

# Spatial Description, Function and Context

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## Abstract

Lexical choices in descriptions of the spatial world around us are affected not only by geometry, but also by variables such as situational context and the extent to which the spatial relations between the objects referred to are seen as consistent with their typical function. In a study of how people describe complex scenes with multiple objects we examined whether descriptive choices (both locally at the lexical level but also at a more global descriptive scheme level) are guided by knowledge about the spatial arrangement (functional versus non-functional doll's furniture arrangements) and by the contextual schemas evoked in the task instruction (a living room context versus a furniture showroom). Participants' choices varied both in terms of the order in which objects in the array were described (trajectory strategies) and in spatial language depending on the functionality of the array. The context of instruction had a more limited role affecting only one aspect of the spatial language used.

**Keywords:** spatial language; functional relations; context; descriptive schemas.

## Introduction

Talking about the spatial world involves making choices regarding the spatial description that would be most fitting to the particular situation at hand (Coventry & Garrod, 2004). One and the same spatial array can be perceived, thought of, and talked about in many different ways. For example, Garrod & Anderson (1987) presented participants with a computer maze game and elicited goal-based dialogues in which the maze and its elements were referred to. In the analysis of participants' references to the maze, different description schemes emerged, e.g., path, coordinate, line, and figural, descriptions which the authors interpret as being associated with different mental models of the maze configuration.

Two important variables that affect lexical choice in spatial description are functional relations and context.

Functionality and context effects are related to our ability to take advantage of visual and situational regularities. Typical arrangements in our environment are represented in context frames (Bar, 2004), alternatively described as schemata, scripts, and frames, that provide us with a set of expectations both about the kinds of objects we may come across, for example, in a living room or a furniture store, and about their spatial relations.

The close relationship between an object's function and its verbal description was first shown in Labov's (1973) study on naming and category boundaries for containers in different contexts of use. Participants' preference for a verbal label for a given container was a function of the object's perceived function. On the other hand, how an object is labeled can itself trigger expectations about its function in a scene (Coventry, Carmichael, & Garrod (1994). Furthermore, Carlson-Radvansky & Radvansky (1996) found that preference for a given reference frame over another in the description of the spatial relation between two objects depended on whether the objects were in a functionally related pair (e.g., a mailcarrier and a mailbox) or not (mailcarrier and a birdbox). In their study, the intrinsic frame of reference was used significantly more for related than for unrelated pairs.

However, work examining the influence of functional relations has focused on individual lexical items in fixed sentential contexts. If function really matters, one should find that functional relations affect spatial description at a range of levels of description and analysis.

Context can affect spatial description as well. Coventry (1999) found that different contexts provided in the form of a text can affect judgments of the appropriateness of spatial prepositions such as *in* as descriptions of one and the same scene. In a study by Grabowski, Hermann, & Weiss (1993), participants' interpretations of where *in front of* is in relation to parking a car differed as a function of the

explicit scenario provided (the driving test scenario vs. the lift home scenario). The context of the scenarios used has also been shown to affect spatial perspective taking (Tvesrky, Lee, & Mainwaring, 1999).

This work, too, has focused at the lexical and/or sentential level. Does context affect spatial description more globally? Our study extends previous research in a direction that offers greater ecological validity by asking participants to describe arrangements of multiple (3D) objects with complex spatial relations where a wide range of spatial language is applicable, and where several levels of description are involved in a connected discourse beyond individual lexically-based references. By asking speakers to provide descriptions that would be useful to a future participant reproducing the arrangement, we approach a situation that resembles a natural interaction scenario which involves both the nature of the scene and a combination of cognitive and interactive aspects.

Given that language production for an audience is guided by considerations about facilitating comprehension and achieving common ground (Clark & Wilkes-Gibbs, 1986; Clark & Brennan, 1991), a speaker's choices should be influenced by the degree to which the spatial scene that he or she describes is congruent with the relevant conceptual schema of the scene which contains information about the objects and their spatial relations. Generally, speakers assume a great deal of common ground between them and their interlocutors with respect to the communicative situation as well as background knowledge on objects, their typical functions, orientations, and spatial arrangements. For example, in retelling stories, speakers are more likely to mention atypical instruments than those that are easily inferable (Lockridge & Brennan, 2002). Based on the assumption of shared knowledge with their interlocutors such as contextual schemata on typical items and their arrangements in a certain situational context (e.g., a living room), a speaker may refrain from explicating such aspects of the situational context that are already implicitly contained in the context frame and could be expected to be shared across interlocutors. Therefore, preferential mention would be given to such objects and spatial relations that deviate from the standard schema and could not therefore be easily reproduced by the hearer without additional information.

