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The impact of culture and recipient perspective on direction giving in the service of wayfinding

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ABSTRACT

We examined how culture and recipient perspective affect direction giving during wayfinding. Participants from the United States and the Netherlands provided directions from starting locations to destinations for fictional recipients driving through a town (route perspective) or looking at a map of the town (survey perspective). US participants provided street names more frequently than did Dutch participants, whereas Dutch participants provided landmarks more frequently than did US participants. Moreover, US participants provided more cardinal descriptors when addressing listeners adopting a survey perspective relative to a route perspective but more landmarks and left-right descriptors when addressing listeners adopting a route perspective relative to a survey perspective. Participants from the Netherlands evinced a similar pattern with the important distinction that they mostly ignored cardinal terms, unless explicitly primed to do so and in a survey condition. In addition, this very low usage of cardinal terms seemed to be replaced by using more landmark descriptions. This study revealed remarkable flexibility in people's spatial descriptions but also stressed major differences in the use of spatial terms between US and Dutch participants.

The ability to find our way through the environment is vital for daily functioning. Often, people rely on verbal directions to facilitate wayfinding, particularly when searching for unfamiliar destinations such as tourist sites. What kinds of descriptive language do people include when providing directions for wayfinding? In what ways might these features vary across cultures and depend on recipient characteristics? Previous research has convincingly shown that there are striking cultural differences in reference frames and associated spatial terms employed to describe space (for a review, see Levinson, 2003). Much of this research has focused on comparisons of Western and non-Western cultures. In contrast, US and European studies investigating flexibility of spatial descriptions and recipient perspectives largely have ignored cultural factors (e.g., Brunyé & Taylor, 2008; Hund, Haney, & Seanor, 2008; Noordzij & Postma, 2005; Pazzaglia, Meneghetti, DeBeni, & Gyselinck, 2010; Taylor & Tversky, 1992). As such, the primary goal of this investigation was to determine how culture and recipient perspective affect direction giving in the service of wayfinding.

People provide a variety of details when giving wayfinding directions, including landmarks, street names, distances, directions, turn descriptions, and commands (Golding, Graesser, & Hauselt, 1996; Lloyd, 1991; Mark & Gould, 1995; Ward, Newcombe, & Overton, 1986; Wright, Lickorish, Hull, & Ummelen, 1995). Moreover, there are marked individual differences in the frequency of each cue (Denis, Pazzaglia, Cornoldi, & Bertolo, 1999; Klein, 1982; Vanetti & Allen, 1988). For example, some people provide only the most basic instructions, such as, "left on Main," whereas others provide many additional details, such as descriptions of landmarks, multiple street names, or distances between turns. As mentioned above, directions also may vary across communicators and languages as a function of reference frames (e.g., Levinson, 1996; Levinson, Kita, Haun, & Rasch, 2002; Pederson et al., 1998).

What factors influence the cues included in wayfinding directions? Previous studies have highlighted the importance of two wayfinding strategies or perspectives (e.g., Galea & Kimura, 1993; Kato & Takeuchi, 2003; Lawton, 1996; Lawton & Kallai, 2002; Pazzaglia & DeBeni, 2001; Sholl, Acacio, Makar, & Leon, 2000). A route perspective involves adopting a first-person spatial perspective (e.g., assuming the perspective of the traveler) as the frame of reference. Route directions are like mental tours that include references to segments of the route, as a traveler would

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experience them during locomotion. In particular, they include left and right turns and landmark descriptions that provide a set of procedures for navigating through the environment (e.g., "Go left on Main, you'll see the park on your right"). In contrast, a survey perspective involves adopting a third-person spatial perspective akin to seeing the entire environment at once (e.g., an aerial view or map). Survey directions provide an overview of the environmental layout, where the frame of reference is global in nature (e.g., the sun, a mountain range). When describing how to get somewhere, the most common survey reference frame involves cardinal directions (i.e., north, south, east, and west) and precise distances/streets (Lawton, 1996; Shelton & Gabrieli, 2002; Taylor & Tversky, 1996). These differences between survey and route perspectives parallel the theoretical distinction between configural/survey and route knowledge (e.g., Golledge, 1999; Hirtle & Hudson, 1991; Pazzaglia & DeBeni, 2001; Shelton & McNamara, 2004; Siegel & White, 1975). Although both survey and route perspectives can be effective, people using a route perspective may find it difficult to deviate from the designated route and, thus, are more likely to become disoriented or lost. In contrast, people using an integrated, survey perspective can deviate from a given path, finding effective shortcuts or detours (Lawton, 1994, 2001; Saucier et al., 2002; Siegel & White, 1975).

