The former describes the location of the dark circle (e.g., verbs meaning ‘be, be located, be moved away’) while the latter specifies the topological relation between the two circles (these are verbs meaning mostly contiguity and contact). The amount and distribution of these verbs are rather different throughout the stimuli and tasks.

In Lithuanian, there are a lot of differences in use of the verbs. The t-test shows a significant difference ($\alpha=0.05$) between electronically and paper-and-pencil data collection methods regarding the length of the responses: in the p-task, Lithuanian participants use remarkably more words to describe the Figure’s location than in the e-task. Thus the number of verbs is also very different in both tasks. However, even though the number of verbs between the p-task and e-task differs significantly, the prevailing tendency is obvious. Stimuli 1 and 3 have the largest amount of non-topological verbs with two equally dominating verbs *yra* ‘is’ and (*yra*) *nutoles* ‘(is) moved away’. The same applies to the stimuli 5 and 7, for which the verbs *yra* ‘is’, *nutoles* ‘moved away’, *pasistūmėjęs* ‘pushed itself, moved’, *nubrėžtas* ‘drawn’, *skiriamas* ‘separated’ are used. Such verbs are usually complemented by quantitative means specifying the remoteness of the dark circle from the light one, e.g.:

Lithuanian

- (5) *Per tris spindulius nutolęs į dešinę.* (stimulus 1)
‘Moved away three radii to the right.’
- (6) *Nutoles į rytus per 5 cm.* (stimulus 3)
‘Moved away to the East 5 cm.’
- (7) *Per spindulį nutolęs į dešinę.* (stimulus 5)
‘Moved away one radius to the right.’
- (8) *Yra per pusę savo skersmens nutolęs į kairę nuo balto skritulio.* (stimulus 7)
‘Is moved away half of its diameter to the left from the white circle.’

For the stimuli with externally connected circles (9 and 11), we observe a decrease of non-topological verbs (only *yra* ‘is’ is used) and an increase of the topological verbs which is most likely because of the necessity to specify the external connection of the circles. It is expressed by various forms of verbs meaning touching and snuggling, e.g., *liečia*, *liečiasi*, *lietųsi*, *yra prisilietęs* ‘touch’, *yra priglaudęs*, *yra prisiglaudęs* ‘pressed itself to’, *susiglaudę* ‘pressed to each other’.

Lithuanian

- (9) *Yra prisiglaudęs prie šviesaus apskritimo iš pastarojo dešinės.* (stimulus 9)
‘Pressed itself to the light circle from the right side of the latter.’

- (10) *Dešinėje balto, susiglaudę.* (stimulus 9)
 ‘To the right of the white one, they are pressed to each other.’
- (11) *Yra balto apskritimo kairėje, liečiasi su juo.* (stimulus 11)
 ‘To the left of the white one, touching it.’

For Latvian, the statistical tests show no significant difference between the p-task and e-task regarding the length of the responses. But we can observe the same tendency as in Lithuanian: the number of verbs in the p-task is usually larger than in the e-task. However, if compared to Lithuanian, non-topological verbs (*ir* ‘is’, *atrodas* ‘is located’, *ir novietots* ‘is placed’) are distributed differently. Non-topological verbs are distributed quite consistently for all the stimuli of both tasks, thus there is not such a considerable decrease of non-topological verbs for the EC stimuli (9 and 11) as in Lithuanian. Nevertheless, the number of topological verbs significantly increases for the EC stimuli. However, this increase is not as substantial as in Lithuanian. In Latvian, mostly the verbs *saskaras* ‘touch each other’, *pieskaras*, *aizskar* ‘touches’ are used.

3.1.2. Results for the vertical axis

Descriptions of the stimuli for the vertical axis show more variation because verticality is expressed by more diverse orientational means than horizontality in the Baltic languages (see Table 4). In stimuli 2, 6 and 10, the dark circle is located in the upper region from the light one and its location is expressed by various ABOVE-terms, namely, LT *virš* ‘above’, *viršuje* ‘on the top’, *į viršų* ‘to the top’, *iš viršaus* ‘from above’, *tiesiai virš* ‘right above’, *viršutinis* ‘one that is above’. The number of ABOVE-terms in Lithuanian is relatively high for all three stimuli (82%/84% for 2, 84%/85% for 6, 82%/74% for 10, see the data in Table 4). Stimuli 2 and 6 also have terms representing UP (*aukštai* ‘high’/ *aukščiau* ‘higher’/ *aukštyn* ‘up’), but they appear more seldom (7%/11% for stimulus 2 and 7%/7% for stimulus 6). In Lithuanian, UP-terms presuppose a higher position of the dark circle on the vertical axis and involve disconnectedness. Because of this, there are no UP-terms for externally connected circles in stimulus 10. Instead, stimulus 10 has 7%/15% of ON (preposition *ant*). Usually, the LT *ant* ‘on’ requires relation of functional support, but in the stimuli set within the RCC+F framework, such an interpretation is rather marginal because the participants focus on geometric properties mostly, but not functional ones (more on support in RCC see Žilinskaitė-Šinkūnienė et al., 2019a).