Here we report an experiment that examined the effects both of functional relations and linguistic context (the context of task instruction) on choice of spatial description. Participants were given an arrangement of doll's furniture presented on a floor extracted from a doll's house, and were asked to provide a description of where objects were in relation to one another so that someone listening to the description in the future would be able to reproduce the arrangement of the objects from the spatial description as accurately as possible. In this experiment we crossed the

functionality of spatial relations between objects in the furniture set and the linguistic context of instruction. We expected that both of these variables would affect spatial description choices. Exactly how they do so for a range of levels in terms of the trajectory of descriptions (the order in which objects in the array were described) and the choice of spatial language as well as assessing their relative importance was of main interest in the present studies.

## Method

**Participants** 97 participants (57 women) took part in the experiment. They were German native speakers, mostly university and high school students with an average age of 21.11 years (age range 17-57, SD=6.03). Participants received course credit or were paid for their participation.

**Stimuli** The stimuli consisted of two arrangements of furniture items from a doll's playhouse. The items were placed on a 3 x 5 grid (3 rows of 5 objects each) and were at approximately equal distances from each other. These 15 objects included chairs, tables, sofas, shelves, etc., all of which could plausibly be found in a living room and in a furniture store. The doll's house items were placed on a flat wooden surface representing one floor plan without doors, windows, or internal partitioning. Pictures of the two arrangements are displayed in the Appendix where (F) shows functional array and (NF) shows the non-functional array.

Each participant viewed one of the two arrangements (arrays) in the same orientation of the grid. Objects remained in the same position in the two arrangements except for four pairs (a sofa and a cupboard, a table and a chair, a shelf and an armchair, a kitchen trolley and a chair) in which objects' positions were exchanged across the two arrays in such a way as to make one of the arrangements appear more functional (e.g., a table flanked by two chairs facing it) and the other less so (e.g., the same table flanked by a smaller corner table and a kitchen trolley). Participants were not allowed to touch, manipulate, or move the objects around.

**Procedure** The procedure was identical for all participants except for one aspect of the instruction. Participants were asked to describe the arrangement of the furniture items they see so that another participant could arrange the items in the correct way later on. There were three versions of the instruction corresponding to the three levels of context manipulation. In one, the arrangement was said to belong to Mr. Meyer's living-room, in another it was Mr. Meyer's second-hand furniture store, and the third one was neutrally phrased without any indication of the nature of the location. Descriptions were recorded as audio material and later transcribed. Participants in the living-room and furniture

store conditions were asked to start their descriptions with a pre-set phrase (*I will now describe the arrangement of furniture in Mr. Meyer's living-room, and in Mr. Meyer's second-hand furniture store, respectively*). The task's duration was approximately 10 minutes.

**Design** The independent variables included the three context-of-instruction conditions (living room, furniture store, neutral) crossed with the two levels of the array (functional vs. non-functional). The dependent measures were based on a set of spatial language categories and six trajectory categories.

**Coding of responses** Participants' descriptions were transcribed, segmented into utterances and coded for the following spatial language categories: (i) locational utterances, (ii) sequential locative utterances, (iii) utterances containing projective terms, (iv) locational projective utterances, (v) utterances containing speaker perspective, (vi) locational speaker perspective utterances, (vii) locational utterances containing an orientational description.

These were chosen because they represent main distinctions identified in earlier research on spatial language. Specifically, we distinguished between utterances that described an object's *orientation* (orientational utterances), and those that described an object's *location* (locational utterances), or both. This measure reflects the speakers' attention towards potential problems in arranging the objects relative to each other. Terms were coded as "sequential" if they expressed sequential organization without specifying a spatial direction, such as *next to, beside, after*, and the like. We expected those terms to be used in descriptions that followed the mental itinerary of an "imaginary wanderer" (e.g., Ehrlich, 1985).

