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Is perception of placement universal? A mixed methods perspective on linguistic relativity

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Abstract

This paper aims to advance theory on how speakers of different languages perceive the act of placement. German and Spanish verbs for example, differ in the specification of object position (e.g., *He stands/lays-puts the binoculars on the shelf*). Do speakers of these languages *perceive* placement events differently? This question relates to the notion of linguistic relativity. We report empirical data obtained with methods not yet applied to placement. These methods stem from three popular theoretical paradigms on language and thought. We examine whether placement verbs affect how speakers categorize (Experiment 1); memorize (Experiment 2) and mentally simulate (Experiment 3) object orientation. For three behavioral tasks, we compare accuracy and reaction time data of native speakers of German ($N = 80$) and Spanish ($N = 50$). Results suggest that German speakers do not categorize object position differently or make mental simulations of object orientation. They do show that German speakers have better recognition memory for object position than Spanish speakers. These findings suggest that language-specific effects may occur for some but not all mental processes. Future work should fine-tune reported methods to advance theory on perception of placement and should strive to combine methods to gain a multifaceted perspective on linguistic relativity.

Keywords: Sapir-Whorf hypothesis; Thinking for Speaking; Grounded Cognition; Placement events; Object orientation

1. Introduction

A classic debate within cognitive science is whether human thought is shaped by language (Gardner, 1985). The idea that speakers of different languages perceive the world differently is usually traced back to Benjamin Whorf (Whorf and Bissel Carroll, 1956). The works of the latter, together with those of Edward Sapir (1929) led to the formulation of the Sapir-Whorf (SW) hypothesis. This hypothesis states that (1) languages vary in their semantic partitioning of the world; (2) the structure of one's language influences the way one perceives the world; and therefore (3) speakers of different languages will perceive the world differently (Hoijer, 1954). In the 1950s and 1960s, the Whorfian position was supported by Brown and Lenneberg's (1954) studies on categorization of color terms, but unsupportive findings by Rosch (1973) introduced a period of skepticism about linguistic influence on thought. In the last decades however, the language-and-cognition area

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has become an area of increased investigation (Gentner and Goldin-Meadow, 2003; Filipović, 2011; Pavlenko, 2016). The area has also been referred to as the study of ''linguistic relativity'' (Wolff and Holmes, 2010). The literature is unresolved about if and in which contexts language affects thought (Trueswell and Papafragou, 2010; Fausey and Boroditsky, 2011). Whether language may affect perception depends on several factors, such as the degree to which the experimental task promotes or inhibits strategic use of linguistic categories or the nature of the linguistic feature and conceptual domain under study (Bylund and Athanasopoulos, 2014; Regier and Xu, 2017).

The initial focus on color in linguistic relativity research has moved to investigation of domains such as motion events and spatial relations. Spatial relations are central to the understanding of our surroundings, yet are highly variable cross-linguistically (Bowerman, 1980; Casad and Langacker, 1985; Talmy, 1975; Talmy, 1985; Talmy, 2000). In recent years, placement events have caught interest as Whorfian testing domain. A placement event is an event where an agent moves an object to a certain location, as in: *He puts the books on the shelf*. This may seem a rather narrow and specialized area of interest, but there are several reasons for this choice (Levinson, 2012). The most important reason is that simple actions of putting and taking things from places are a ubiquitous part of everyday human experience. Thus, it is not surprising that verbs of putting and taking are amongst the most frequent, basic verbs in a language and that they are amongst the earliest verbs learned by children. However, different languages display a large amount of variation in the use of placement verbs, varying from a tight closed obligatory set of 3–5 verbs, to a much wider set of 12–20 or more verbs (Ameka and Levinson, 2007; Kopecka and Narasimhan, 2012). German and Spanish placement verbs for example, differ as to whether they encode the end position of the object being placed. German speakers express whether the object ends up in a vertical (*legen* [lay]) or horizontal (s*tellen* [stand]) position with respect to the Ground ((Fagan, 1991; Lemmens, 2006). In Spanish, object orientation is not expressed through placement verbs (*poner* [put]; *dejar* [leave in a place]) (Ibarretxe-Antuñano, 2012; Cadierno et al., 2016). In order to express object orientation for placement events in Spanish, one needs to add an adverb like *horizontalmente* [horizontal] or *verticalmente* [vertical]) to a given placement verb. The variation between German and Spanish offers an interesting laboratory to study the interaction between linguistic descriptions of placement actions and non-linguistic cognition.

Several theories have been developed to examine linguistic relativity questions with their own dominant methods of study. This paper aims to advance three of these theories, and the overarching linguistic relativity question, by investigating how speakers of different languages perceive object position in placement events. We do so by applying methods that are dominant within three theoretical paradigms: the Sapir-Whorf (SW) hypothesis (Whorf and Bissel Carroll, 1956; Hoijer, 1954); the Thinking-for-Speaking (TFS) hypothesis (Slobin, 1996, 2003, 2006); and Grounded Cognition theory (Barsalou, 1999; Barsalou, 2008). We investigate if and how German and Spanish speakers understand placement events through language in three exploratory experiments. First, we investigate whether placement verbs affect how German and Spanish speakers categorize object position in placement events without overt language use (Experiment 1). Second, we examine German and Spanish speakers' recognition memory of object position in placement events after reading placement verbs (Experiment 2). The general hypothesis is that speakers of these languages will behave differently on these tasks due to language differences. Finally, we employ a sentence-picture verification task to examine whether German speakers use mental simulations as a route to language comprehension when reading placement verbs (Experiment 3). Through this three-fold operationalization of perception we aim to gain a multifaceted perspective on linguistic relativity for the domain of placement.

2. Theoretical background

2.1. Semantics of placement verbs

Placement events form a subcategory of the domain ''motion events'' that has received much attention in cross-linguistic studies. Talmy's typology of motion events (1975, 1985, 2000) has greatly contributed to this attention. He showed that different aspects of motion are expressed in all languages, yet different languages show preferences to describe motion in a certain way, which are ''colloquial, frequent and pervasive'' (Talmy, 2000:166). Talmy (2000) distinguished ''verb-framed'' languages, like Turkish and Spanish, that rely on monomorphemic path verbs, such as Spanish *entrar* [enter] and *subir* [ascend], to encode direction of movement. In contrast, English and German are ''satellite-framed'', using verb particles to encode direction. Compare, for example, German *geh rein* [go in] and *geh runter* [go down], with Spanish *entrar* [enter] and *subir* [ascend]. A subtype of a (caused) motion event is a placement event (e.g. *He puts the book on the shelf*). A placement event occurs when someone moves an object to another location. Research suggests that the basic components of a placement events are: Figure (what is moved); Agent (the causer of the movement); Ground (the location where a Figure is placed); Causation (what triggers the placement), Motion (the act of moving), and Path (the trajectory followed by the Figure) (Talmy, 1985; Jackendoff, 1990). In a volume edited by Kopecka and Narasimhan (2012) researchers report linguistic descriptions of placement for eighteen areally, genetically and typologically diverse languages. These languages range from Jahai, Tamil, Hindi, Marroccan Arabic to Japanese, Polish, German and Spanish. They show important asymmetries in the description of Motion and Path.

