# ‘This is a wall’ – Assigning Function to Objects

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**Abstract**

Construction tasks involve numerous demanding sub-tasks such as creating a mental model of the goal object and integrating the object parts into this model. For this purpose object parts need to be assigned a function within the overall structure. In this paper we examine the linguistic representation of this process. Participants were given 16 object parts to assemble without a manual, and were asked to think aloud while doing so. Depending on condition they were not given any specific information, or told that the goal object was a dollhouse, or shown a picture of the dollhouse. In a second study, participants were asked to instruct a partner to assemble the dollhouse. Results of our linguistic analysis of think-aloud data and instructions reveal three strategies of assigning function to objects, one of which occurred exclusively in instructions. With less specific information about the goal object, functions were more often assigned explicitly. In these cases function tended to relate to the overall structure (e.g. ‘house’) rather than to structural parts (e.g. ‘wall’).

**Keywords:** verbal reports, cognitive discourse analysis, function assignment, conceptual domains

## Introduction

Adults who observe children play are often amazed by their imagination. In their play a plastic cup becomes a boat that sails on the stormy sea. The existence of the boat in the children's mind can be seen as the result of a conceptual mapping process. The child performs a mapping between the domain of plastic objects (cup) and vehicles (boat). Mapping phenomena between different conceptual domains have been widely studied in research on metaphorical transfer (Lakoff & Johnson, 1980; Croft, 1993) and analogical problem solving (Gentner, 1983). Here we address how speakers use language to assign an object's function in relation to a target domain, in a situation where this function is not self-evident and needs to be identified. This kind of conceptual domain shifting is essential for everyday reasoning. It is required whenever the 'meaning' of an object or depiction needs to be determined that represents something else, for example a symbol on a map that stands for an environmental feature. Our study sheds light on this kind of conceptual mapping by a closer look at the language used to represent it, providing both qualitative (*how* do speakers say this?) and quantitative (*how often* do they say it under different circumstances?) insights.

Our scenario concerns the construction of a dollhouse from wooden parts that bear little resemblance to their function within the dollhouse. A board, for instance, needs to be recognised as a 'wall' before it can be placed correctly to serve its function. We investigate the linguistic representation of function assignment in two set-ups: think-aloud protocols collected while assembling the dollhouse, and verbal instructions to another person assembling the dollhouse. In particular, we analyze the referential terms that are used in reference to both of the domains involved (wooden objects with particular structural features and functional parts within the dollhouse), as well as the linguistic means by which the domains are linked. In the next section we will take a closer look at relevant previous findings on linguistic domain mapping.

## Mapping between conceptual domains

### Use of functional terminology in construction tasks

Malt et al. (1999) propose that the categorization of objects involves two levels: *knowing* an object vs. *naming* it. Object perception leads to a representation in terms of a recognition category, along with similar objects. The communication of objects, however, involves a representation in terms of linguistic categories, using conventional or new labels.

So far object categorization within construction tasks has only been studied in settings involving a real or an imagined addressee. Rieser (1996;1997), for example, studied object references in a dialogue scenario where assembler and instructor did not share the same workspace while constructing a toy airplane. As a result, they could share conceptualizations by spoken interaction only. Rieser examined the instructors' strategies of reference to facilitate identification of object parts, and found that they frequently described them in terms of their function in the conceptualized target object (i.e., the toy airplane; e.g., 'this is a horizontal stabilizer', Rieser, 1997:181). He called this phenomenon *representational metonymy*. The effect may be seen as a kind of reconceptualization and is based on world knowledge and the specific context. Apart from representational metonymy, the physical object itself could also be referred to in descriptive terms, based on the object’s structural appearance along with conventional terms for them (e.g. ‘Fünfträger’ refers to a bar with five holes).

Studies of conceptual layers in construction tasks have focused on the frequency (e.g. von Stutterheim et al., 1993) or interactional purpose of usage of goal structure specific terminology (Rieser, 1997). For a task of instructing a generic addressee on assembling a TV stand, Daniel and Tversky (2012) report that lay instructors started their instruction by giving a list of objects. Although they did not analyze object reference directly, one of their examples shows that functional assignment took place at least once.