The following are examples of utterances referring to the same object in the same position on the grid given by two participants in the furniture store context condition, one describing the non-functional array (a), and the other one the functional array (b):

(a) "links neben dem Sessel steht ein Eckregal mit der spitzen Ecke ähm Richtung Wand" (E., *left next to the armchair there is a corner-shelf unit with its sharp corner uhm towards the wall*)

(b) „im linken Rand am unteren an der unteren Seite steht eine kleine ein kleines Regal ein Eckregal“ (E., *on the left part at the lower at the lower side there is a small a small shelf unit a corner shelf unit*).

These examples illustrate the usage of an orientational term in the first participant's utterance referring to the object and the absence of such a term in the description of the second participant. In addition, (c) is an example of an

utterance containing a sequential term from a participant in the furniture store context condition, functional array:

(c) "daneben ein Regal ein kleines ähm ein Eckregal das ganz links in der Ecke steht" (E., *next to it there is a shelf a small uhm a corner-shelf unit which is in the far left corner*).

The order in which objects were described in the array (hereafter 'trajectories') was coded on the basis of the transcripts and contained information matching the sequence of utterances with the objects in the arrangements that they referred to. The following were calculated as percentages out of the total number of task-relevant utterances for each trajectory: direct horizontal links (describing an object immediately to the left or right of an object just described), direct vertical links, indirect links (including diagonal links and jumps over adjacent nodes on the grid), and clusters of objects. Overall trajectory shape was also analyzed and coded as either regular (mostly linear, following either the horizontal or vertical lines of the 3 x 5 grid) or irregular (for example, chaotic, or cluster-based).

## Results and Discussion

The Appendix illustrates two examples of trajectories, one for the functional array (F) and the other one is for the non-functional array (NF). In the analysis of the trajectories of scene description, a 3 x 2 analysis of variance revealed a main effect of spatial array on the percentage of indirect links ( $F(1,91)=6.94, p<.01$ ), a main effect of array on the percentage of clusters referred to ( $F(1,91)=24.34, p<.001$ ), and no interaction between spatial array and context for any of the dependent variables (see Table 1). Indirect links (diagonal and jumps) were present in a higher proportion in the descriptive trajectories for the functional array (20.82%) than the non-functional array (13.74%). Clusters of furniture items were mentioned considerably more frequently in the functional arrangement (13.70%) than in the non-functional arrangement (2.72%) condition.

Table 1: Trajectory analysis categories (% each category out of all utterances)

	Functional array		Non-functional array	
	Mean (SD)	Range	Mean (SD)	Range
Horizontal	37 (16)	12 - 73	39 (21)	0 - 73
Vertical	22 (13)	0 - 57	21 (16)	0 - 62
Indirect	21 (15)	0 - 80	14 (11)	0 - 48
Clusters	14 (15)	0 - 71	3 (5)	0 - 29

*Note.* Horizontal – direct horizontal links, Vertical – direct vertical links, Indirect – diagonal links or jumps across the grid, Clusters – objects described in a cluster.

An analysis of the frequency data for overall shape of the trajectories of scene description using a 6 x 2 Chi Square analysis showed a significant effect of experimental condition  $\chi^2(5)=13.19$ ,  $p<.05$ . Participants' descriptive trajectories were more likely to have a regular shape in the non-functional array condition (70.59%) than for the functional arrangements (41.30%).

The results from the analysis of trajectories reveal that participants' descriptive strategies differed on the basis of the spatial array's functionality. When speakers communicated about the functional array, they naturally opted for a non-linear trajectory where clusters of functionally related objects became a suitable basis for organizing information. Visual objects are functionally (contextually) related when they tend to co-occur in typical environments, and a scene is contextually coherent if it contains items that tend to appear together in similar environments (Bar, 2004). When functionally motivated spatial relations between objects were hard to find in a given scene, as in the non-functional array condition, participants relied on an abstract alternative organizing schema such as following a linear horizontal or vertical sequence of items on the 3x5 grid. In this case, more orderly linear descriptive trajectories dominated their choices as seen both in the analysis of overall shape, the lower percentage of indirect links and of clusters mentioned in this condition.