In Latvian, the distribution of ABOVE- and UP-terms do not differ as much as in Lithuanian: ABOVE (*virš* ‘above’, *viršū* ‘on the top’, *viršpusē* ‘on the top side’, *viršējais* ‘one that is above’) and UP (*augšā* ‘up’, *uz augšu* ‘upwards’, *augšpusē* ‘on the upper side’, *augstu* ‘high’, *augstāk* ‘higher’, *augšējais* ‘the one that is higher’) occur for all the three stimuli, and the numbers do not exhibit such a big gap. Moreover, in contrast to Lithuanian, Latvian UP-terms (*augšā*) are not limited to disconnectedness, thus they are used to describe stimulus 10. Latvian *uz* ‘on’, occurs even more rarely than Lithuanian *ant* ‘on’: it is used only in 7% of responses for stimulus 10 in the paper task.

Stimuli 4, 8 and 12 depict the dark circle in the lower region of the white circle and are described employing orientational terms BELOW, DOWN and UNDER. In Lithuanian, BELOW-terms are most frequent (*apačioj* ‘below’, *į apačią* ‘downwards’, *iš apačios*, *nuo apačios* ‘from below’, *apatinis* ‘one that is below’). DOWN-terms (*žemai* ‘low, below’/ *žemyn* ‘down’/ *žemiau* ‘lower’) are used more frequently when the circles

are disconnected, because they presuppose a bigger distance downwards from the white circle (UP-terms are their counterpart in the upper region). UNDER-terms, namely LT *po*, *po apačia* ‘under’, *po pat* ‘right under’ are induced by connectedness as they are most frequently used for stimulus 12, but their usage is not limited to the condition of connectedness only as it is the case for ON-grams³ on the vertical axis: ON-grams are confined to connectedness and support relations.

In contrast to Lithuanian, Latvian UNDER-terms cover the majority of the cases: *zem* occurs 51%/52% for stimulus 4, 58%/35% for stimulus 8 and 64%/50% for stimulus 12. BELOW (*apakšā* ‘below’, *apakšpusē* ‘on the lower side’, *apakšējais* ‘one that is below’) and DOWN (*lejā* ‘down’, *uz leju* ‘downwards’, *lejšus* ‘below’) are used more rarely.

The orientation of the dark circle on the vertical axis is also described applying cardinal directions (the absolute frame of reference). Again, as already observed in respect to the horizontal axis, in the p-task, Lithuanians use cardinal directions for all the stimuli of the vertical axis regardless the distance between the circles (11% for the stimulus 2 and 7% for the rest of the stimuli). In LT e-task and Latvian data, it is used only sporadically as the amount of such responses usually does not exceed 5%.

Table 4. Results for the vertical axis stimuli, %

Conceptual categories	Language	2		6		10		4		8		12	
		<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>
ABOVE / VIRŠ, VIRS	LT	82	84	84	85	82	74						
	LV	60	38	60	45	60	50						
UP / AUKŠTAI, AUGŠĀ	LT	7	11	7	7	-	-						
	LV	40	48	38	48	27	42						
ON / ant, uz	LT					7	15						
	LV					7	-						
BELOW / APAČIOJ, APAKŠĀ	LT							42	64	49	54	51	56
	LV							16	23	11	30	20	30
DOWN / ŽEMAI, LEJĀ	LT							27	21	31	18	16	3
	LV							16	12	22	13	16	10
UNDER / PO, ZEM	LT							18	10	20	21	27	28
	LV							51	52	58	38	64	50
NORTH	LT	11	5	7	5	7	2						
	LV	4	5	2	2	4	2						
SOUTH	LT							7	3	7	7	7	3
	LV							4	5	2	5	-	2
NEAR	LT	4	-	2	7	17	5	2	2	4	8	15	7
<i>šalia</i> ‘next to’		2%		2%	2%	7%	2%	2%	-	2%	2%	11	
<i>greta</i> ‘beside’						2%	3%		-		2%		5%
<i>prie</i> ‘near’						4%			-		2%		
<i>prie pat</i> ‘right at’						4%			-			2%	2%
<i>labai arti</i> ‘very close’						-			-			2%	-
<i>netoli</i> ‘not far’		2%		-	5%	-		-	2%	2%	2%		-

³ The term *gram* is used after Svorou (1994): it denotes any grammatical element bearing spatial meaning.