Although various authors have thus reported sporadic examples of function assignment, the phenomenon has not been studied systematically so far, and it is unclear to what extent it relates to the need to communicate. However, this kind of conceptual domain mapping is central to the ubiquitous process of recognizing what things are for. In this paper we investigate the linguistic representation of function assignment in two assembly scenarios, and we discuss the cognitive implications that are implied by different options. The next subsection gives some indications of possible linguistic forms.

### Linguistic representation of assignment of function in verbal reports

Rieser (1996; 1997) did not aim to analyze the linguistic features of representational metonymy, but the examples in these papers provide a good impression of how conceptual mapping is represented in assembly dialogues. Participants used phrases such as "das *ist* das Leitwerk" (this *is* a horizontal stabilizer) (1997:181), "diese zwei Schienen *als* Propeller" (those two tracks *as* propeller) (1997:191), and "dieses Baufix, diese Baufixschraube" (this Baufix, this Baufix screw) (1996:13).

Similar linguistic forms were found by Tenbrink and Seifert (2011) for conceptual mapping processes in a spatial problem-solving task. They analyzed written reports of participants planning holiday tours based on a map. This scenario involves two conceptual domains: that of the physically present road map, and that of the real world environment represented by the map. In their analysis of conceptual mapping processes, Tenbrink & Seifert focused on the distribution and nature of nouns, verbs, adjectives/ adverbs, and temporal markers as indicators of either domain. If indicators for both domains were used within a single sentence, this sentence typically also contained indicators for conceptual mapping between them, such as the modal verbs *could* and *should* (e.g., 'I looked for a route that could be traveled'). Further indicators were final discourse markers (i.e. 'in order to') and the particle 'als' (as), which signaled "mapping from plan to purpose" (Tenbrink & Seifert, 2011:116).

## Dollhouse assembly: Empirical studies

### Research goals

Gralla (in prep.) collected an explorative corpus of unconstrained language production data related to the assembly of a dollhouse from a set of wooden object parts in various conditions (explained below). For the purposes of this paper we inspected this corpus to identify the ways in which participants spontaneously used language to assign function to objects. Based on Malt et al.'s (1999) distinction between perceiving and communicating about objects, we expected systematic differences to emerge between the two distinct discourse tasks (thinking aloud vs. instructing a partner). Furthermore, the linguistic representation of function assignment should also be affected by the amount of prior knowledge available about the goal object.

In order to systematize our insights on linguistic forms, we define a *mapping phrase* as consisting of the reference to a physically present object **x** that is assigned the functional term **y** by a *relational term*. Preliminary findings (reported in Tenbrink & Gralla, 2009) and the examples seen in Rieser (1996; 1997) suggest that these relational terms can vary with respect to the amount of certainty expressed. Relational verbs, as in "**this** *is* a **wall**", for instance, signal that the speaker is absolutely certain about the assignment, since the relation is expressed as a plain fact. The modal verb 'müssen' (must) implies a lesser but still high amount of certainty, as in "**this** *must be* a **wall**", whereas 'können' (can) reflects uncertainty, and 'sollen' (should) encodes a medium level (Halliday, 1985). In other cases the relational term expresses a comparison (*look* <u>*like*</u>, *use* <u>*as*</u>). This strategy implies that the speaker decides that **x** *represents* **y** because **x** and **y** share some features. This assignment is tentative because **x** may also be something else.

Interestingly, Tenbrink and Seifert (2011) also identified different kinds of modal verbs as markers of domain mapping for their tour planning scenario, in which certainty did not play any role as the planning process was entirely in the participants' hands. However, modal verbs also carry different connotations, which might play a role in this context. Whereas 'wollen' (want) expresses the subject's intention 'können' (can) expresses the possibility given that the subject is granted the permission (Engel, 2002), and 'sollen' (have to) signals an obligation. In our study, we aimed to shed further light on the repertory of linguistic forms used to express conceptual mapping, along with their distribution across the different conditions in the corpus.

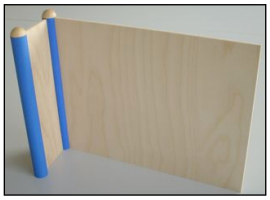
Regarding the influence of prior knowledge, we expected that participants who were provided with unspecific information about the goal object should signal more uncertainty in their assignment of function than participants provided with a picture of the goal object. Participants asked to instruct another person (rather than think aloud while constructing the dollhouse themselves) should introduce the given objects and assign their function explicitly in mapping phrases (cf. Rieser, 1996; 1997; Daniel & Tversky (2012).