Putting German and Spanish placement verbs in contrast, we find important differences in spatial information given about the orientation of the placed object – the Figure – with respect to the Ground (Berthele, 2012; Ibarretxe-Antuñano, 2012). This difference in verb semantics applies as well to other Germanic languages such as Dutch, Danish and Swedish (Lemmens, 2006; Cadierno et al., 2016; Gullberg and Burenhult, 2012) as compared with other Romance languages as French (Gullberg, 2009). In German one employs a set of semi-obligatory placement verbs, *legen* [lay] and *stellen* [stand], that indicate whether the final position of the moved entity is either vertical or horizontal in relation to the Ground (Fagan, 1991; Lemmens, 2006). In Fig. 1, the action in the left picture would thus be described with *legen* [lay] and the right pictured action with *stellen* [stand]. In contrast, Spanish typically employs placement verbs like *poner* [put] or *dejar* [leave in a place] that do not indicate a certain position of an object or person in relation to the Ground (Ibarretxe-Antuñano, 2012; Cadierno et al., 2016). In Fig. 1, the action performed in both the left and right picture would thus be described with a single verb *poner* [put]. We expect that German speakers will be guided by their language to attend to concepts of verticality and horizontality when perceiving placement events, whereas Spanish speakers will not be guided to attend to object position. This expectation is supported by literature on saliency of linguistic and conceptual forms.

Berman and Slobin (1994:640) have posed that ''(. . .) frequent use of forms directs attention to their functions, perhaps even making those functions (semantic and discursive) especially salient on the conceptual level. That is, by accessing a form frequently, one is also directed to the conceptual content expressed by that form.'' Due to their high frequency (Levinson, 2012; Lemmens, 2006) we expect placement verbs to be salient linguistic forms, which thus affect speakers' perception of space. Saliency refers to the general perceived strength of a linguistic form (e.g., a placement verb) and the concept is describes (e.g., object position) (Author et al., 2009; Ellis, 2006; Goldschneider and DeKeyser, 2001). Linguistic forms may be more or less salient and attract more or less attention (Talmy, 2000; Ellis, 2008). For example, in the sentence ''She starts school today'', the word ''today'' is a stronger psychophysical form in the input than is the morpheme ''-s'' marking third person singular present tense. While both cues refer to time, ''today'' is much more likely to be perceived and ''-s'' can thus become overshadowed and blocked. Several factors determine the saliency of a linguistic form (Talmy, 2008; Ellis, 2008), but frequency of occurrence plays an important role (Berman and Slobin, 1994; Larsen-Freeman, 1976; Talmy, 2000; Ellis, 2008).

So far, placement verbs have been investigated by analyzing language and gestures (Gullberg, 2009; Narasimhan and Gullberg, 2011; Alferink and Gullberg, 2014; Cadierno et al., 2016) or eye-tracking (Van Bergen and Flecken, 2017). These studies have investigated both native (L1) speakers, children and adults, as well as second language (L2) speakers. They show that children and L2 speakers struggle with the meaning of placement verbs that encode object position. In L2 production, for example, Gullberg (2009) found that Dutch L2 learners of French performed target-like in their production of placement verbs, but showed transfer of a focus on object position (marked in Dutch with the verbs *leggen* [lay] and *zetten* [stand]) in their accompanying gestures. Narasimhan and Gullberg (2011) report an overextension of the Dutch verb *leggen* [lay] by 4- and 5-year old children acquiring Dutch. Alferink and Gullberg (2014), investigating early French–Dutch bilinguals, report an overgeneralization of *leggen* [lay] in Dutch. Van Bergen and Flecken (2017) showed that variation in the semantics expressed by placement verbs may affect how fast L2 speakers move their eyes toward Figure objects upon reading Dutch placement verbs (e.g. *zetten/leggen* [stand/lay]). They found that German learners of L2 Dutch anticipated objects that matched the verbally encoded position (like L1 Dutch speakers). However, a sample of equally proficient English and French users of L2 Dutch did not predict objects based on verbal semantics. The authors attribute findings to transfer of L1 processing routines as German, like Dutch, encodes the position of objects in

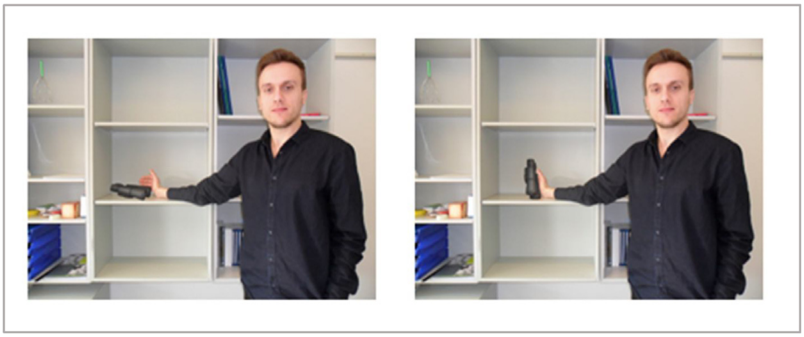

Fig. 1. Two picture examples of placement events, showing a man laying (left) and standing (right) a pair of binoculars on a shelf.

placement verbs (e.g., *stellen/legen* [stand/lay]), whereas English and French participants do not consistently attend to object position when describing placement events.

2.2. Methods in perception of placement

We understand perception as the ''organization, identification, and interpretation of sensory information in order to represent and understand the environment'' (Schacter, 2011). Important theoretical constructs about language and perception include the Sapir-Whorf (SW) hypothesis (Whorf and Bissel Carroll, 1956; Hoijer, 1954); the Thinking-for-Speaking (TFS) hypothesis (Slobin, 1996, 2003, 2006); and Grounded Cognition theory (Barsalou, 1999; Barsalou, 2008). In the following, we describe the main tenets of these constructs and focus on frequently used methods within these paradigms. We cite empirical work drawing upon these methods and work that is relevant to the domain of placement. Importantly, the discussed methods have not been applied yet to investigate perception of object position in placement events by speakers of different languages. Our review is limited in scope for reasons of space.

