Cognition 153 (2016) 99–107

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Original Articles

# Language and memory for object location

Harmen B. Gudde *, Kenny R. Coventry *, Paul E. Engelhardt

*University of East Anglia, UK*

ARTICLE INFO

*Article history:*
Received 11 November 2015
Revised 19 April 2016
Accepted 26 April 2016

*Keywords:*
Memory
Object location
Spatial demonstratives
Possessives
Peripersonal/extrapersonal space

ABSTRACT

In three experiments, we investigated the influence of two types of language on memory for object location: demonstratives (*this*, *that*) and possessives (*my*, *your*). Participants first read instructions containing demonstratives/possessives to place objects at different locations, and then had to recall those object locations (following object removal). Experiments 1 and 2 tested contrasting predictions of two possible accounts of language on object location memory: the *Expectation Model* (Coventry, Griffiths, & Hamilton, 2014) and the *congruence account* (Bonfiglioli, Finocchiaro, Gesierich, Rositani, & Vescovi, 2009). In Experiment 3, the role of attention allocation as a possible mechanism was investigated. Results across all three experiments show striking effects of language on object location memory, with the pattern of data supporting the Expectation Model. In this model, the expected location cued by language and the actual location are concatenated leading to (mis)memory for object location, consistent with models of predictive coding (Bar, 2009; Friston, 2003).



## 1. Introduction

The relationship between language and non-linguistic representations is a fundamental topic in the cognitive sciences. Often this relationship is approached from the standpoint of the extent to which non-linguistic representations are necessary for language comprehension (e.g. within the framework of 'embodied' cognition; cf. Barsalou, 1999). However, equally important is the extent to which language can influence non-linguistic processes (Coventry, Christophel, Fehr, Valdés-Conroy, & Herrmann, 2013). Language can direct the attention of a conspecific to the spatial world; spatial expressions, such as *these coins* or *the cup is on the table* serve to direct the attention of a hearer to regions of space (Miller & Johnson-Laird, 1976). And the pairing of language with visual events and images also affects what is recalled about the spatial world. For example, Loewenstein and Gentner (2005) found that children performed better in a mapping task when spatial relations were paired with spatial language at encoding (e.g., "I'm putting the book on the shelf"). They argue that relational language fosters the development of representational structures that facilitate cognitive processing (see also Hermer-Vazquez, Spelke, & Katsnelson, 1999).

Language can facilitate the binding and maintenance of color-location conjunctions (Dessalegn & Landau, 2008, 2013; Farran & O'Leary, 2015). For example, in a memory experiment, four-year olds performed a task in which a target (e.g. a square split in half by two different colors) was presented which they then had to find in an array. Performance was enhanced if the target was accompanied by spatial cues (e.g., "yellow is on top"). There was no additional benefit for children verbalizing the linguistic cue themselves over just hearing the cue, as long as they had a stable understanding of the spatial terms (Farran & O'Leary, 2015).

As well as facilitating memory, language presented with a spatial scene can also lead to memory errors (Feist & Gentner, 2007; Gentner & Loftus, 1979). For instance, Feist and Gentner (2007) showed that recognition memory for spatial scenes was shifted in the direction of the spatial relational language (spatial prepositions) presented with scenes at encoding. In their study, participants saw with ambiguous pictures depicting spatial relations accompanied with or without spatial sentences. When participants responded in a later yes-no recognition task, spatial language at encoding was associated with more false positives (in cases where the spatial language at encoding was associated with a more prototypical version of the spatial relation than the relation actually shown). Feist and Gentner (2007) suggest this is a result of an interactive encoding of language and visual memory, in which language influences the way people encode visual scenes. More broadly, language can be used as a tool in a task to aid memory and/or processing of spatial information (see for example Frank, Everett, Fedorenko, & Gibson, 2008; Li, Abarbanell, Gleitman, &

* Corresponding authors at: The School of Psychology, University of East Anglia, Norwich NR4 7TJ, UK.

*E-mail addresses:* h.gudde@uea.ac.uk (H.B. Gudde), k.coventry@uea.ac.uk (K.R. Coventry).

http://dx.doi.org/10.1016/j.cognition.2016.04.016
0010-0277/© 2016 The Authors. Published by Elsevier B.V.

Papafragou, 2011) consonant with some weaker variants of so-called ‘linguistic relativity’ (see Wolff & Holmes, 2011 for review).

The effects of language on memory are not limited to spatial cognition. It has also been found that presenting possessive pronouns in combination with a memory task enhances response times and memory for objects (Shi, Zhou, Han, & Liu, 2011). Shi et al. presented Chinese nouns preceded by a pronoun (*my*/*his*). Participants had to scale the presented nouns for likeability and were given a surprise memory test. In the *my* condition, participants responded faster and showed a better memory performance for the nouns than in the *his* condition.

Although it has been shown that language can influence memory, it has yet to be demonstrated *how* it does so. In this paper, our focus is on the (possible) influence of spatial demonstratives and possessives on memory for object location. The continuous nature of object location memory errors affords testing directly between a number of possible mechanisms regarding how language affects memory for object location.