### Methods

In the first of the studies carried out by Gralla (in prep.), think-aloud protocols were recorded while participants assembled a two-story dollhouse for themselves. 50 university students (22 male, 28 female; aged 19-42 years, mean age 24 years) participated for course credit or mone-

tary compensation. They were told that they would be given object parts to be assembled without a manual. Knowledge of the goal state varied between mention of "a dollhouse" (*verbal goal* condition), being shown a picture of the assembled dollhouse for 30 seconds (*verbal and visual goal* condition), and no such information (*underspecified goal* condition). Following the instruction, participants entered a room and saw a cardboard box, two wooden boards, and a triangular piece of wood on a table. The box contained 13 wooden parts (see picture 1 for an example of one object). Participants were instructed and reminded to think aloud while solving the task. There were no time constraints.

Picture 1: One wooden assembly piece



In the second study, verbal instructions on the assembly of the same two-story dollhouse were recorded. 16 students (9 male, 7 female; aged 20-28 years, mean age 23 years) who did not participate in the previous experiment were first instructed to assemble the dollhouse for themselves. They were given the same information as in the *verbal and visual goal* condition but without the task to think aloud. After successful completion of the task the participants were introduced to another student (a confederate). They were asked to instruct this person to assemble the dollhouse, using a Skype-based one-way video connection that did not allow for any responses by the assembler.

## Analysis methods

Our data set contained 50 think-aloud protocols that were equally distributed between conditions (17 *underspecified goal*, 16 *verbal goal*, 17 *verbal and visual goal*), and 16 instructions. First, mapping phrases were identified in a qualitative analysis. They contained one object reference (either deictic or nominal, e.g. *this thing*) and a domain specific functional term, e.g. *wall*. Nouns belonging to the semantic field of the goal domain 'house' were classified as domain specific. Second, all phrases were classified either as *direct mapping* (use of relational verbs) or as *representational mapping* (use of comparison). Third, all verbs were annotated with regard to verb kind and type. Furthermore, the referential terms for the object (either deictic or nominal) as well as the functional term were annotated.

Example 1 (which refers to the object in picture 1) represents *direct mapping* with the verb 'sein' (*be*) as the relational term, and a deictic reference (*this*) for the object **x** that is assigned the functional term (**y**) *wall*.

(1) so **das** *ist* dann so ne **Wand** (so **this** *is* some **wall** then)

Example 2 (which refers to the roof of the dollhouse) illustrates *representational mapping* with the verb phrase 'aussehen wie' (*look like*) as the relational term, and the nominal reference *red building part* for the object **x** that is assigned the functional term *roof*.

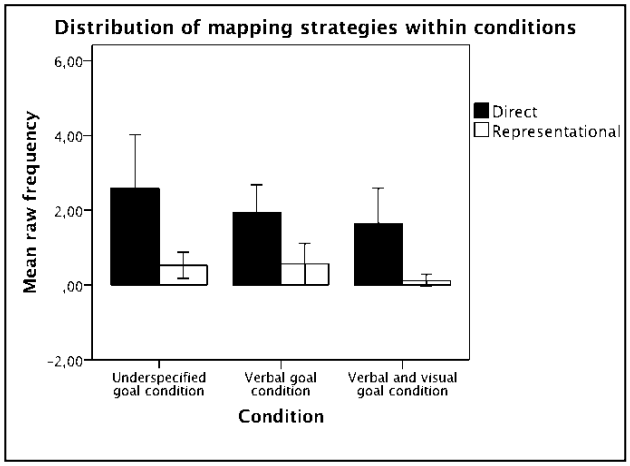
(2) … das **rote Baustück** nen bisschen *wie* n **Dach eines Hauses** *aussieht* (… this **red building part** *looks* a bid *like* a **roof of a house**.)

The qualitative analysis and annotation of categories then led to the identification of quantitative frequencies in the various conditions.

# Results

131 mapping phrases were identified in the think-aloud protocols. The highest frequency (54 cases produced by 14 participants) was observed in the *underspecified goal* condition, as opposed to 44 cases produced by 14 participants in the *verbal goal* condition, and 33 cases produced by 11 participants in the *verbal and visual goal* condition. 23 cases of function assignment could be identified in 12 of the 16 instructions.

