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Brief article

Spatial demonstratives and perceptual space: To reach or not to reach?

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ABSTRACT

There is much debate regarding the relationship between spatial demonstratives (*'this'* or *'that'*) and perceptual space. While some have argued for a close mapping between the use of demonstratives and the peripersonal/extrapersonal space distinction (Coventry et al., 2008, 2014; Diessel, 2014), others have argued that distance from a speaker does not affect demonstrative choice (e.g. Kemmerer, 1999; Peeters, Hagoort, & Özyürek, 2015). We investigated the mapping between demonstratives and perceptual space across sagittal and lateral planes. Manipulation of object location on the lateral plane, and the hand used to point at objects (left, right) afforded a critical test of the the mapping between demonstratives and the reachability of objects. Indeed, we found that objects positioned at the same locations were described using *this* when the hand pointing at the object could reach it. Furthermore, we found no overall effects of handedness or visual field on demonstratives choice. This provides strong support for a mapping between perceptual space and the use of demonstratives. Such a mapping may help explain the influence of other variables on demonstrative choice, including interactive factors.

1. Introduction

Spatial demonstratives, including the words *this* and *that* in English, constitute an important class of lexical items across all languages. Not only are they present in all languages and are among the highest frequency words within a language (Deutscher, 2005; Diessel, 1999, 2006), but they are also among the earliest words to be acquired (Clark, 1978, 2003). Moreover, they are closely linked with the action system – demonstratives often involve pointing at objects (Clark, 1996; Diessel, 2006), and in some languages it is obligatory to point when using such terms (*Goemai*, Hellwig, 2003; *Kilivili*, Senft, 2004).

Typologically, the most common demonstrative system across languages is a binary system, as in English (Diessel, 1999, 2005). This has prompted many linguists to assume that the binary distinction is distance based, with one term, the proximal term, used for near distances and the other (distal) term for far distances. More precisely, this distance distinction in the case of demonstratives has been mapped onto the peripersonal (near) space and extrapersonal (far) space distinction made by the vision and action systems (Coventry, Valdés, Castillo, & Guijarro-Fuentes, 2008; Kemmerer, 1999). Peripersonal space (PPS) may be defined as "a network of body-part-centred representations responsible for the coordination of actions toward, and avoidance of, objects and other living entities." (Hunley & Lourenco, 2018, p14; see also Di Pellegrino & Làdavas, 2015). More specifically, the distinction between PPS and extrapersonal space is assumed to map onto different brain systems (Berti & Rizzolatti, 2002; Legrand, Brozzoli, Rossetti, & Farné, 2007; Làdavas, 2002) with recent evidence suggesting that processing of objects within reachable/manipulable space is associated with dorsal stream activation, and in particular the reach-related area of the superior parieto-occipital cortex (SPOC) and the intraparietal sulcus (IP) (Gallivan, McLean, & Culham, 2011; Makin, Holmes, & Zohary, 2007). Moreover, there is much evidence that PPS is flexible and graded. For example, extending one's reach using a tool extends PPS (Berti & Frassinetti, 2000; Farné, Bonifazi, & Làdavas, 2005; Longo & Lourenco, 2006; Maravita, Spence, & Driver, 2003) and PPS is contracted when the arm is weighted (Lourenco & Longo, 2009).

Experimental work on demonstratives has provided support for a link between the PPS/extrapersonal space distinction and the use of proximal versus distal demonstratives. In a series of studies, Coventry and colleagues (Coventry, Griffiths, & Hamilton, 2014; Coventry et al., 2008) found a rapid graded drop off in the use of *this* in English and *este* in Spanish to describe object locations in egocentric space when the object moves across the graded boundary to extrapersonal space (see also Maes & De Rooij, 2007; Stevens & Zhang, 2013). Moreover, when participants point at objects with a stick, the area in which *this* and *este* are used extends to the area reachable with the end of the stick, consistent with the extension of near-space neglect reported by Berti & Frasinetti (2000).