Within the Whorfian tradition, categorization tasks have been a popular means to test for linguistic effects on non-linguistic cognition. Linguistic differences in the expression of manner of motion (e.g., *creep*, *slither*, *hop*, etc.) in motion events have received much attention in previous studies (Gennari et al., 2002; Papafragou et al., 2002; Cardini, 2010; Papafragou and Selimis, 2010). Categorization is considered to operate based on similarity, so that two stimuli that are perceived similar are likely to be classified as members of the same category (Nosofsky, 1986). Therefore, categorization tasks measure ''cognitive preferences'' (Boroditsky et al., 2002). A typical setup involves speakers of two different languages (e.g., German vs. Spanish), with one group that linguistically marks aspects of a domain (e.g., German) whereas the other group does not (e.g., Spanish). Speakers are presented with two pictures (or video clips) and are asked to rate their similarity on a Likert scale (see Boroditsky et al., 2002). High similarity ratings to linguistically related pictures and low ratings to linguistically unrelated pictures (e.g., for German speakers), and no differences for the control group (e.g., Spanish) are interpreted as support for the Whorfian view. In a variation on this task participants see three pictures and choose two that are most similar (see Gennari et al., 2002). Note that these tasks do not involve verbalizing critical language and thus (aim to) measure implicit effects of language on cognitive preference.

In relation to placement, Hae in Park and Ziegler (2014) found that linguistic differences in the expression of ''put in'' and ''put on'' affected how speakers of English and Korean categorized placement events. Speakers based their categorization preferences on the categories described in their native language, without verbalizing those. Related Whorfian categorization studies focused on manner of motion expressed in motion verbs or temporal descriptions of goal-orientated motion. Most of these studies have compared speakers of English to speakers of another language. The studies into temporal descriptions have yielded effects in favor of the Whorfian view (Athanasopoulos and Bylund, 2013; Bylund and Athanasopoulos, 2014; Athanasopoulos et al., 2015). Yet studies into manner of motion both lead to results in favor of the Whorfian view (Papafragou and Selimis, 2010) as well as non-supporting results (Gennari et al., 2002; Papafragou et al., 2002; Cardini, 2010). The mixed nature of the manner of motion studies' results can be explained by several factors such as the degree to which the experimental task promotes or inhibits strategic use of linguistic categories, the specific characteristics of the linguistic feature under investigation and the use of static versus dynamic stimuli (Trueswell and Papafragou, 2010; Fausey and Boroditsky, 2011; Bylund and Athanasopoulos, 2014). This paper contributes to this debate by providing empirical data on a linguistic distinction left uninvestigated so far, that is object position (un)marked by German and Spanish placement verbs. We ask whether differences in the indication of object position affect categorization choices.

Alternatively to the SW hypothesis, the TFS hypothesis (Slobin, 1996; Slobin, 2003; Slobin, 2006) poses that language may affect thought when one is thinking with the intent to *use* language. In his 1996 paper Slobin mainly speaks about the study of ''mental processes that occur during the act of formulating an utterance'' or speaking. The focus on speaking may result from his extensive study of the verbalization of motion events in the famous frog stories by speakers of different languages (Berman and Slobin, 1994). Yet in 2003, next to speaking, Slobin poses that he regards all forms of linguistic production (speaking, writing, signing) and reception (listening, reading, viewing) as well as a range of mental processes (understanding, imaging, remembering etc.) as evidence for TFS effects. Within the TFS tradition, recognition memory tasks have been a popular means to test for linguistic effects on cognition. Recognition memory is the ability to recognize previously encountered events, objects or people. Again, we find mixed results in studies that have applied such tasks.

Bosse and Papafragou (2010) have addressed TFS and memory in a relevant study into expression of object position. They found no effects of the German verbs *stehen* [sit] and *liegen* [lie] on memory for objects that were positioned vertically or horizontally onto a flat Ground. Cross-linguistic differences in the expression of manner of motion or intentionality in motion verbs have received much attention. There have been reports of improved memory accuracy for more specific language (Billman et al., 2000; Gennari et al., 2002; Filipović, 2011, 2016). However, for spatial prepositions, Feist and Gentner (2007), reported worse memory accuracy for more specific language, and Coventry et al.

(2010) reported no effects. Coventry et al. (2010) argue that the different time frames used in tasks may explain the mixed results found in studies on TFS and memory. In previous studies this has varied from 10 min (Billman et al., 2000) and one day (Gennari et al., 2002). The authors argue that adopting a shorter time course yields more fine-grained results than methods employed previously as it ensures that (noncritical) language is less likely to be used as a tool at encoding and on retrieval to remember a previously encountered image. Therefore, they designed a two-phased memory task with minimum delay (750 ms) administered with a computer (see Fig. 1). This paper contributes to this debate by providing German-Spanish empirical data on recognition memory of object position in placement events by employing a fine-grained memory task adapted from Coventry et al. (2010).

The mental mechanisms underlying potential perceptual differences remain unspecified in both the Whorfian and TFS hypothesis. Following Grounded Cognition theory (Barsalou, 1999; Barsalou, 2008; Glenberg, 1997; Lakoff, 1987; Pecher and Zwaan, 2005), however, unconscious ''mental simulations'' underlie perception and language comprehension. A mental simulation is a reactivation of previous physical experiences linked to a word and its meaning. It is claimed that simulations happen unconsciously and out of control of the language comprehender. A popular means to examine mental simulations is the sentence-picture verification task (Stanfield and Zwaan, 2001). In empirical simulation studies participants sit behind a computer and read sentences like ''The carpenter hits the nail into the floor''. Subsequently they see a picture of a nail that matches (vertical) or mismatches (horizontal) the orientation implied by the context sketched in the sentence (Stanfield and Zwaan, 2001). At this stage, they are asked whether the depicted object was mentioned in the preceding sentence or not (see Fig. 2). It is argued that faster reaction times (RTs) to matching pictures support the notion that speakers have simulated object orientation during sentence comprehension. That is, a comparison with a simulated model that matches takes less time than a comparison with a mental simulation that mismatches.