Figure 1: Distribution of mapping strategies
(mean raw frequency with error bars +/- 2SE)



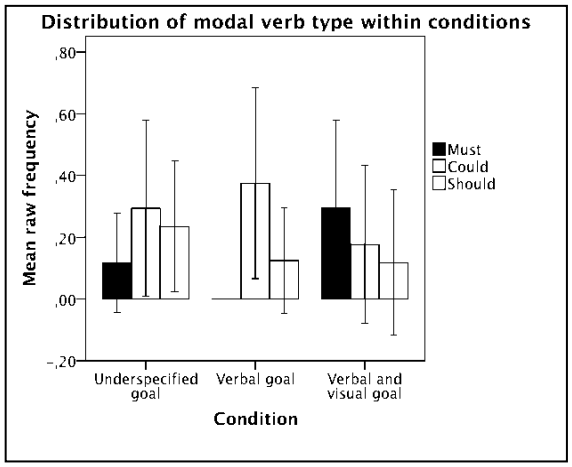

## Assignment of function in assembly

*Direct mapping* (108 cases) was more frequent than *representational mapping* (22 cases). The frequency of mapping strategies did not differ significantly between conditions (see Figure 1), $\chi^2$ (4, N = 131) = 7.12, p = .130. With respect to the linguistic representation of both mapping strategies, the verb 'be' was most frequent (91.51%) in *direct mapping*. In *representational mapping* 'look like' (59.09%) was used along with 'use as' (22.73%).

29 modal verbs were identified in 18 protocols. They were almost equally distributed between conditions (11 in the *underspecified goal* condition: M = 0.59, SD = 0.23; 8 in *verbal goal*: M = 0.50, SD = 0.13; and 10 in *verbal and visual goal*: M = 0.58, SD = 0.23). Almost all (27) modal verbs occurred in *direct mapping* phrases. Three modal

verbs were used, namely *could*, *must*, and *should*. These were distributed between conditions as follows (figure 2). Participants in the *underspecified goal* condition used all three modal verbs, with *could* (M = 0.83, SD = 0.31) and *should* (M = 0.67, SD = 0.21) being more frequent than *must* (M = 0.33, SD = 0.21). Participants in the *verbal goal* condition showed a preference for *could* (M = 1.00, SD = 0.26) whereas participants in the *verbal and visual goal* condition used *must* most frequently (M = 0.83, SD = 0.31). However, the observed differences between conditions did not reach statistical significance, $L\chi^2$ (4, N = 29) = 8.51, p = .075, probably due to the low numbers and varied individual production of linguistic choices in our setting.

Figure 2: Distribution of modal verb type in mapping processes within conditions (mean raw frequency with error bars +/- 2 SE)




## Assignment of function in instructions

Besides identifying instances of *direct* and *representational mapping*, our qualitative data analysis revealed a further (unexpected) strategy of function assignment in instruction texts. Instructors used a more implicit way of assigning function, illustrated in example 3:

(3) „jeweils mit einem kurzen Stück einem ähm einem Wandelement …" (each with a **small piece** a um a **wall element**)

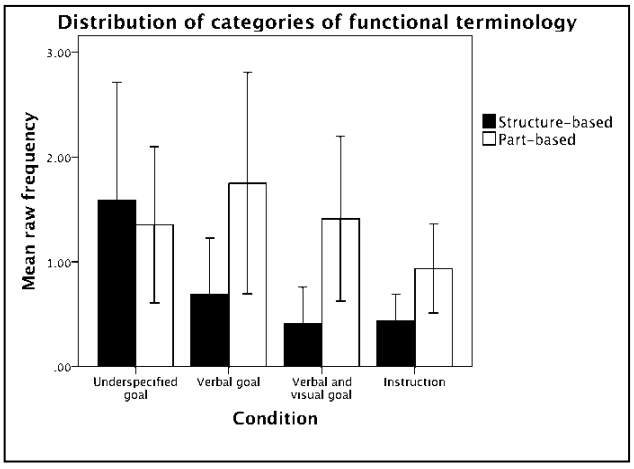
In this example the object (a small piece) is assigned its function (wall element) by simply renaming it after a hesitation phase. Since there is no relational term connecting object reference and functional term, no conclusions can be drawn about the level of certainty reflected in this strategy. This type is called *reframing* because the speaker changes the frame of conceptualization from unspecific to specific. The distribution of mapping strategies shows that instructors used *direct mapping* most frequently (M = 0.63, SD = 0.20). A closer look at the linguistic structure of *direct mapping* reveals that the verb 'be' was used in all cases; instructors never used modal verbs to assign function. Furthermore, *representational mapping* and *reframing* (M = 0.31, SD = 0.12) were also frequently used. The influence of discourse type on mapping strategies is significant, $\chi^2$ (3, N = 141) = 8.37, p = .039. *Representational mapping* was used more frequently in instructions (0.44 (SD = 0.18)) than in think aloud protocols (0.40 (SD = 0.77), z = 2.0, p <.05).