It is important to note that a mapping between perceptual space and demonstratives is not the only factor that determines their use. Other

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factors have been identified empirically, including object properties such us visibility, ownership, familiarity (Coventry et al., 2014), the position of a hearer (Coventry et al., 2008; Rocca, Wallentin, Vesper, & Tylén, 2018), and joint attention (see for example Diessel, 2014; Küntay & Özyürek, 2006). However, although demonstratives seem determined by multiple factors, with perceptual space among them, the role of the mapping between demonstratives and perceptual space has been challenged on two grounds.

First, a possibility that might still be consistent with the experimental data on demonstratives to date is that the proximal-distal contrast may have to do with a more general distance contrast rather than a direct mapping between peripersonal-extrapersonal space and demonstratives. For example, it is possible that the stick manipulation simply rescaled space in some way, extending the proximal scope that supplied a new artificial proximal-distal boundary. Such a possibility might be consistent with a point made by Kemmerer (1999) that one can use *this* and *that* (e.g. *this* planet and *that* planet) when objects are clearly not in peripersonal space (although one needs to be cautious extrapolating from contrastive to non-contrastive uses of closed class terms), and in a similar vein, the distal term can also be used in peripersonal space (see for example Bonfiglioli, Finocchiaro, Gesierich, Rositano, & Vescovi, 2009).

Second, it has been argued that the joint attentional function of demonstratives is the primary function, and that use is not affected by egocentric distance (Peeters & Özyürek, 2016; Peeters et al., 2015). For example, Peeters et al. (2015) challenge the very notion that there is any kind of mapping between perceptual space and demonstratives, citing EEG evidence from matches/mismatches between heard demonstratives and locations when participants viewed photographs varying object location with reference to a pictured speaker faced outwards from behind a photographed table. While the EEG data supports the view that people in face-to-face communication do not seem to differentiate between (egocentric) peripersonal and extrapersonal space (preferring *this* at any distance between speaker and hearer), the pretest data reported by Peeters *et al.* where participants were asked to indicate the appropriate demonstrative to use for each position did support the importance of distance as a determinant of demonstrative choice when people were face-to-face. It is therefore rather hard to know what to make of the Peeters *et al.* findings, especially since they used pictures rather than physical distances in three-dimensional space.

Here our main goal was to further test the mapping between demonstratives and perceptual space. In order to do so, we manipulated the location of objects in both the sagittal and lateral planes. This allows us to precisely test the mapping between peripersonal/extrapersonal space by manipulating when an object is reachable and when it is not, depending on the hand used to point at the object. If the PPS-extrapersonal space distinction is indeed important for demonstrative choice, one should find a drop off in the use of *this* in lateral locations dependent on the hand used to point at the object when naming it (see Fig. 1B). Specifically, pointing at an object on the far left should be associated with increased use of *this* when pointing with the left hand (as the object can be reached) compared to the same location when pointing with the right hand (where the object cannot be reached). And the reverse should be the case for an object positioned at an equivalent contralateral location. Therefore, the lateral axes affords a strong test of the mapping between perceptual space and the use of demonstratives.

We also consider two other potential variables that may affect demonstrative use: the hemifield in which an object appears (left versus right visual field of the speaker) and the handedness of the speaker. First, demonstratives can be used temporally to denote objects and events in current focus of attention/temporal proximity (*this month*) versus objects and events that appeared in the past (*that was a particularly good year*), and the proximal term usually occurs first when referring to two objects (e.g. '*this cup and that cup*'). Moreover, there is a general processing bias in the left visual field (Marzoli, Prete, & Tommasi, 2014), for example, manifest in facial asymmetries in face processing and visual attention to faces (see for example Burt & Perrett, 1997). Given the processing biases from left to right, often also associated with writing direction (Bergen & Lau, 2012; Shaki, Fischer & Petrustic, 2009) or the dominance of right handers (Marzoli et al., 2014), one can postulate that *this* might be used more in the left visual field than in the right (and vice versa for *that*).