NEAR	LV	-	-	6	4	7	9	2	2	6	2	6	6
<i>blakus</i> 'next to'		-		2%	2%	7%	7%	-	2%	2%	2%	4%	2%
<i>tieši blakus</i> 'right at'												2%	2%
<i>līdzās</i> 'beside'												2%	2%
<i>cieši klāt</i> 'tightly at'							2%						2%
<i>netālu</i> 'not far'				2%	2%					2%			
<i>tuvu</i> 'close'				2%				2%		2%			
FAR (<i>tolī, tolēliāu</i>)	LT	7	8	-	-	-	-	9	5	-	-	-	-
FAR	LV	6	2	7	2	-	-	6	5	-	5	-	-
<i>atstatus</i> 'apart'		4%	2%	7%	2%			4%	2%		2%		
<i>tālu</i> 'far'		2%						2%	3%		3%		
distance-specifying phrases	LT	7	3	9	-	-	-	11	3	11	3	-	-
	LV	11	17	4	12	-	-	13	15	9	10	-	-
non-top-verbs	LT	58	23	49	21	22	7	57	21	44	15	27	7
	LV	42	22	40	23	36	18	38	25	42	22	40	18
top-verbs	LT	4	-	2	2	49	15	-	-	4	-	44	20
	LV	-	7	4	7	24	30	2	5	4	7	13	23

NEAR-terms are not frequent for the vertical axis in both languages. If horizontal and vertical axes are compared, proximity terms occur more frequently when the circles are aligned horizontally. In the vertical axis, NEAR-terms are mostly attested for stimuli 6 / 8 and 10 / 12. However, there is some intralinguistic variation between the tasks. For example, the LT data of the p-task and e-task are distributed differently: the p-task has the largest amount of proximity terms for the stimuli in which the circles are externally connected, namely 10 (18%) and 12 (15%), but in the e-task, proximity terms are most frequently used for stimuli 6 (7%) and 8 (8%) with the disconnected circles.

As already observed for the horizontal axis, proximity adpositions LT *šalia* 'next to', *greta* 'beside' and LV *blakus* 'next to' are the most common ones. LT *prie pat* 'right at' and LV *cieši klāt* 'tightly at' require connectedness – for this reason they are employed for stimuli 10 and 12. However, if compared to the horizontal axis, the vertical axis is described using fewer proximity terms. For example, Lithuanian lacks lexemes adopting a usage which is confined to a lateral position because of its lexical meaning, such as the adverb *šone* 'at the side'. The adverb *kartu* 'together' is not used, because it usually expresses accompaniment or comitative relation, and thus is also much more plausible in horizontal alignment. In Latvian, the vertical axis lacks the preposition *pie* 'near'.

FAR-terms in Lithuanian occur only for in the case of 2 and 4, in Latvian – also for 6 and 8. In addition, Latvians more frequently specify the distance employing different numerical information, e.g.:

Latvian

- (12) *Virš (augšpusē) otra apļa un ar ~2x apļa diametra lielu atstarpi.* (stimulus 2)
'Above (on the top) of the second circle and with the distance of ~2 circle diameters.'
- (13) *Zem baltā, ~2 diametru attālum.* (stimulus 4)
'Below the white one, at the distance of ~2 diameters.'
- (14) *Virš gaišā, apmēram 1 cm attālumā.* (stimulus 6)
'Above the light one, at about 1 cm distance.'

- (15) *Tumšais aplis atrodas uz leju no baltā apla. attālums, aptuveni puse apla diametra.* (stimulus 8)
 ‘The dark circle is down from the white circle. The distance is about half the diameter of the circle.’

In Lithuanian, specification of distance usually goes together with the participle *nutoļes* ‘moved away’. In addition to quantitative information, lexemes indicating approximate distance are used, namely verbs denoting remoteness are modified by adverbs *šiek tiek* ‘a little’, *gerokai* ‘by far’, *labiau* ‘more’, cf.:

Lithuanian

- (16) *Šiaurėje nuo balto, nutoļes.* (stimulus 2)
 ‘In the North, moved away.’
- (17) *Maždaug per tris diametrus nutoļes nuo šviesaus į apačią.* (stimulus 4)
 ‘Moved away approximately three diameters downwards from the light circle.’
- (18) *Virš balto, šiek tiek pakilęs virš jo.* (stimulus 6)
 ‘Above the white one, a little bit risen above it.’
- (19) *Nubrėžtas balto apskritimo apačioje. Centrai nutolę 2-3 cm vienas nuo kito.* (stimulus 8)
 ‘Drawn below the white circle. The centers are 2–3 cm apart.’

As already seen from the examples, verbs also highly contribute to the spatial information of distance and orientation. In Lithuanian, the usage of verbs in vertical alignment shows a similar pattern to the horizontal one: non-topological verbs are predominant for disconnected circles, but the number of topological verbs increases twice or even more for externally connected ones. For Lithuanian data, non-topological verbs are *yra* ‘is’, *yra nuloļes* ‘(is) moved away’, *yra pakilęs* ‘(is) risen’, *yra skiriamas* ‘is separated by’, *nubrėžtas* ‘is drawn’, topological – *nesiliečia* ‘does not touch each other’, *atskirtas* ‘is separated’. The latter verbs are used for stimuli 2, 4, 6, and 8, but other verbs, usually indicating contact, occur for stimuli 10 and 12 with externally connected circles, namely, *susilietę*, *susiliečia*, *liečia*, *liečiasi*, *liestųsi* ‘touch’, *prisišliejęs* ‘is adjoined’, *priglundęs* ‘pressed itself to’, *susiglaudžia* ‘pressed to each other’, e.g.:

Lithuanian

- (20) *Yra virš balto apskritimo, taip, kad jie nesiliečia.* (stimulus 2)
 ‘Is above the white circle in a way that they are not touching each other.’
- (21) *Žemiau balto, atskirtas.* (stimulus 8)
 ‘Lower than the white one, separated.’
- (22) *Virš balto apskritimo, liečiasi su juo.* (stimulus 10)
 ‘Above the white one, touches it.’
- (23) *Apačioje balto, priglundęs.* (stimulus 12)
 ‘Below the white one, pressed itself [to the white circle].’
- (24) *Prisišliejęs prie baltojo apskritimo iš pietų pusės.* (stimulus 12)
 ‘Adjoins the white circle from the Southern side.’