Mis-/match effects have been shown for object shape (Zwaan et al., 2002; Engelen et al., 2011; Sato et al., 2013); color (Zwaan and Pecher, 2012; Hoeben Mannaert et al., 2017) and size (Winter and Bergen, 2012; De Koning et al., 2016). Effects for object orientation have been shown to be unstable and modest in size (Zwaan and Pecher, 2012; Rommers et al., 2013; Zwaan, 2014; De Koning et al., 2017). This is in line with Connell (2005, 2007) who argues that psychophysically, properties such as shape or size are more salient than object color or orientation. Harris and Dux (2005) have also shown that object recognition was not affected by object orientation. Orientation simulation studies have only investigated implied orientation so far and did not consider explicit marking of orientation within a language, as is the case with the German placement verbs *legen* [lay] and *stellen* [lay]. Here, one may expect that German readers generate univocal, clear simulations of object orientation. This paper contributes to the simulation debate by providing empirical data on how German speakers react to pictures objects that mis-/match in object position indicated by preceding placement verbs.

2.3. Hypotheses

Following the theoretical review we formulate hypotheses about German and Spanish speakers' perception of object position in placement events.

Hypothesis 1. German speakers will categorize placement scenes based on object orientation, whereas Spanish speakers will not or will do so to a lesser degree.

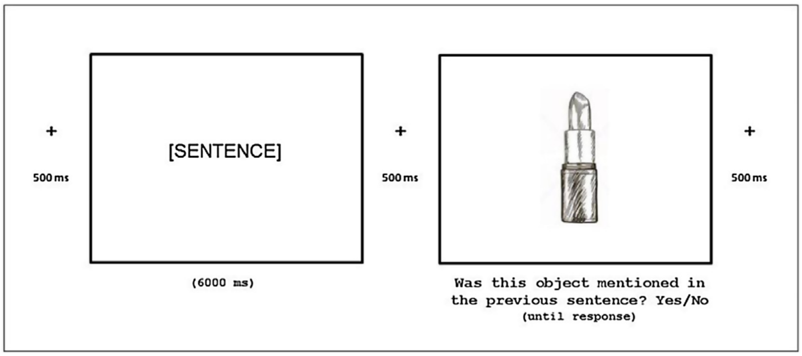

Fig. 2. Example of a two-phased experimental trial in Experiment 3.

Table 1
Overview of experimental tasks, measures and number of participants in this paper.

	Experimental task	Measure	*N* participants
Experiment 1	Similarity judgment	Rating (scale 1–7)	German 22; Spanish 23
Experiment 2	Picture recognition	Yes/no response Reaction time	German 27; Spanish 27
Experiment 3	Sentence-picture verification	Yes/no response Reaction time	German 30

Hypothesis 2. German speakers will have a better recognition memory for object orientation in placement scenes as compared with Spanish speakers.

Hypothesis 3. German speakers will react faster to pictures that match object orientation marked by placement verbs as compared with mismatching pictures.

3. Methods and results

We examined the hypotheses in three experiments with each employing a different method or experimental task (see Table 1). We used a non-random sampling technique relying on available subjects (Babbie, 2015). This means that not all individuals in the population had an equal chance of being selected. Sample sizes were based on previous related studies. The German participants were recruited at Bremen University (Germany); the Spanish speakers at Seville University (Spain). German and Spanish speakers were paid a nominal fee to participate. Some participants participated both in Experiment 1 and 2. If this was the case, the order of administration was counterbalanced and found not to be statistically relevant. Groups were roughly matched for sex (approximately 70% female) and all participants were right-handed (see Table 1 for numbers). Most participants reported knowledge of English and limited knowledge of other languages. German speakers were instructed in German; Spanish speakers in Spanish. Students were tested in a quiet computer room in groups of 5–20.

The critical experimental items showed so-called orientation-free objects (e.g., lipstick, deodorant, tube of toothpaste, binoculars, battery, bell, spool, glue stick). In an English pilot-study with 12 participants, we found that these objects can naturally occur in a horizontal or vertical position when being placed onto a flat Ground (e.g., table, table cloth, shelf, wooden floor, book, plate, cutting board, piece of paper). In the pilot study, we crossed 15 figure objects (e.g., lipstick) with 15 grounds (e.g., table), which led to a list with 112 items (6 participants) and a list with 113 items (6 participants). Participants were asked to indicate for presented object combinations (e.g., lipstick-table) how they would place the first object onto the second object – lying (value 1), either way (value 3) or standing (value 5). In the experiments reported below, we only used figure-ground combinations that received an average rating between 2.5 and 3.5 (no preference for either lying or standing). This way, we ensured that speakers would be primed by their placement verbs only and not by a preferred placing orientation. All experiments started with 3–5 practice items and the order of items was randomized.

3.1. Experiment 1: Placement verbs and categorization

3.1.1. Task and materials

Participants completed a computer-based similarity judgment task with 36 trials. A set of 13 color pictures served as stimuli, which portrayed two agents[1] putting four orientation-free objects on a table or a koala (control condition) (see Fig. 3). Each trial consisted of a basic picture (e.g., Agents place object horizontally) and an alternate picture in one of five conditions, that are: (A) identical picture; (B) different picture (koala); (C) different agents place object horizontally; (D) agents place object vertically; and (E) agents place a different object horizontally. The koala picture cannot be described with placement or posture verbs and we thus expected low similarity ratings when this picture appeared together with a placement scene (control condition B). In contrast, we expected high similarity ratings for the condition with identical pictures (control condition A). For each scene, we manipulated gender, which means that the male agent changed into a female agent (control condition C); we manipulated the object, thus a deodorant versus a lipstick (control condition E) or

[1] The reason for having two agents perform the placement action was related to a manipulation that we do not discuss in this paper, as it focuses on the manipulation of object position.

the orientation of the placed object, that was vertical versus horizontal (critical condition D). For condition C and E, we expected similar average ratings for both German and Spanish speakers, but for condition D, we expected different ratings between groups. Each picture pair appeared at every possible position on the screen. We chose static instead of dynamic stimuli as static stimuli are more controlled (dynamic stimuli consist effectively of several static frames presented in fast succession). However, to ensure that participants perceived the events as motion events (lying, standing), and not as merely touching or holding an object, we informed them that the pictures were stills taken out of a video and showed them a video and an abstracted still image before the judgment task.

3.1.2. Design

A set of 36 items was created: 4 placement scenes (lipstick, deodorant, tube of toothpaste, binoculars) × 5 (conditions A-E, see above) × 2 (screen position: left, right). Four double (E) items were taken out as screen position was not relevant here (identical pictures). See Appendix 1 for a full list with items.