Regarding handedness, it is generally easier to manipulate objects with one's preferred hand, so one can also predict that pointing with the preferred or dispreferred hand potentially could affect the language one uses to describe object location, with *this* being used more when pointing with the preferred hand. This would be consistent with results showing mappings between preferred hand and other categories of language (see Casasanto, 2011), and how such mappings can be disrupted changing manipulability of objects (Casasanto & Chrysikou, 2011). Furthermore, there is evidence for differences in the representation of body space as a function of handedness and of lateralized mental imagery of actions (Willems, Hagoort, & Casasanto, 2010). Neurologically healthy subjects have the tendency on line bisection tasks to bisect with a bias toward the left (a phenomenon labelled 'pseudoneglect'). Pseudoneglect is influenced by a range of variables included handedness, with dextrals manifesting a slightly bigger bias toward the left side than sinistrals (Jewell & McCourt, 2000; Luh, 1995).

In summary, we manipulated the location of objects on the sagittal and lateral axes, handedness, and the hand used to point at objects when describing object location in order to further test (1) the mapping between PPS/extrapersonal space and demonstrative use, (2) and the possible influence of visual attention and handedness on demonstrative use.

2. Method

The method employed the 'memory game' previously used to elicit demonstratives without participants being aware that language data are being collected (Coventry et al., 2008, 2014; Gudde, Griffiths, & Coventry, 2018). Objects (6 coloured disks) were placed in front of participants in 30 different positions (25 cm apart) on a table, resulting in a 6 sagittal X 5 lateral grid (Fig. 1A).

2.1. Participants

31 left-handed (8 males) and 32 right-handed participants (16 males) took part. The age range was 18–30 (left-handed: $M = 21.32$, $SD = 2.7$; right-handed: $M = 19.83$; $SD = 1.29$). All were English native speakers receiving payment or course credit for their time.

2.2. Procedure

Handedness was assessed with the Edinburgh Handedness inventory (Cohen, 2008 version adapted from Oldfield, 1971) and Stereo acuity was tested using the Randot Stereo Test (Stereo Optical Inc. Chicago, USA) (all participants had a threshold of at least 40 arcseconds). Participants were then asked to sit at the table where the 30 different positions were marked on a tablecloth. Participants were instructed to touch several key locations on the tablecloth so reaching distances to locations were strictly controlled (moving the tablecloth according to reach ensured participants were able to reach the second far right position with their right hand, but not with their left hand and vice versa, to test our main hypothesis: Fig. 1B).

Participants were then instructed they were taking part in a 'memory game' task assessing the possible impact of language on memory for object location (based on Coventry et al., 2008, 2014). On each trial, the experimenter placed an object (one of 6 coloured plastic disks) on one of the 30 marked positions. When the experimenter was behind the participant, they were instructed to point at the object, half of the time with their preferred hand and half of the time with their