In Latvian, the use of verbs for the vertical axis is also very similar to the horizontal one, except for the fact that for stimuli 10 and 12 in the e-task, the number of topological

verbs (*saskaras*, *pieskarties*, *sastapties*, *sakļauties*, *nepārklāt*) exceeds the number of non-topological verbs (*ir* ‘is’, *atrodas* ‘is located’) indicating that EC is cognitively prominent, e.g.:

Latvian

(25) *augšpusē pieskaras gaišajam aplim.* (stimulus 10)

‘Touches the light circle at the top.’

(26) *Zem neiekrāsotā, saskaras vienā punktā.* (stimulus 12)

‘Under the non-colored (circle), they meet at one point.’

3.1.3. Results for the oblique axis

Table 5. Results for the oblique axis stimuli, %

Conceptual categories	Language	17		18		19	
		<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>	<i>p-task</i>	<i>e-task</i>
ABOVE / <i>virš, virs</i>	LT	47	54				
	LV	18	10				
UP / AUGŠTAI, AUGŠĀ	LT	9	3				
	LV	47	63				
BELOW / APAČIOJ, APAKŠĀ	LT			33	31	46	28
	LV			9	12	16	20
DOWN / ŽEMAI, LEJĀ	LT			20	18	13	15
	LV			36	38	40	28
UNDER <i>po, zem</i>	LT			4	5	7	7
	LV			24	18	18	17
RIGHT	LT	56	46	58	43		
	LV	60	57	53	53		
LEFT	LT					54	38
	LV					53	53
NORTHEAST	LT	18	21				
	LV	9	10				
SOUTHEAST	LT			18	25		
	LV			4	10		
SOUTHWEST	LT					18	23
	LV					4	10
OBLIQUE AXIS	LT	16	11	9	11	9	11
	LV	13	17	20	13	22	12
NEAR	LT	4	7	11	20	26	19
<i>šalia</i> ‘next to’		2%	2%	2%	7%	9%	11%
<i>greta</i> ‘beside’			2%		5%	4%	3%
<i>prie</i> ‘near’						2%	3%
<i>prie pat</i> ‘right at’						7%	2%
<i>šone</i> ‘at the side’						2%	
<i>arti</i> ‘close’				2%	5%	2%	
<i>netoli</i> ‘not far’		2%	3%	7%	3%		

NEAR	LV			14	2	23	14
<i>blakus</i> ‘next to’				7%		16%	10%
<i>līdzās</i> ‘beside’							2%
<i>pie, tieši pie</i> ‘near, right near’						7%	
<i>netālu</i> ‘not far’				7%			
<i>cieši tuvu</i> ‘tightly close’					2%		2%
FAR (<i>tolī, toliāu, tolēliāu</i>)	LT	11	13	2	2	-	-
FAR	LV	8	7	4	7	-	-
<i>atstatus</i> ‘apart’		4%	2%		5%		
<i>tālu, tālumā</i> ‘far’		4%	3%		2%		
<i>nostatus</i> ‘afar’				2%			
<i>attālāk</i> ‘remotely’			2%				
<i>sānis</i> ‘aside, apart’				2%			
distance-specifying phrases	LT	11	5	9	-	-	-
	LV	7	12	7	8	2	-
non-top-verbs	LT	53	20	42	13	35	8
	LV	36	27	38	27	38	22
top-verbs	LT	2	-	4	2	41	23
	LV	-	-	4	5	22	27

The description of the location on the oblique axis is the most complex, as it requires the greatest specification (see Table 5). Participants use the same orientational terms for above / below and left / right regions: ABOVE (LT *aukštyn, aukščiau, LV augšā, augšējā, uz augšu, augstu*), UP (LT *virš, LV virs*) for stimulus 17, BELOW (LT *apačioj, LV apakšā, apakšpusē, apakšējais*), DOWN (LT *žemai, žemiau, žemyn, LV lejā, uz leju, lejpus*) for stimuli 18, 19, and RIGHT (17, 18) / LEFT (19), but their quantity is smaller than for horizontal or vertical axes. The only exception is observed for Latvian: the number of DOWN-terms increases if compared to the vertical axis. Also, it is worth mentioning that both languages lack ON-grams (LT *ant*, LV *uz*) for externally connected circles (stimulus 19). ON-grams are not frequent, even in the canonical vertical position (stimulus 10), thus it is not surprising that for the oblique axis that such a support interpretation is even more implausible.