3.1.3. Instructions

Each picture pair appeared on a computer screen with the two pictures shown simultaneously in the center of the screen with a scale below. Participants were asked to rate similarity of the picture pair on a scale from one to seven (not similar at all; not very similar; not similar; more similar than not similar; similar; very similar; totally similar). Each pair stayed on the screen until the subject pressed a key to indicate his similarity rating. After the experiment, we asked participants to write down one-sentence descriptions of eight critical placement scenes (four horizontal, four vertical). This was done to ensure that participants had perceived the scenes as placement events.

3.1.4. Results

Hypothesis 1 posed that German speakers would categorize placement scenes based on object orientation whereas Spanish speakers would not. For each participant, we calculated the mean similarity rating for each of the five conditions and treated the means as interval data. A 2 (language: German, Spanish) × 5 (condition: A–E) ANOVA showed there was no main effect of language $F(1,44) = .273$, $p = .604$, $\eta_p^2 = .007$. There was a main effect of condition $F(4,41) = 604.895$, $p < .001$, $\eta_p^2 = .937$. See Table 2 for mean ratings for the different conditions. There was no significant interaction between language and condition $F(4,41) = .320$, $p = .864$, $\eta_p^2 = .008$. This means there were no significant differences in ratings for different conditions between groups. Critically, it means that for the critical condition where object position differed, similarity ratings for German ($M = 4.91$, $SD = .95$) and Spanish (M = 5.05, $SD = .67$) were not significantly different. All in all, these data do not support Hypothesis 1.

We also analyzed the linguistic descriptions of the eight critical placement scenes (four horizontal, four vertical). For each participant, we calculated the number of trials where predicted forms were used. German speakers employed *legen/stellen* [lay/stand] in 39.8% (SD = 42.2) of all cases, and Spanish speakers employed *poner/dejar* [put/leave in a place] in 17.9% (SD = 25.0) of all cases. Within the German alternative descriptions, the most frequent used verbs were *halten* [hold] (25%) and *greifen* [grab] (21.3%), with specifiers as *liegende(s)* [lying] or *stehende(s)* [standing]. Within Spanish alternative descriptions, the most frequent verbs were *colocar* [place] (11.4%) or *coger* [take] (8.9%), with specifiers as *horizontalmente* [horizontal] or *verticalmente* [vertical]. All in all, 48.9% of German and 54.3% of Spanish descriptions indicated object position. These data thus suggest that object position was equally relevant for speakers of both languages for roughly half of all cases. They also suggest that, despite instructions with a video showing a placement event, more than half of the presented events were not perceived as placement events, but as ''holding'', ''grabbing'' or ''taking'' events. This finding has important consequences for the interpretation of the categorization results (see Section 5).

3.2. Experiment 2: Placement verbs and recognition memory

3.2.1. Task and materials

Participants completed a computer-based memory task adapted from Coventry et al. (2010) with 96 trials. Each trial started with a prime display, which was present until a response was made. Hereafter a fixation cross (+) was presented for 750 ms, followed by the recognition display, which remained on screen until a response was made (see Fig. 4). In the prime display, participants were asked to verify whether two identical pictures depicting a placement scene matched a sentence describing the placement scene (e.g., *They put the binoculars on the shelf*).[2] The purpose of this task was to ensure that participants read the sentences and studied the pictures. In the recognition display, participants were asked to

[2] The reason for having two identical pictures in the prime display was related to a manipulation that we do not discuss in this paper, as it focuses on the manipulation of object position.

Table 2
Mean rating values and standard deviations for the similarity judgment task (scale 1–7).

Condition	Specification	German rating		Spanish rating	
		Mean	SD	Mean	SD
A	Control: Identical	6.95	.13	6.95	.13
B	Control: Different picture (koala)	1.13	.32	1.07	.23
C	Control: Different agent	4.25	.95	4.23	.97
D	Critical: Different object position	4.91	.95	5.05	.67
E	Control: Different object	5.28	.87	5.38	.61

Fig. 3. Two examples of trials in Experiment 1, with the left trial depicting condition D (different object position) and the right trial depicting condition B (different picture).

verify whether the presented picture was identical to the picture(s) just seen. Here, the purpose was to determine whether the language presented in the prime display would affect their recognition memory accuracy. The four placement scenes were presented in the target condition, that is (A) the angle of the object changed 20 degrees up/downward (congruent with German placement verbs); or in three control conditions: (B) identical picture; (C) the object disappeared; or (D) we changed facial masculinity.[3] In the prime display, participants saw language and picture stimuli. The critical language stimuli were 48 sentences describing placement scenes (e.g., *They put the binoculars on the shelf*). The sentences described four critical placement scenes: men put binoculars on shelves; men put glue sticks on plates; women put flashlights on pieces of paper; women put lipsticks on cutting boards. We created two prime sentences and one ''neutral'' sentence (e.g., *There are men, binoculars and shelves*) describing the four scenes. In this paper we only consider prime sentences where German readers read *legen/stellen* [lay/stand] and Spanish readers read the verb *poner* [put]. 48 Filler sentences and pictures described and showed people performing other actions with different objects.

3.2.2. Design

The 48 experimental items were obtained by presenting each of the four placement scenes in a 3 sentence type (see above) $\times$ 4 picture condition (identical, object disappears, facial change, orientation change) design.

3.2.3. Instructions

The experimental instructions, employing a cover story so participants would not guess the hypotheses, were as follows: In this experiment we investigate binocular vision. Binocular vision is sight where one uses both eyes. Sometimes one sees different things with the left and right eye, and we want to find out how this works. You will see a number of phrases and pictures that describe and show people performing an action with an object. First, you will see two identical pictures and a sentence. You are asked to verify whether the pictures match the sentence or not. Give your answer by

[3] The reason for manipulating facial masculinity was related to a design factor that we do not discuss in this paper, as it focuses on the manipulation of object position.

pressing Q(Yes) or P(No). Second, you will see a single picture. You are asked to verify whether this picture is identical to the pictures you just saw. Please do not take the number of pictures into account (the fact that there were two images first, and then one), but what is shown on the pictures. Differences can be small or large. Give your answer by pressing Q(Yes) or P(No). Please concentrate during the experiment and take the time you need to complete it. Keep your fingers at the Q and P keys during the whole experiment.' They were informed about the tasks at hand. Considering the identification task, we asked "Please do not take the number of pictures into account (the fact that there were two images first, and then one), but what is shown on the pictures. Differences can be small or large. (. . .). Keep your fingers at the response keys during the whole experiment."