Spatial demonstratives (e.g., *this*/*that*) are among the earliest words children learn (Diessel, 2006) and have been shown to be associated with discrete zones of peri-personal (near) and extra-personal (far) perceptual space (Coventry, Valdés, Castillo, & Guijarro-Fuentes, 2008; Diessel, 2006; Maes & de Rooij, 2007; Stevens & Zhang, 2013; cf. Peeters, Hagoort, & Ozyürek, 2014). However, this distinction is flexible and graded. Near space can be extended or contracted by tool or weight use (Longo & Lourenco, 2006), and the use of *this* is similarly extended when participants use a stick to point at objects (Coventry et al., 2008). In addition to distance, demonstrative choice is also affected by other variables. Coventry, Griffiths, and Hamilton (2014) explored the relationship between object knowledge and distance on both demonstrative choice in English and memory for object location. Across seven experiments they found that object familiarity (i.e., familiar versus unfamiliar colored shapes), object ownership (whether the participant owned the object or not) and object visibility (whether the object was covered with an opaque cover or not) all affected demonstrative choice to describe object location and (non-linguistic) memory for object location. For example, unfamiliar objects (low frequency color-shape combinations, such as a viridian nonagon) were misremembered as being further away than they actually were relative to familiar objects (e.g., a red square). In order to account for both the demonstrative choice data and the memory data, Coventry et al. (2014) proposed a model of the influence of object knowledge on both measures. In their *Expectation Model*, memory for object location is a combination of where an object is located and where an object is expected to be located (see Fig. 1a). The expectation of the objects’ location is combined with the actual object location (with an associated estimation error) in memory, as follows:

$$M_D = f(D_a, D_{exp}, D_{err})$$

where M = signed memory error, D = distance, $_a$ = actual, $_{exp}$ = expected and $_{err}$ = estimation error.

Coventry et al. (2014) acknowledge that the model may operate at encoding of object location or at retrieval. If the former is the case, it is assumed that an object expected to be in peripersonal space (such as an object owned by the participant), activates peripersonal space as the participant encodes object location, and therefore that the actual representation of location at encoding, and later memory is a concatenation of expectation of where an object is most likely to be located and where it is actually located. The alternative possibility is that the location errors emerge only at retrieval, consistent with effects found in the verbal overshadowing (Alogna et al., 2014; Schooler & Engstler-Schooler, 1990) and eye-witness testimony literatures (Loftus, Miller, & Burns, 1978; Loftus & Palmer, 1974; McCloskey & Zaragoza, 1985).

Coventry et al. (2014) did not examine the influence of language on memory for object location, but by extension, the expectation model makes predictions regarding how language might impact upon memory for location. As *this* is associated with near space and *that* with far space, one can assume that the expected distance value associated with *that* would be greater than the expected value distance associated with *this*. Combined with the actual distance, the expectation model therefore predicts a main effect of language on memory for object location, with *that* associated with (mis)memory for objects further away than they actually were compared to *this* (Fig. 1a). Consistent with earlier studies, an effect of location, in which memory for objects further away is worse than for objects closer by, would be expected.

In contrast to the expectation model, there is a considerable body of work within an ‘embodied cognition’ framework providing evidence for the importance of congruence/incongruence effects between language and space that makes different predictions from the expectation model. A growing number of studies suggests that participants’ performance is affected by congruence/incongruence between language or concepts and space. For example, it has been shown that participants respond more quickly to positively valenced stimuli in a congruent high location than an incongruent low location, and vice versa for negative stimuli (e.g., Barsalou, 2008; Meier & Robinson, 2004; cf. Lynott & Coventry, 2014). What one might term a ‘congruence account’ has been extended to movement planning, whereby movements are prepared based on given language (Bonfiglioli, Finocchiaro, Gesierich, Rositani, & Vescovi, 2009; see also Stevens & Zhang, 2013). For example, Bonfiglioli et al. (2009) required participants to grip an object after listening to an instruction that indicated whether the object was near or far. A significant interaction was found in which performance was better when the descriptive language and space were congruent compared to incongruent situations - reaction times were significantly longer when language was incongruent with space compared to when language and space were congruent. Bonfiglioli et al. (2009) therefore concluded that they found

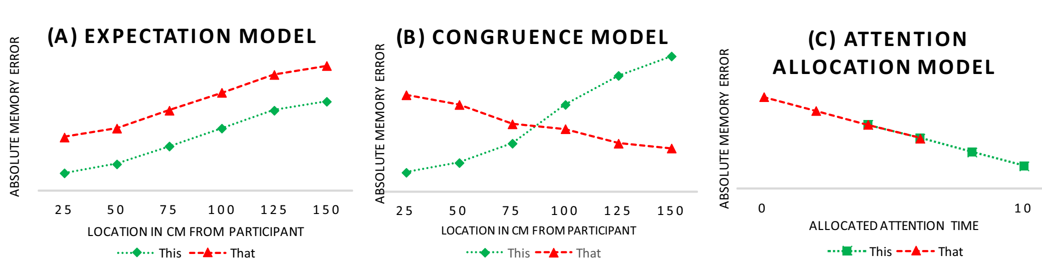


**Fig. 1.** Predictions from the different models, from left to right: a. Expectation Model, b. Congruence Model, c. Attention Allocation model. On the y-axis the difference between the actual location and the remembered location is presented, a higher value on the y-axis means an object is remembered as being further away than it actually was. In a and b, the six distances from the participant (in cm) used in Experiment 1 and 2 are plotted. In c, the x-axis represents the total possible fixation time (10 s) for participants in Experiment 3. The lines represent the influence of demonstratives (*this*/*that*). In c more attention leads to a smaller memory error, and ‘*this*’ is predicted to elicit more attention than ‘*that*’.