Interestingly, participants used cardinal directions for the oblique axis more than for horizontal and vertical axes as cardinal directions are a convenient way to refer to obliqueness. It is rather obvious for Lithuanian: 18%/21% (stimulus 17), 18%/25% (stimulus 18) and 18%/23% (stimulus 19). In Latvian, however, this increase is not as evident: LV 9%/10% for stimulus 17 and 4%/10% for stimuli 18 and 19.

In addition to cardinal directions, both languages employ other strategies for obliqueness. These are the terms for the oblique axis: LT *diagonaliai, įstrižai* ‘diagonally’ and LV *diagonāli, slīpi, šķērsām* ‘idem’, e.g.:

- (27) LT *tolī, diagonaliai* // LV *pa diagonāli augšup* (stimulus 17)
‘far, diagonally’ ‘diagonally upwards’
- (28) LT *įstrižai šone apačioje* // LV *šķērsām blakus gaisajam* (stimulus 19)
‘obliquely, on the side, below’ ‘obliquely, next to the light’

Moreover, diagonality is also expressed specifying the angle in degrees or clock arrows, cf. some Latvian and Lithuanian examples below. However, such metric descriptions never exceed 5% of the responses, e.g.:

Latvian

- (29) *Tumšāk iekrāsotais aplis ir virs neiekrāsotā apļa gabaliņu attālāk, **apmēram 45grādu leņķī** virzienā pa labi.* (stimulus 17)
 ‘The darker painted circle is above the unpainted circle, a bit farther away, at an angle of about 45 degrees to the right.’
- (30) *45grādos pa labi.* (stimulus 18)
 ‘45 degrees to the right.’
- (31) *45 grādu leņķī zem baltā apļa, pa kreisi.* (stimulus 19)
 ‘45 degrees angle below the white circle to the left.’

Lithuanian

- (32) *Tolėliau balto apskritimo 1:30 laikrodžio kryptimi.* (stimulus 17)
 ‘Farther from the white circle at 1:30 clockwise.’

Latvian

- (33) *Ir nedaudz nostatus no gaišā apļa **pulksteņa 4:30 virzienā**.* (stimulus 18)
 ‘Is slightly away from the light circle in 4:30 direction.’
- (34) *Pieskaras gaišajam aplim **pulksteņa 7:30 virzienā**.* (stimulus 19)
 ‘Touches the light circle in 7:30 direction.’

Obliqueness is also expressed indirectly: the participant chooses the means that are typical for the vertical axis and then specifies it further with additional determining spatial descriptors, e.g.:

Lithuanian

- (35) *Yra **po** BA ir **ne tiesiai po** BA, o **nutoles į dešinę pusę**.* (stimulus 18)
 ‘Is located under the white circle and not directly under, but is moved to the right side.’

The diversity of ways to describe oblique orientation leads to the observation that participants tend to use most words in responses and most precisely describe the location of the circles for the stimuli 17, 18 and 19 (see image 1 and image 2 in Škilters et al., submitted).

The usage of proximity terms shows a similar pattern as for the horizontal and vertical axes: as the distance between the circles decreases, the amount of spatial terms increases or remains approximately the same. In the case of the FAR category and distance-specifying phrases, the situation is reversed: the greater the distance, the more such responses are attested, e.g., stimulus 18 in LV:

Latvian

- (36) *Atrodas pa diagonāli (uz leju un pa labi) no baltā apļa **aptuveni 1/4 no apļa diametra attālumā**.*
 ‘Located diagonally (down and to the right) from the white circle at the distance of about 1/4 of the circle diameter.’

Interestingly, in Latvian the distance is also indicated for the externally connected circles in stimulus 19, but if we look at this example more carefully, we see that the distance from the horizontal and vertical axes is meant, not from the white circle:

Latvian

(37) *Vienādā attālumā pa kreisi un zem. Ir kopīgs punkts.*

‘In equal distance to the left and under. There is a common point.’

Verbs are used in a similar way as in the responses to other axes. In Lithuanian, as the distance between the circles decreases, the number of non-topological verbs also decreases, but topological verbs become predominant. LT *yra* ‘is’ is used in the majority of cases, but there are also verbs that indicate remoteness of the dark circle, such as LT *nutoleş, atitoleş* ‘moved away’. Stimulus 19 has 35%/8% of non-topological verbs, but 41%/23% of topological verbs (*liečiasi, yra prisilietęs* ‘touches’, *prisiglaudęs* ‘pressed itself to’, *prijungtas* ‘connected to’), e.g.:

Lithuanian

(38) *Pietvakariuose. Prisilietęs prie balto apskritimo.*

‘In the Southwest. Touches the white circle.’

(39) *Jis yra ties 7–8 valanda, liečiasi su šviesiuoju apskritimu.*

‘It is at 7–8 o’clock, in contact with the light circle.’

(40) *Yra prie sviesaus apskritimo prisiglaudes istrizai kaireje puseje.*

‘It is near the white circle, pressed itself to it diagonally on the left side.’

(41) *Istrižai iš apačios prijungtas prie baltojo.*

‘Diagonally from below connected to the white one.’