3.2.4. Results

Hypothesis 2 posed that German speakers would have a better recognition memory for object orientation in placement scenes as compared with Spanish speakers. First, we examined accuracy scores. We ran a 2 (language: German, Spanish) × 3 (picture change: orientation change, 2 control) ANOVA on % of noticed picture changes. There was no significant main effect of group, $F(1,52) = 3.220$, $p = .079$, $\eta_p^2 = .059$. There was a significant main effect of picture change condition $F(2,104) = 455.529$, $p < .001$, $\eta_p^2 = .898$; overall, participants were most accurate for an object disappearing (M = 90%), and less accurate for the orientation change (M = 14%) and gender change (M = 7%) conditions. Pairwise comparisons (LSD) showed that differences between all conditions were significant, $p < .04$. There was also a reliable interaction between picture change condition and group, $F(2,104) = 3.855$, $p = .024$, $\eta_p^2 = .069$. Thus, German and Spanish speakers had different accuracy scores for different picture changes. Pairwise comparisons (LSD) showed a significant difference for the orientation condition for German (M = 22%) and Spanish (M = 6%), $p = .002$, but not for the other conditions, $p > .7$. These data support Hypothesis 2. German speakers had better recognition memory for changes in object orientation than Spanish speakers.

3.3. Experiment 3: Placement verbs and mental simulation

3.3.1. Task and materials

German-speaking participants completed a computer-based sentence-picture verification task (as in Stanfield and Zwaan, 2001) with 128 trials. Each trial started with a display where a sentence was being shown for 6000 ms. After this, a new display appeared with a black-and-white drawing of an object and the question "Was this object mentioned in the preceding sentence, Y/N?" (see Fig. 2). The eight critical objects were: lipstick, battery, flashlight, bell, spool, deodorant, tube of toothpaste and glue stick. The black-and-white drawings presented objects in four different conditions: small and large sized[4] and horizontal and vertical. The size condition was included for design purposes not relevant to this paper. Materials consisted of sentences and pictures. The critical sentences described placement events (e.g., *Mary puts the lipstick on the table*) and included the German *legen/stellen* [lay/stand]. Filler sentences described people performing an action with an object that did not indicate object orientation. The critical black-and-white drawings showed objects in a vertical or horizontal manner (object rotated 90° on its vertical axis) and measured 3.5 × 3.5 in.

3.3.2. Design

For each of the eight objects we created 4 sentences in German obtained by a 2 condition (mis-/match) × 2 object orientation (horizontal, vertical) design, yielding 32 critical trials. To reduce the duration of the experiment, we distributed these trials over two lists (A and B) with 16 trials each. We expected these 16 trials to be answered with "Yes", so we augmented each list with 16 further "Yes" trials; and 32 "No" trials for the same objects (here, an object appeared that was clearly different from the one previously mentioned). Finally, we introduced 64 further trials per list for eight other objects, with half of the trials expected to receive "Yes" and the other half "No" answers. List A was given to 13 and list B to 17 participants.

3.3.3. Instructions

The instructions explained the task at hand. We also informed participants that reaction times were being measured and that it was important for them to make the decisions about the pictures as quickly as possible. We thus asked them to keep their fingers at the response keys during the whole experiment.

[4] The reason for having size as a condition was related to a manipulation that we do not discuss in this paper, as it focuses on the manipulation of object position.

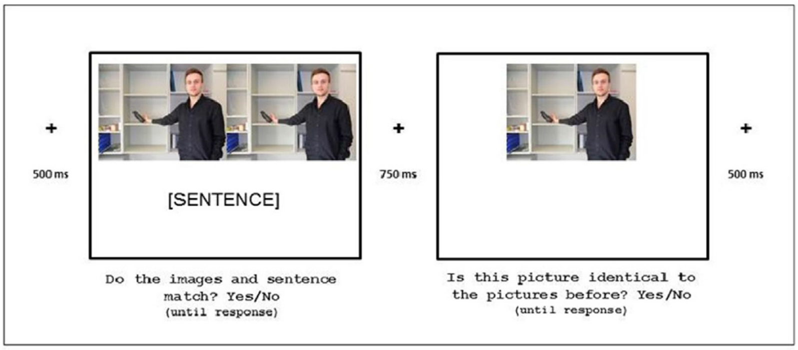

Fig. 4. Example of a two-phased experimental trial in Experiment 2.

3.3.4. Results

Hypothesis 3 posed that German speakers would react faster to pictures that mismatch object orientation marked by placement verbs as compared with mismatching pictures. We first separated Yes from No (4.6% of total) responses. We continued to analyze Yes RTs. We cleaned the data following a procedure by Zwaan and Pecher (2012). This meant that we removed responses faster than 300 and slower than 3000 ms; and removed responses further away than 2SD from each participant's mean per mis-/match condition (3.5% of data). We ran a one way ANOVA on RTs for match and mismatch trials, which showed no effect of condition $F(1,29) = .2.266$, $p = .143$, $\eta_p^2 = .072$. This means that RTs to match ($M = 673$, $SD = 149$) and mismatch ($M = 729$, $SD = 249$) trials did not differ significantly. These data do not support Hypothesis 3.

4. Discussion

The aim of this paper was to give a multifaceted perspective on linguistic relativity for the domain of placement. We drew methods from three theoretical paradigms on language and thought to examine whether German and Spanish speakers perceive placement events differently. Based on previous research, we posed that German and Spanish provide an excellent testing case as German encodes object position in its semi-obligatory placement verbs *legen/stellen* [lay/stand] whereas Spanish placement verbs as *poner* [put] do not. Due to frequent occurrence and use of placement verbs (Levinson, 2012; Lemmens, 2006) we expected that the verbs would be salient in cognition and would lead German speakers to attend to object position whereas this would not be the case for Spanish speakers. We applied the three selected methods in three consecutive experiments (Experiment 1, 2 and 3), with each method shedding light on a different, yet interconnected, aspect of perception of placement (i.e., categorization, memory and mental simulation of object orientation).