## Object reference and functional terminology in mapping phrases

A significant difference emerged between the two different discourse types (think-aloud vs. instruction) with respect to the referential term used for the object, $L\chi^2$ (6, N = 154) = 57.73, p = .000. Participants who were thinking aloud while assembling the dollhouse mostly used deixis (e.g., *this, that*) rather than nominal references. Instructors, on the other hand, used nominal object references (0.94 (SD = 0.85)) more frequently than assemblers (0.06 (SD = 0.24), z = 7.5, p <.001), and they used deictic references (0.50 (SD = 0.63)) less frequently than assemblers (2.42 (SD = 2.54), z = -2.6, p <.01).

Five nouns or their synonyms were used most frequently to express function in the dollhouse: *floor, roof, wall, story,* and *house*. This list represents two perspectives. Some of these terms (*floor, roof,* and *wall*) highlight individual pieces of the dollhouse and are therefore part-based, while the others refer to the whole structure (*house*) or larger portions of it (*story*), which may consist of several individual pieces and are therefore structure-based, e.g. "aah das könnten auch *Stockwerke* sein" (aah this could also be *stories*). Conditions differed with respect to the distribution of these two perspectives (see figure 3). While participants in the *underspecified goal* condition used structure-based terminology (M = 1.65, SD = 0.57) frequently, participants in all other conditions (including instruction) referred to individual parts significantly more often, $\chi^2$ (6, N = 154) = 13.44, p = .037.

Figure 3: Functional terminology assigned to objects in mapping phrases – categorized according to perspectives (mean raw frequency with error bars +/- 2 SE)



## Discussion

Our studies addressed the linguistic representation of function assignment in an unaided object assembly task. We presented a qualitative analysis of the different components of functional mapping phrases, i.e. relational term, object reference, and assigned functional terminology. Furthermore, we examined the relative frequencies of occurrence in different conditions, highlighting the influence of prior knowledge as well as differences between think-aloud protocols and instructions. The most striking differences were found with regard to the latter, revealing the influence of the speaker's communicative intention on the linguistic representation of function assignment. With respect to the former, lack of information appeared to lead to a more structure-based (rather than part-based) perspective, as expressed by the nouns used to refer to objects.

In our qualitative analysis, we identified three strategies of function assignment that reveal various levels of certainty. In the *direct mapping* strategy, the relational terms directly connect an object to a functional purpose, typically using the verb 'be', which signals a high level of certainty. Modal verbs (such as *must, could*) were used to modify the level of certainty by weakening it. In the *representational mapping* strategy, the relational terms *look like, use as*, etc. signal that the object is assigned to a goal-object based concept that serves a particular function. Since the relation signals representation rather than 'being', participants signal the tentative character of their assignment by choosing this strategy. In the *reframing* strategy, which in our study only occurred in instructions, the relational term is replaced by a hesitation marker between the reference to the object and the assigned functional term.

On the whole, participants giving instructions used mapping phrases only rarely. This can be interpreted in two ways. First, it may mean that they focused on the step-by-step procedure of the assembly, rather than attending to the goal structure as such. This explanation is supported by the finding that instructors used part-based terminology more frequently than structure-based references when assigning function. Furthermore, Daniel and Tversky (2012) found that instructors omitted explicit information on object parts and sequential order, but not on sequences of actions, when time was constrained. Second, our instructors may have believed that functional terms would not facilitate object identification, but rather result in additional cognitive load for their addressee (cf. von Stutterheim et al. 1993) because the wooden objects did not resemble their function in the goal structure in any obvious way.

Whenever instructors used mapping phrases, this happened with certainty, as reflected in the linguistic form chosen. This result straightforwardly reflects the fact that participants were already familiar with the dollhouse assembly task when they gave the instructions, and therefore did not need to assign objects to function in a tentative way. However, instructors used *representational mapping* more often than participants in the assembly study did. This may be seen as an explicit strategy of emphasizing that function is *assigned* to an object. The instructors may have considered their addressee's situation, who could only see the wooden objects rather than their function. Explicitly highlighting the mapping process may therefore be felt as a useful supportive strategy.