In Latvian, the same stimulus, 19, has 38%/22% of non-topological verbs (*ir* ‘is’, *atrodas* ‘is located’, *ir nobīdīts* ‘is moved from’, *attālināts* ‘moved away’) and 22%/27% of topological ones (*saskaras* ‘touches each other’, *pieskaras* ‘touches smth’, *ir kombinācijā ar balto apli* ‘is in combination with the white circle’). Thus, non-top-verbs remain predominant for the p-task, but in the e-task the number of top-verbs exceeds the number of non-top-verbs. In Lithuanian, however, the top-verbs for EC circles are predominant in both tasks.

3.2. The usage of proximity and distance terms

Figure 2 below presents the distribution of NEAR-terms for horizontal (stimuli 1–11 from the left side), vertical (stimuli 2–12 in the middle) and oblique (17–19) axes in both tasks and in both languages. The stimuli within the horizontal and vertical axes are organized according to the decrease of the distance: stimuli 1 / 3 and 2 / 4 depict large distance, 5 / 7 and 6 / 8 – small, but 9 / 11 and 10 / 12 have no distance between the circles, as the circles are externally connected.

The data in the Figure 2 show a strong link between the stimulus type in relation to distance between the circles and the usage of NEAR-terms: as the distance between the circles decreases, the number of proximity terms increases. In addition, the horizontal axis seems to be the most compatible with proximity terms and, moreover, the horizontal axis has the highest variety of proximity terms. The oblique axis (stimuli 17, 18 and 19) follows the horizontal one in respect to the frequency of proximity terms, but the vertical axis has least of them. The vertical axis is different not only in frequency of these terms, but also in scope: in Lithuanian, it lacks adverb *šone* ‘at the side’ which is present for the other axes, but in Latvian *pie* ‘near’, *tieši pie* ‘right near’ are absent for the verticality.

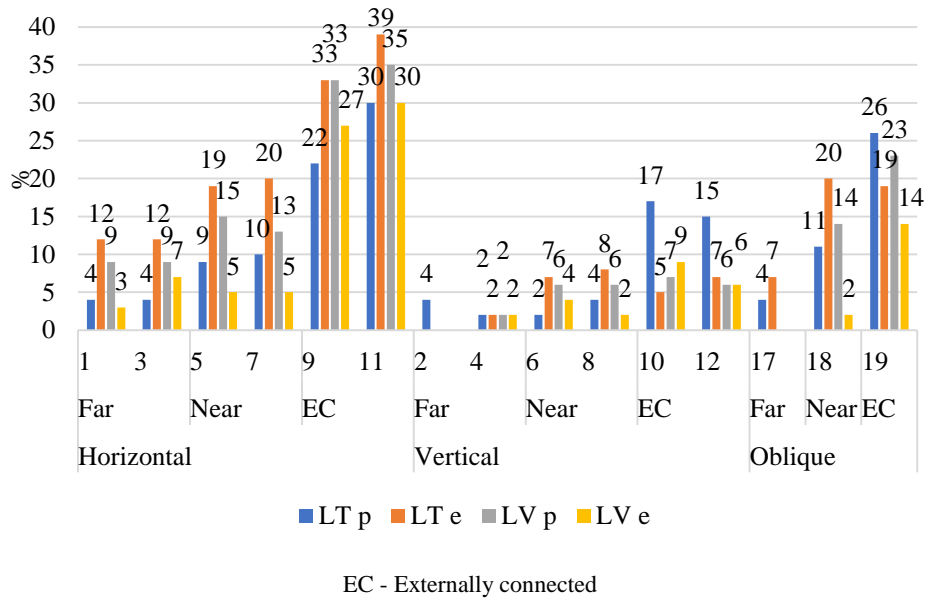


Figure 2. Usage of NEAR-terms for horizontal, vertical and oblique axes, (%)

Moreover, if we look at the diversity of spatial terms indicating proximity, we see that in the vast majority of cases, LT *šalia* ‘next to’, *greta* ‘beside’ and LV *blakus* ‘next to’ are used. In Lithuanian, these prepositions usually describe location and coexistence of the Figure and the Ground in vicinity to each other, and often presuppose the same status resp. symmetry of these two basic elements of the spatial scene. Moreover, they do not presuppose any interaction between the Figure and the Ground; the same must be said about the Latvian *blakus*. In contrast, prepositions LT *prie* and LV *pie* occur very sparsely in the data of both languages, as the semantic scope of these prepositions is usually not limited to pure locative relation between the objects of equal status. LT *prie* and LV *pie* may entail Figure-Ground asymmetry and functional interaction. Therefore, the participants use LT *šalia*, *greta* and LV *blakus* to locate the light circle, but the connectedness (and possible interaction) is expressed by the verbs (see discussion section).