In Experiment 1, results showed no support for the hypothesized categorization differences, since German and Spanish speakers gave similar ratings for pictures where object position differed. The null results comply with studies into manner of motion that have reported null effects too (Gennari et al., 2002; Papafragou et al., 2002; Cardini, 2010). Yet, results do not comply with those studies that have documented categorization effects for ‘‘put in/on’’ (Hae in Park and Ziegler, 2014); or temporal descriptions of goal-oriented motion (Athanasopoulos and Bylund, 2013; Bylund and Athanasopoulos, 2014; Athanasopoulos et al., 2015). What factors can explain our null results and different findings across studies? We note that previous studies have employed pictures (Papafragou et al., 2002; Hae in Park and Ziegler, 2014) as well as videos (Gennari et al., 2002; Cardini, 2010; Athanasopoulos and Bylund, 2013; Bylund and Athanasopoulos, 2014; Athanasopoulos et al., 2015). Considering the results of these studies, we find no clear indication that studies with pictures lead to null effects and studies with videos to effects. Yet, a plausible explanation for the null results in our picture study is the following. The descriptions given after categorization of our pictures strongly indicate that participants perceived a considerable number of depicted events not as placement events but as ‘‘holding’’, ‘‘grabbing’’ or ‘‘taking’’ events, despite being primed with a placement video. If these descriptions are reflective of those employed during categorization, cognitive preferences guided by cross-linguistic differences in placement verbs did not occur. We strongly suggest future studies into placement to employ videos instead of pictures, which aligns with the current trend in studies into motion events (Athanasopoulos, personal communication). This way we can determine whether placement verbs affect categorization of placement videos and whether these results align with studies that report relativity effects for motion events.

Another factor that can explain our null results, and potentially different findings across motion studies, is that language was hardly used or not used at all to complete the task, and therefore effects remain absent. Regier and Xu (2017) argue that uncertainty determines whether language is used to fill in missing elements and whether effects of language on cognition thus emerge. The authors write that ''When relevant nonlinguistic information is comparatively certain, when object details are already clearly mentally available, there is little missing information for language to supply, so there should be little or no effects of language'' (p. 1). They support their idea with empirical and computational evidence for color and numbers terms. It can be argued that our pictures presented clear spatial information with clear details about object position (horizontal versus vertical). Therefore, language was not employed to fill in missing information during categorization and did not shape categorization preferences. In the same line, it could be argued that manner of motion of humans in pictures and motion videos is straightforward as well, leading to null effects (Gennari et al., 2002; Papafragou et al., 2002; Cardini, 2010). Pictures showing ''put in/on'' events (Hae in Park and Ziegler, 2014) and videos of goal-oriented motion that can be described with temporal descriptions (Athanasopoulos and Bylund, 2013; Bylund and Athanasopoulos, 2014; Athanasopoulos et al., 2015) would arguably be less straightforward and lead to language effects on categorization. The validity of these speculative claims could be addressed in a study that compares the strength of categorization differences for different type of motion events.

In Experiment 2, results showed higher accuracy scores for recognition of changes in object position by German speakers. This may be interpreted as evidence for TFS (Slobin, 1996). How do we explain the difference between positive (Billman et al., 2000; Gennari et al., 2002; Filipović, 2011, 2016; current study) versus negative (Feist and Gentner, 2007) or null (Coventry et al., 2010; Bosse and Papafragou, 2010) effects of language on memory accuracy? Let us start by looking at appropriateness of critical language at encoding. The only study that documented negative (within-) language effects (Feist and Gentner, 2007) is also the only study reporting that the critical language (e.g., spatial prepositions) presented was inappropriate to describe the presented images. One can argue that in studies with positive findings, critical language (e.g., motion verbs) was (more) appropriate, which may explain the difference in directionality of the effect. In studies with null findings (Coventry et al., 2010; Bosse and Papafragou, 2010), however, it can be argued that critical language was appropriate (enough) as well. Do these studies differ from the other studies in other aspects? Language mode offers no satisfactory explanation, as reading as well as writing led to both positive, negative and null results (speaking only led to positive results so far). A more plausible cause of differences is the time course employed between encoding and memory phase, with short time courses leading to similar results. Yet we employed the same short time course as that by Coventry et al. (2010), but found different results. Different type of stimuli (drawings. vs. pictures); the different inclinations employed (different degrees of open-closed vs. different degrees of inclination); or the different language phenomenon under study (spatial prepositions vs. motion verbs) may then explain the difference between latter and current findings.

The language phenomenon-explanation for null or positive effects appears the most plausible. Reviewing previous studies results' through the lens of spatial prepositions versus motion verbs, we find that studies with positive effects concern motion verbs, and the negative/null effects appeared in work on spatial prepositions or positional verbs, that is static language. Is it thus the case that motion verbs systematically affect memory, whereas static language does not? Support for this idea comes from behavioral, electrophysiological, neuropsychological and imaging studies (see Pulvermüller, 2005; Meteyard et al., 2007; Vigliocco et al., 2011 for overviews). Wallentin et al. (2011) for example, showed that motion verbs in sentences activate the temporal cortex despite a static context (e.g., ''The path comes into the garden''), whereas static verbs do not. This finding indicates that dynamic language has powerful effects on parts of our brains. As empirical studies on language and memory for motion and space will culminate, the validity of the dynamic versus static thesis could be examined by means of a meta-analysis in future work. We also note that all previous studies employing dynamic stimuli (videos) found positive effects, whereas studies with static stimuli (drawings or pictures) found negative or null effects. This study is the first to document positive TFS effects for caused motion verbs with static stimuli.

In Experiment 3, we examined whether German speakers make (unconscious) mental simulations of object orientation comprehending placement verbs. Results do not reveal support for mental simulation of object orientation, even though our placement verbs explicitly marked object orientation. These results do not comply with previous simulation effects for implied orientation (Stanfield and Zwaan, 2001; Zwaan and Pecher, 2012), but they add to the null effects reported by Rommers et al. (2013) and De Koning et al. (2017). How do we explain these discrepancies? A lack of effects may be explained through the plausible suggestion put forward by Connell (2005, 2007), Zwaan and Pecher (2012) and De Koning et al. (2017) that psychophysically, properties as shape or size are more salient than orientation, leading to less robust effects for the latter. Yet still, because placement verbs so specifically indicate object orientation, we may expect that orientation is salient to some degree, or at least to a higher degree as compared with implied orientation in previous studies. What other notions could then explain our results?