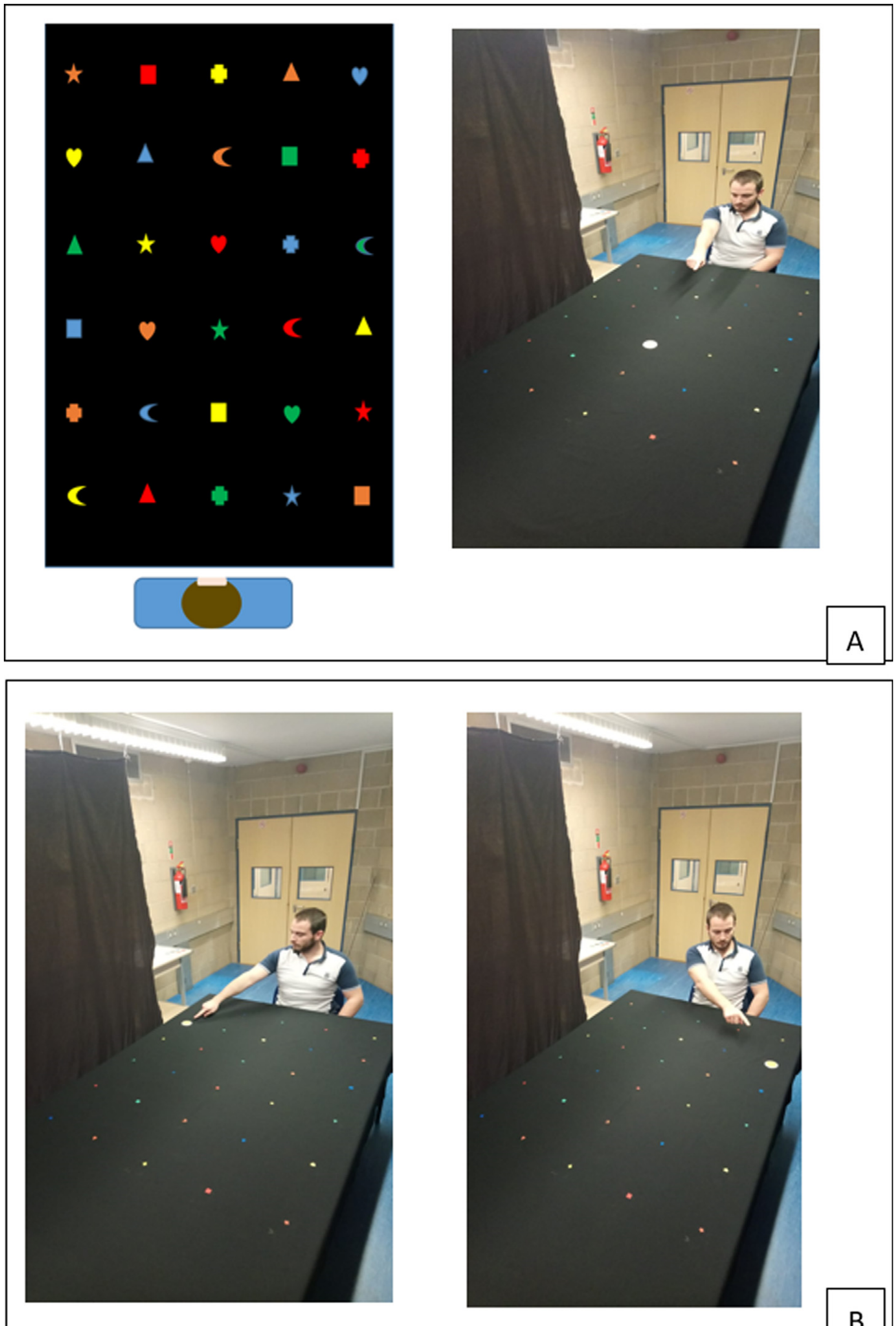

Fig. 1. A. Left panel: a schematic representation of the table used for the study, with all the placement positions marked. Right panel: a picture of a participant pointing at an object placed on one of the midline locations. **B.** An example of a participant able to reach the object on their right with their right hand but not at the equivalent contralateral location.

dispreferred hand, and to name the object using a combination of three words (so all particiants used the same amount of language on each trial): a demonstrative (the word *'this'* or *'that'*), the object colour and the word *disk*, e.g. ***this*** *red disk* or ***that*** *red disk.* To maintain the memory cover, after a random number of trials, participants were asked to recall the position of an object previously placed. At the end of the experiment, the experimenter ensured that the 'memory game' cover persisted during the entire experiment by checking that the participant was not aware the experiment was testing demonstrative use (for detailed instructions see the supplemetary materials in the Appendix).

3. Results

The percentage of the use of *'this'* was calculated (see Table 1) for each of the location × pointing hand × handedness combinations. We ran two analyses, first considering the middle locations on their own, and then the outer (lateral) locations (see Appendix for raw data).