Figure 3 below shows the usage of FAR terms. Obviously, externally connected circles have no FAR-terms in the responses. For the rest of the stimuli, the frequency of FAR-terms is relatively opposite to NEAR-terms, because the larger the distance is, the more FAR expressions are used by the participants: the largest number of them is observed for the stimuli 1 / 3 (the horizontal axis), less for the stimulus 17 (the oblique axis) and least for 2 / 4 (the vertical axis) with the circles displaying remote disconnectedness. If the distance between the circles is smaller (5 / 7 for the horizontal axis, 6 / 8 for the vertical axis and 18 for the oblique axis), the distribution of FAR-terms is relatively similar for the horizontal and oblique axes, but the vertical axis varies according to the language: Lithuanian has no FAR-terms at all, but Latvian does. The Baltic languages also differ in respect to the array of lexemes. In Lithuanian, the horizontal axis has most adverbs for farness: *toli* / *toliau* ‘far, farther’, *atskirai*

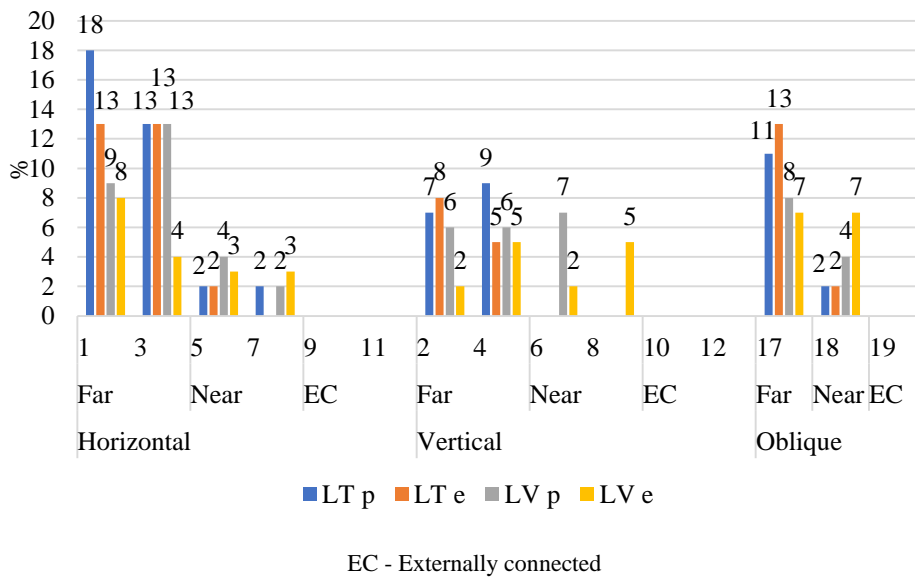


Figure 3. Usage of FAR-terms for horizontal, vertical and oblique axes, (%)

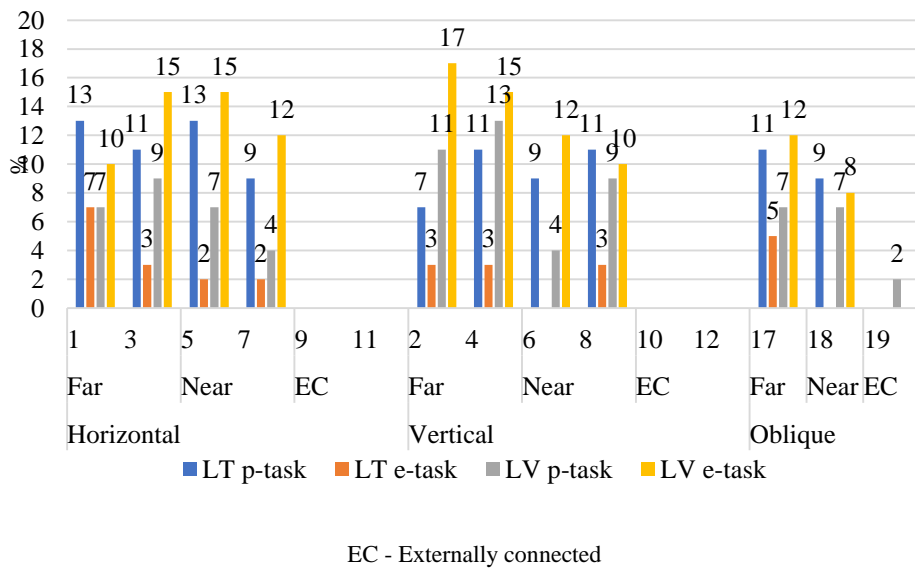


Figure 4. Usage of distance-specifying phrases for horizontal, vertical and oblique axes, (%)

‘separately’, *atokiai* ‘rather far from’, but the remaining axes are characterized by *toli* ‘far’ / *toliau* / *tolėliau* ‘farther’ only. In Latvian, however, the oblique axis has most lexemes, such as *atstatus* ‘apart’, *nostatus* ‘afar’, *tālu*, *tālumā* ‘far’, *attālāk* ‘remotely’, *sānis* ‘aside, apart’, horizontal – *atstatus* ‘apart’, *tālu*, *tālumā* ‘far’, *nostāk* ‘away from’, whereas the vertical axis – only *atstatus* ‘apart’ and *tālu* ‘far’.