We turn next to the analysis of spatial language employed in participants' descriptions and examine the evidence available there in support of the results from the trajectories' analysis. Given that we found considerable differences in trajectories across spatial arrays, we reasoned that these should be reflected in characteristic spatial features of the language used. In addition, spatial language categories may be a particularly sensitive measure for the second variable in this study, i.e., the contextual manipulation. Note that no effect of context was obtained in the trajectories' analysis. One possible explanation is that the choices of descriptive sequences were guided to a large extent by the visual spatial characteristics of the scene, the objects in it, and their relations, and less so by background knowledge and contextual schemas that are meant to differentiate between a neutral anonymous environment, a living room, and a furniture store. However, spatial language may differ across contexts with respect not to the arrangements of these objects, i.e., the trajectories, but in terms of the overall schema of the situation of use and dynamic routines associated with it.

In the analysis of spatial language categories, a 3 x 2 ANOVA revealed a main effect of spatial array on the percentage of orientational terms used ( $F_{(1,91)}=9.35$ ;  $p=.01$ ), a main effect of context on the percentage of sequential terms ( $F_{(2,91)}=3.48$ ;  $p<.05$ ), and no significant interaction

between spatial array and context for any of the dependent measures (all  $p's>.05$ ). Orientational terms were used to a higher degree in descriptions of non-functional than functional spatial arrangements (27.44% vs. 15.26%). The contextual cue in the instruction led participants to produce a higher ratio of use of sequential terms in descriptions of the furniture store (47.42%) than in any of the other two (36.49% for the living room and 35.15% for the neutral condition) as confirmed by a Duncan posthoc test.

Thus, the results of this analysis confirm that the type of spatial arrangement that is being described influenced not only participants' preferences for certain trajectories over others but it also affected the kind of spatial descriptions that were offered for these arrangements. Not only did speakers follow a regular-shaped linear-like trajectory but they also made objects' orientations in this sequence explicit in their descriptions when they communicated information about the non-functional array. This follows from the need to refer to atypical visual and spatial features more than to typical default characteristics that are part of the schema already (Lockridge & Brennan, 2002). Whereas in the functional array participants may rely on general background knowledge to fill the gaps in the description, they choose to describe orientation explicitly in the non-functional array in order to facilitate their listeners who would not be able to infer this kind of information merely on the basis of their context schemas. In this way, speakers can be said to adhere to Grice's cooperative principle (Grice, 1989): they provide information that is needed by the listener.

We also found an effect of context on the percentage of sequential terms used (see example C above) – descriptions of the furniture store had a higher proportion of these than descriptions of either the living room or the neutral context condition. This result is in line with a furniture store schema where one would describe the arrangement sequentially following the path of an imaginary “wanderer” or visitor to the store. As this is not part of the living room schema or an unspecified generic environment (as in the neutral condition), sequential term usage in those conditions was lower than in the furniture store scenario.

However, the context manipulation had a weaker influence overall; it only emerged as a contributor to variance in one aspect of the spatial language used (sequential terms). There was also no interaction between the functionality of the array and context for any of the dependent measures analysed in this study. The visual spatial information derived from the arrangements appeared to dominate choices in descriptions.

## Conclusion

The primary purpose of this study was to examine the combined effects of functional relations among objects and of the context of the task they are presented in on

participants' choices at the level of spatial language and in terms of the overall descriptive trajectories employed. Previous research has highlighted the importance of each of these factors for lexical and sentential-level choices. The results of this study support previous findings and theoretical accounts of spatial description that attribute a major role to functional non-geometric information (Coventry & Garrod, 2004). The effects found here indicate that the influence of the array's functionality is not confined to basic lexical choices in descriptions of simple 2- or 3-object arrays but extends to communicating about a complex environment with multiple objects presented simultaneously. Furthermore, such an influence is observed not only in item-based language choices but in the overall organization of information that is considered useful and salient enough to convey to an imaginary addressee. The difference in the usage of orientational terms across the two spatial arrays, for example, contributes to a wider understanding of salience beyond what is perceptually relevant to what is cognitively helpful—in communicating to an absent partner it is important to address explicitly aspects of the scene that are not consistent with the commonly shared schema of typical arrangements of a set of related objects. The context effect on the usage of sequential terms that we found reveals that specific scenarios of interaction with the environment were evoked by the different context instructions and that consistency with the abstract scenario type was an important part of speakers' discursive choices.

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