The most interesting case, in our view, is the third strategy, which was found only in instructions: introducing the functional term after a marker of hesitation (*reframing*) rather than a relational term. Although this construction may seem accidental due to the hesitation marker, which is by its nature exclusive to spoken language, it was used by as many as 5 out of 12 participants. Arguably, Rieser's (1996:13) example cited above (*this Baufix, this Baufix screw*) is similarly structured, although no hesitation marker is reported.

What might lead speakers to use this function assignment strategy in instructions? In effect, the previous reference is *elaborated* by the first. In interactive scenarios, such an elaboration would happen frequently in response to a request for clarification, as described in the literature related to the referential communication paradigm (e.g. Clark & Wilkes-Gibbs, 1986; Horton & Gerrig, 2002). However, this cannot explain our observations, since our scenario did not allow any interaction between instructor and assembler. Instead, speakers apparently *spontaneously* felt the need to be more specific with regard to the function of the object that had just been referred to. Conceivably, the function of this particular object was so prominent in their minds that they directly reframed the sentence. Again, they started from their addressee's perception, leading over to the function of the wooden object. This suggests that the strategy is specific to the communicative goal of shared attention and object identification.

The analysis of the referential form for the physically present object provides further evidence that our participants in the instruction scenario took an addressee-centered perspective. Participants who were thinking aloud while assembling the dollhouse used deictic references more frequently than instructors, who tended to use nominal references instead. These findings highlight the influence of communicative intention on referential form and thereby support the assumption that think-aloud data reflects the speaker's thoughts that are not tailored for an addressee (Ericsson & Simon, 1984).

A clear effect of prior knowledge emerged with respect to the perspective expressed by the functional term assigned to an object. Participants who had to construct the goal object from scratch, i.e. without prior knowledge, frequently assigned function by reference to the whole structure of the goal object, or larger portions of it, as in *house* or *story*. Participants who knew about the goal structure, on the other hand, assigned function mostly to object parts (e.g. 'wall'). This difference suggests that participants who had associations about typical parts of the goal object assigned these functions to the given objects. Participants who needed to construct a mental model of the goal object, on

the other hand, additionally seemed to assign function to the object arrangement as a whole, either to construct the model or to confirm their hypotheses about the goal object. This suggests that instances of function assignment are traces of the mental process of conceptualization of objects within the mental model of the goal object.

The consistency of using direct mapping strategies across conditions in the unaided assembly study showed that participants assigned function with a high amount of certainty in most cases, independent of the amount of prior knowledge. Some differences were observed at the level of certainty expressed by the use of modal verbs. Surprisingly, less knowledge about the goal objects appeared to result in higher certainty as expressed in mapping phrases. Specifically, participants who were provided with no specific prior knowledge or only a verbal clue tended to use mapping phrases frequently, with a preference for *direct mapping* using the relational term *be* without modification by modal verbs that signal uncertainty. This may suggest that participants who were shown the picture of the goal object may feel somewhat constrained by their expectation to match the given objects to their memory of the picture. If the provided objects do not match this memory, the matching process may be felt as less certain than in a more flexible situation where the only information given (if any) is the nature of the goal object. The verbal clue would then result in useful associations that are not too specific to constrain the participants' flexibility in assigning function to the wooden object parts.

In this paper we reported findings on explicit function assignment only (i.e., verbalizations directly assigning function to object parts). For this set of results, significant differences could be found only in the comparison of think-aloud vs. instruction studies, but not between the three think-aloud assembly conditions. Gralla (in prep.) further considered indirect function assignment by investigating all domain-specific nominal references in the think-aloud protocols. With this larger data set, a clear influence of prior knowledge could be observed. Participants who were told about the nature of the goal object used domain specific nouns more frequently than participants in the other conditions did (Gralla, in prep.).

## Conclusion

Our study addressed for the first time how speakers assign function to objects during an explorative unaided object assembly task and in instructions. Results show influences of the situational context on the ways in which this domain mapping is made explicit, on certainty expressed in language, and on the functional term chosen for reference. Those findings encourage more controlled studies to further explore the effects of problem solving conditions on mapping processes of this kind.

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