Data from the midline locations were analysed in a distance × pointing hand × handedness ANOVA (with Greenhouse-Geisser corrections where necessary). There was a significant main effect of distance, $F(2.880, 175.691) = 43.258$, $p < 0.00001$, $\eta p^2 = 0.415$. Follow-up analyses (using LSD tests) revealed significant

Table 1
Mean % use of *this* (and SDs) by distance, pointing hand and handedness. (Sagittal distances are labelled from closest (1) to furthest (6) from participants.)

Sagittal position		RIGHT-HANDED									
		Left hand pointing					Right hand pointing				
		Far left	Near left	Middle	Near right	Far right	Far left	Near left	Middle	Near right	Far right
6	**Mean**	29%	26%	29%	30%	26%	26%	30%	28%	30%	23%
	(SD)	(0.23)	(0.26)	(0.25)	(0.27)	(0.26)	(0.29)	(0.24)	(0.32)	(0.27)	(0.23)
5	**Mean**	23%	20%	40%	30%	28%	34%	32%	26%	30%	26%
	(SD)	(0.24)	(0.24)	(0.32)	(0.27)	(0.27)	(0.30)	(0.21)	(0.25)	(0.29)	(0.26)
4	**Mean**	23%	43%	35%	34%	36%	33%	46%	40%	37%	35%
	(SD)	(0.23)	(0.29)	(0.28)	(0.33)	(0.30)	(0.24)	(0.35)	(0.30)	(0.22)	(0.28)
3	**Mean**	41%	52%	50%	47%	45%	44%	47%	52%	46%	40%
	(SD)	(0.27)	(0.31)	(0.29)	(0.27)	(0.31)	(0.28)	(0.30)	(0.25)	(0.30)	(0.26)
2	**Mean**	53%	66%	63%	60%	39%	50%	55%	69%	55%	60%
	(SD)	(0.35)	(0.30)	(0.32)	(0.31)	(0.32)	(0.28)	(0.30)	(0.25)	(0.30)	(0.26)
1	**Mean**	63%	71%	73%	63%	62%	63%	70%	80%	70%	63%
	(SD)	(0.26)	(0.27)	(0.28)	(0.28)	(0.35)	(0.29)	(0.29)	(0.27)	(0.33)	(0.28)
		LEFT-HANDED									
Sagittal position		**Left hand pointing**					**Right hand pointing**				
		Far left	**Near left**	**Middle**	**Near right**	**Far right**	**Far left**	**Near left**	**Middle**	**Near right**	**Far right**
6	**Mean**	27%	21%	29%	17%	29%	20%	26%	36%	23%	27%
	(SD)	(0.28)	(0.24)	(0.26)	(0.83)	(0.27)	(0.28)	(0.25)	(0.26)	(0.24)	(0.23)
5	**Mean**	22%	31%	34%	31%	29%	31%	24%	33%	32%	24%
	(SD)	(0.28)	(0.28)	(0.33)	(0.28)	(0.25)	(0.32)	(0.31)	(0.33)	(0.32)	(0.26)
4	**Mean**	32%	35%	37%	34%	34%	29%	43%	43%	28%	28%
	(SD)	(0.30)	(0.26)	(0.29)	(0.27)	(0.29)	(0.28)	(0.29)	(0.31)	(0.26)	(0.29)
3	**Mean**	35%	48%	63%	48%	51%	41%	43%	53%	48%	40%
	(SD)	(0.28)	(0.27)	(0.32)	(0.34)	(0.30)	(0.25)	(0.30)	(0.27)	(0.33)	(0.28)
2	**Mean**	56%	64%	69%	57%	49%	46%	62%	64%	63%	52%
	(SD)	(0.56)	(0.29)	(0.27)	(0.37)	(0.28)	(0.30)	(0.33)	(0.36)	(0.32)	(0.33)
1	**Mean**	65%	64%	68%	65%	60%	60%	67%	70%	61%	60%
	(SD)	(0.29)	(0.34)	(0.33)	(0.29)	(0.28)	(0.29)	(0.31)	(0.29)	(0.29)	(0.34)