Figure 4 displays the results of distance-specifying phrases. This category is characterized by expressions attempting to indicate a concrete distance between the circles employing geometric terms, metric information, adverbial modifiers (e.g., *tam tikru atstumu* ‘at certain distance’) etc. The responses do not include such information for externally connected circles (2% for stimulus 19 in LV p-task seem to indicate the distance from x and y axes, not from the white circle). For the rest of the stimuli, certain axes and increase / decrease in distance do not influence the usage of distance specifiers in the same way as for NEAR- or FAR-terms. The presence of any distance seems to be a determining factor for attempting to express it in certain measurements.

3.3. Discussion and conclusions

Our results show that both topological and geometric knowledge determines spatial descriptions in RCC+F framework. When specifying the location of the dark circle in all three axes, orientational terms of the relative frame of reference seem to be the most prominent and frequent ones, as they structure space into robust categories: the horizontal axis is primarily described using LEFT / RIGHT-terms, but vertical – ABOVE / UP / ON and BELOW / DOWN / UNDER. For the oblique axis, the terms referring to both verticality and horizontality are used with a slight predominance of the former ones. In addition, in the Lithuanian sample, the oblique axis has a larger number of responses containing cardinal directions (the absolute frame of reference) than the remaining two axes. Moreover, subjects of both languages use different other strategies to express obliqueness: lexemes denoting diagonality (LT *diagonaliai*, *įstrižai*, LV *diagonāli*, *slīpi*, *šķērsām*), metric information (angle specification with degrees or clock arrows), and indirect descriptions referring to obliqueness with the means that are characteristic of other axes.

The terms that express proximity (NEAR-terms) or remoteness (FAR-terms) and specify distance between the circles are used to a lesser extent and thus are of secondary importance. However, all of them not only contribute to the localization of the Figure-object, thus making the description more accurate, but also reveal different determining variables that underline the usage of these terms. Axial information, distance and connectedness affect the usage of NEAR-terms, axial information and disconnectedness – of FAR-terms, disconnectedness and presence of any distance – of distance-specifying phrases.

One interesting finding is that connectedness between the circles (*EC*, in particular) causes the largest number of NEAR-terms in RCC+F framework. Even when the circles are connected and aligned vertically (stimulus 10), participants still use NEAR-terms and the number of NEAR-terms sometimes may even exceed the number of ON-grams. In this case, geometric information seems to be more important than support (Žilinskaitė-Šinkūnienė et al., 2019a). But if real-world spatial situations are considered, connectedness between everyday objects might indicate interaction between the Figure

and the Ground, and therefore the Figure becomes constrained by the Ground in various ways; typical support prepositions are then used (the data for support category with everyday objects in the Baltic languages and Estonian can be found in Žilinskaitė-Šinkūnienė et al., 2019b).

In addition, connectedness (and eventually a possible interaction) has one more consequence: it substantially induces the application of topological verbs in RCC+F framework. In Lithuanian, the usage of the verbs is consistent in relation to all the three axes: non-topological verbs are used for all types of stimuli, but their number decreases for the externally connected ones allowing topological verbs to take a predominant status. Hence the number of topological verbs for externally connected circles always exceeds the number of non-topological verbs. It is not usually the case in Latvian: non-topological verbs remain predominant when describing both disconnectedness (both tasks) and external connectedness (the p-task), but in the e-task the number of topological verbs exceed the non-topological verbs. However, this increase is not as considerable as in Lithuanian. These results are in line with our previous findings with support in RCC+F: when expressing the location of the dark circle on the vertical axis under the conditions of partial overlap and partial occlusion, Lithuanian participants in both tasks and Latvian participants in the e-task use the topological verbs more than the non-topological ones (Žilinskaitė-Šinkūnienė et al., 2019a, 244).

The topological verbs express the connection of the circles in different perspectives. The circles may be treated as equal resp. symmetric members in a spatial scene employing reciprocal verbs LT *susiliesti* / LV *saskarties* ‘touch each other’, *susijungti* / *savienoties* ‘join each other’, LT *susiglausti* / LV *sakļauties* ‘press to each other’, LV *sastapies* ‘meet each other’. Also, participants may put emphasis on the Figure (the dark circle) and describe connection from its perspective using the verbs LT *liesti*, *prisiliesti* / LV *pieskarties* ‘touch’, LT *prisišlieti* ‘adjoin’, *priglusti* ‘press itself to’. In the latter way, these verbs reflect Figure-Ground asymmetry and convey not only the topological information of connectedness, but also refer to the interactional element. This suggests that topological NEAR-terms are not efficient to reflect external connectedness of the circles as connectedness might also mean (a) interaction which causes the participants to additionally use an increased number of topological verbs, or (b) necessity of specification the exact area of contact between both regions.

The findings on expressing proximity and distance within an extended RCC framework lead to questions about the determining factors for them in the functional domain (resp. everyday situations). Although the participants produce most NEAR-terms for externally connected circles in RCC+F framework, connectedness might not be necessary or relevant for expressions of proximity in real-world spatial scenes. Various other prominent causes should be taken into account, which, however, remains a question for future research.

Abbreviations

ADV – adverb, ILL – Illative, LT – Lithuanian, LV – Latvian, LOC – Locative.

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