It could still be argued that extrinsic visual object properties initially elicit automatic activations in visual areas (Yaxley and Zwaan, 2007), but that corresponding mismatches are quickly nullified by relying on additional processes such as mental rotation. In this case, to make a verification decision, readers try to map the presented picture to the visual-spatial image they created from the object described in the sentence. Depending on the extent to which the implied (or explicated) and pictured orientation of an object match, readers engage in a 90° mental rotation of the object, so that it corresponds to the picture. The time needed to decide whether the orientation and picture match then changes accordingly. De Koning et al. (2017), however, argue that the rotation explanation is less likely, as a previous study showed no reliable correlation between mental rotation and the magnitude of the orientation match advantage (Stanfield and Zwaan, 2001). They also argue that additional time-consuming processes do not fit with the fact that in their study, the overall RTs were faster for orientation than for the other visual properties. What the current study can contribute to this debate is that we too found fast RTs for orientation trials, which correspond to the ones in De Koning et al. (2017). As has been suggested by De Koning et al. (2017), future research could try to tackle the issue by directly addressing the recruited brain areas with time-sensitive measures (e.g., MEG/EEG).

There is another explanation for the orientation null effect that relates to task demands. Remember that participants gave answers by pressing Q(Yes) or P(No) buttons on a keyboard. Pressing buttons on a keyboard involves up-and downwards motion of fingers to a key (on a vertical axis) and coordination of left and right finger pressing a left or right key (on a horizontal axis). The Theory of Event Coding (TEC) (Hommel et al., 2001) predicts that when one motor response is completed (such as running a vertical orientation simulation needed to comprehend a given sentence), the (vertical) feature will be bound to that outcome, making it temporarily unavailable (or less available) to other responses (such as the downward motion needed for the button press). Under such circumstances, priming between motor responses may be eliminated or reversed (Hommel et al., 2001; Hommel, 2015). If priming is eliminated, a null effect may appear in a task such as ours. However, the TEC is still much in need of empirical verification. In line with De Koning et al. (2017), we recommend further experimenting with placement verbs by means of time-sensitive measures (e.g., MEG/EEG) to verify whether the binding and blocking mechanisms proposed by TEC indeed occur when comprehending placement verbs.

5. Conclusion

In sum, this paper has provided a multifaceted perspective on the linguistic relativity question for the domain of placement. Based on results of three exploratory experiments we conclude that speakers of different languages do not categorize placement events differently in case they do not read/verbalize placement verbs while categorizing; that they do show different recognition memory for object position in placement events after reading sentences with placement verbs; but that German speakers do not make mental simulations of object position upon reading sentences with placement verbs. The methods reported in this empirical work should be fine-tuned to advance our understanding of cross linguistic effects on speakers' perception of placement even further. However, the picture that arises thus far shows that effects of (different modes of) language do not occur on all theorized mental processes.

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Appendices

Appendix 1
List of items in Experiment 1 in non-randomized order. The *-items were deleted as left- or right-hand picture position was not relevant here.

Trial	Figure object	Condition	Left-hand picture	Right-hand picture
01	Lipstick	A	ManWoman-LipstickLying	ManWoman-LipstickLying
02	Lipstick	B	Koala	ManWoman-LipstickLying
03	Lipstick	C	ManWoman-LipstickLying	WomanWoman-LipstickLying
04	Lipstick	D	ManWoman-LipstickLying	ManWoman-LipstickStanding
05	Lipstick	E	ManWoman-LipstickLying	ManWoman-DeodorantLying
06	Lipstick	A2*	ManWoman-LipstickLying	ManWoman-LipstickLying
07	Lipstick	B2	ManWoman-LipstickLying	Koala
08	Lipstick	C2	WomanWoman-LipstickLying	ManWoman-LipstickLying

Appendices (*Continued*)

Trial	Figure object	Condition	Left-hand picture	Right-hand picture
09	Lipstick	D2	ManWoman-LipstickStanding	ManWoman-LipstickLying
10	Lipstick	E2	ManWoman-DeodorantLying	ManWoman-LipstickLying
11	Toothpaste	A	ManWoman-ToothpasteLying	ManWoman-ToothpasteLying
12	Toothpaste	B	Koala	ManWoman-ToothpasteLying
13	Toothpaste	C	ManWoman-ToothpasteLying	WomanWoman-ToothpasteLying
14	Toothpaste	D	ManWoman-ToothpasteLying	ManWoman-ToothpasteStanding
15	Toothpaste	E	ManWoman-ToothpasteLying	ManWoman-BinocularsLying
16	Toothpaste	A2*	ManWoman-ToothpasteLying	ManWoman-ToothpasteLying
17	Toothpaste	B2	ManWoman-ToothpasteLying	Koala
18	Toothpaste	C2	WomanWoman-ToothpasteLying	ManWoman-ToothpasteLying
19	Toothpaste	D2	ManWoman-ToothpasteStanding	ManWoman-ToothpasteLying
20	Toothpaste	E2	ManWoman-BinocularsLying	ManWoman-ToothpasteLying
21	Deodorant	A	ManWoman-DeodorantLying	ManWoman-DeodorantLying
22	Deodorant	B	Koala	ManWoman-DeodorantLying
23	Deodorant	C	ManWoman-DeodorantLying	WomanWoman-DeodorantLying
24	Deodorant	D	ManWoman-DeodorantLying	ManWoman-DeodorantStanding
25	Deodorant	E	ManWoman-DeodorantLying	ManWoman-LipstickLying
26	Deodorant	A2*	ManWoman-DeodorantLying	ManWoman-DeodorantLying
27	Deodorant	B2	ManWoman-DeodorantLying	Koala
28	Deodorant	C2	WomanWoman-DeodorantLying	ManWoman-DeodorantLying
29	Deodorant	D2	ManWoman-DeodorantStanding	ManWoman-DeodorantLying
30	Deodorant	E2	ManWoman-LipstickLying	ManWoman-DeodorantLying
31	Binoculars	A	ManWoman-BinocularsLying	ManWoman-BinocularsLying
32	Binoculars	B	Koala	ManWoman-BinocularsLying
33	Binoculars	C	ManWoman-BinocularsLying	WomanWoman-BinocularsLying
34	Binoculars	D	ManWoman-BinocularsLying	ManWoman-BinocularsStanding
35	Binoculars	E	ManWoman-BinocularsLying	ManWoman-ToothpasteLying
36	Binoculars	A2*	ManWoman-BinocularsLying	ManWoman-BinocularsLying
37	Binoculars	B2	ManWoman-BinocularsLying	Koala
38	Binoculars	C2	WomanWoman-BinocularsLying	ManWoman-BinocularsLying
39	Binoculars	D2	ManWoman-BinocularsStanding	ManWoman-BinocularsLying
40	Binoculars	E2	ManWoman-ToothpasteLying	ManWoman-BinocularsLying

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