differences between the first two (reachable) positions ($M_{dist1} = 72.82$, $M_{dist2} = 66.07$)and all the others ($M_{dist3} = 54.43$, $M_{dist4} = 38.69$, $M_{dist5} = 33.13$, $M_{dist6} = 30.56$)(all $p < 0.01$). No other effects or interactions were significant (all $p > 0.16$).

Next we considered the outer lateral locations in a sagittal distance (6 distances) × lateral distance (near, far) × side (left, right) × handedness (left, right) ANOVA. Consistent with the previous sagittal distance analyses, there was a main effect of sagittal distance ($M_{dist1} = 64.27$, $M_{dist2} = 55.53$, $M_{dist3} = 44.64$, $M_{dist4} = 34.43$, $M_{dist5} = 28.05$, $M_{dist6} = 25.56$), $F(1.801, 109.843) = 60.779$, $p < 0.0001$, $\eta p^2 = 0.499$. There was also a main effect of lateral distance, $F(1, 61) = 21.387$, $p = 0.00002$, $\eta p^2 = 0.260$. *This* was used more for near locations overall ($M = 44.35$) than for far locations ($M = 39.81$) in the lateral plane. There was also a significant lateral distance × sagittal distance interaction, $F(5, 305) = 3.086$, $p = 0.010$, $\eta p^2 = 0.048$; there was an effect of lateral distance for the first four locations (all $p < 0.001$) but not for the two furthest locations ($p > 0.05$).

Of most interest was a significant pointing hand × side × sagittal distance interaction, $F(5, 305) = 4.403$, $p = 0.0007$, $\eta p^2 = 0.067$, displayed in Fig. 2. For each distance we compared possible differences between the hand used for pointing as a function of the side the object appeared on. As shown in Fig. 2, there was no effect of pointing hand for the nearest distance or for the majority of distances clearly beyond peripersonal space (all contrasts $p > 0.05$). However, when the object appeared on the left side in location 2, *this* was used significantly more when pointing with the left hand ($M = 59.85$) compared with the right hand ($M = 53.37$) ($p = 0.012$). The opposite pattern was the case in the equivalent locations on the right side; when the object appeared on the right side in location 2, *this* was used more when pointing with the right hand ($M = 57.5$) compared with the left hand ($M = 51.38$) ($p = 0.018$). Additionally there was one other distance (location 5), but only on the left side, where *this* was used more when pointing with the right hand ($p = 0.013$). None of the other main effects or interactions were significant (all $p > 0.15$).

4. Discussion

Our goals were threefold. First we set out to test the mapping between peripersonal/extrapersonal space and spatial demonstratives through manipulation of objects on both the sagittal and lateral axes. Second we tested whether handedness might play a part in determining demonstrative choice. Third, we examined potential visual field influences on demonstrative choice.

Taking the second and third goals together, we found no evidence for the effects of handedness or visual field on demonstrative choice, save for an isolated effect of pointing hand at one location in extrapersonal space on the left side. Despite previous evidence for a mapping between left and right and visual attention on the one hand, (see for example Bergen & Lau, 2012), and handedness and language on the other (see for example Casasanto, 2011), limited evidence for the predicted mappings materialised in our data (see also Griffiths, Bester, & Coventry, 2019). It is possible that contrastive use of demonstratives would reveal a different pattern, especially with respect to visual attention (with *this* used before *that* in the contrastive pair). Moreover, the use of other paradigms might be more sensitive to such manipulations, for example, one can ask if people are more likely to gesture with their preferred hand when using *this*, consistent with the previous data for valence in the analyses of gesture (e.g. Casasanto & Jasmin, 2010).

In contrast, the results strongly support the mapping between perceptual space and demonstrative choice. Consistent with previous studies (e,g, Coventry et al., 2008, 2014), *this* is used more in PPS in the

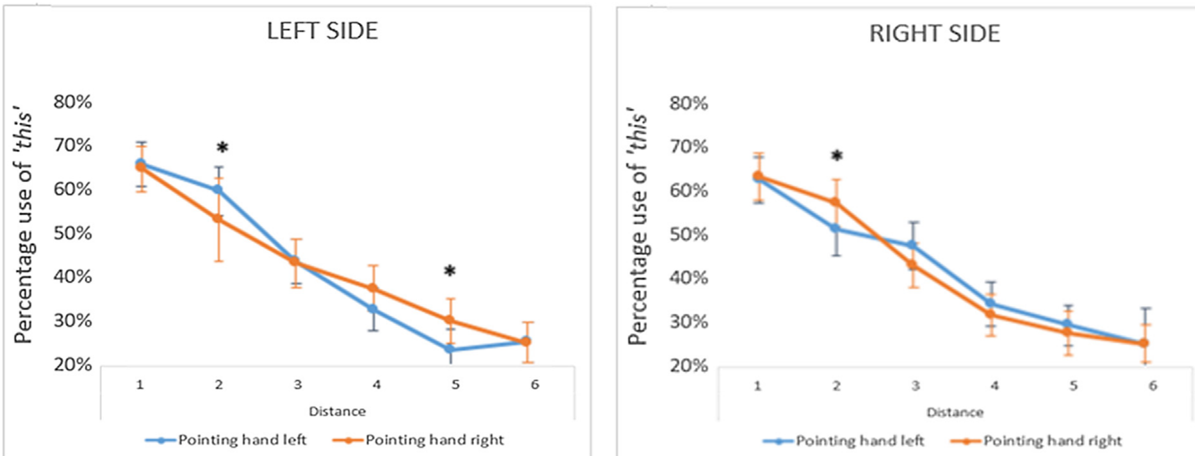

Fig. 2. Line graph showing the use of "this" for the 6 sagittal positions when participants pointed with their left hand and right hand on the left side (left panel) and right side (right panel). Error bars show 95% confidential intervals. *$p < 0.05$.

sagittal plane, with reliable differences between reachable and non-reachable locations. In addition, the experiment has produced two new findings that strengthen evidence for the mapping. First, *this* is used more in near lateral positions compared to far lateral positions, showing the effects of distance don't only operate on the sagittal plane. Second – and most compellingly – the use of the proximal term in the same locations is affected by the hand used to point at those locations, and critically whether the object is within or outside of reachable distance.

Overall the results offer the strongest evidence yet for a mapping between spatial demonstratives and PPS. However, some remarks are in order. It is also the case that a range of other parameters affect demonstrative use, and among these the position of a hearer and the setting in which language occurs seem paramount. Far from negating the importance of perceptual space for demonstrative use, the very flexible nature of PPS may help to explain these and other findings. For example, it has been established that the size of PPS is modulated by social interaction. Specifically, Teneggi, Canzonieri, di Pellegrino, and Serino (2013) found that the PPS representation is contracted when a participant is faced by someone else, and is expanded when working collaboratively in a space with a partner. Notions of shared space in the linguistic literature on demonstratives may be enriched with consideration of how the perceptual system processes space as a function of social interaction. It remains to be tested whether changes in PPS provides the mechanism by which more interactive factors affect demonstrative choice in context.

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Declaration of Competing Interest

Authors report no disclosures.

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Appendix. Supplementary material

Supplementary data for this article are available at: https://doi.org/10.17632/ywt6rm83fr.1.

The archive contains an excel sheet with the mean percentage use of *this* for each participant for all combinations of pointing hand and distances in the lateral and saggital planes (also noting handedness as measured by the Edinburgh Handedness Questionnaire). The dataset also contains detailed instructions to participants.

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