How might perspective affect direction giving in the service of wayfinding? Adults in the United States tend to use route descriptors more often than survey descriptors when asked to describe environments for listeners (e.g., Taylor & Tversky, 1996). For example, in one classic study, when asked to describe their apartments, 97% of participants provided a walking tour starting at the front door, whereas only 3% of participants provided a survey-like description of the overall layout of their apartments (Linde & Labov, 1975). Developmental research reveals that in the US, older children are more likely to organize their descriptions using a mental tour than are younger children, highlighting the importance of experience (Gauvain & Rogoff, 1989). Similarly, Hund et al. (2008) found that university students living in the Midwestern US provided positive effectiveness ratings for wayfinding directions that contained left-right details. Moreover, they provided more left-right descriptors and landmarks when giving directions for fictional listeners driving through a town. Together, these findings are consistent with the adoption of route strategies/perspectives. It is interesting that this preference for route strategies may be stronger in the US than in other parts of the world, such as Hungary (Lawton & Kallai, 2002), highlighting the importance of cultural considerations.

It is likely that culture influences the relation between perspective and wayfinding. That is, psychological, social, and physical aspects of communities and cultures impact wayfinding, particularly verbal descriptions to facilitate finding one's way. For instance, Evans (1980) highlighted the importance of daily activity patterns for spatial cognition, including wayfinding. In particular, it is critical to consider the ways in which topography, landmarks, and the layout of property boundaries and road patterns interact to shape people's experiences with the environment, as well as their knowledge about and descriptions of their surroundings (Davies & Pederson, 2001; Evans, 1980; Lawton, 2001; Wolbers & Hegarty, 2010, see Carlson, Hölscher, Shipley, & Dalton, 2010 and Hölscher, Büchner, Meilinger, & Strube, 2009 for similar effects resulting from differences in building structure and complexity). For example, in one cross-cultural study, Davies and Pederson (2001) assessed differences in spatial knowledge (e.g., sketch maps, pointing accuracy) for residents of Milton Keynes, England and Eugene, Oregon. Unlike many cites in England, Milton Keynes was designed with a grid system of streets and relatively systematic patterns of street names and address numbering, making it similar to Eugene, Oregon in these respects. Nonetheless, the authors hypothesized that residents of Milton Keynes would be less familiar with the grid system overall, leading to differences in sketch maps and pointing accuracy across cultural groups. As expected, Eugene residents evinced greater reliance on grid features than did Milton Keynes residents when drawing maps of their towns and when pointing to unseen locations.

In a related study, Lawton (2001) assessed regional differences in spatial strategies within the United States by asking adults to provide driving directions to locations in their hometowns. Like many portions of Europe and the world, the patterns of property boundaries and roads in the Northeastern and Southern US are irregular. In contrast, property boundaries and road systems are much more regular (e.g., often following a grid system) in the Midwestern and Western US, due in large part to the United States Public Land Survey. Consistent with these environmental differences and resulting differences in patterns of daily activities, people from the Midwest/West provided cardinal directions more frequently than did people from the Northeast/South when giving driving directions for people finding their way through their communities. Moreover, preferences for cardinal directions increased with age, suggesting an important role of experience. These findings are some of the first to document cultural differences in wayfinding direction features, though additional research would be helpful to understand the nature and locus of similarities and differences across cultures.

The overall goal of this investigation was to specify how culture and perspective impact direction giving in the service of wayfinding. Participants from the United States and the Netherlands were asked to imagine that they were giving directions to a person driving in a town (i.e., using a route perspective) or looking at a map of the town (i.e., using a survey perspective). We expected that the features provided in directions would differ depending on recipient perspective (Hund et al., 2008). Specifically, we predicted that people would use more left-right descriptors and landmarks when addressing someone using a route perspective (i.e., driving) than when addressing someone using a survey perspective (i.e., viewing a map). On the other hand, we predicted that people would use more cardinal descriptors (e.g., north, south, east, or west) when addressing a person using a survey perspective than when addressing someone using a route perspective. Overall, we expected left-right descriptors and landmarks to be included frequently, whereas cardinal directions would be included less frequently, consistent with overall preferences for route strategies. Nonetheless, we expected that participants living in the Midwestern United States would provide cardinal descriptors more frequently than would participants living in the Netherlands, demonstrating an important impact of culture, particularly experience with grid systems of property boundaries and roads. In the Midwestern United States, property boundaries often conform to regular grid systems. In the Netherlands, in contrast, the traditional method of land partitioning is "traditionele blokverkaveling." Similar to the metes and bounds method in the Eastern United States, this method uses natural physical features to define property borders, creating relatively small, irregular parcels of land (Barends, Renes, & Baas, 1991). Furthermore, the US highway system is organized and denoted in terms of cardinal directions. Contrastingly, in the Netherlands, road denotations are more often based on city names or numbers. Altogether, these findings suggest that the cardinal system is less salient in the Netherlands than in the United States (particularly Midwestern and Western regions). It seems likely that people living in the US generally are more accustomed to cardinal concepts and generally make more use of cardinal descriptors than do people living in the Netherlands.

Another goal of this investigation was to specify whether the inclusion of cardinal descriptions was sensitive to changes in task demands. One previous direction giving study by Ward et al. (1986) demonstrated that people massively increased the use of cardinal descriptions when being alerted to the concept of cardinality. Similar effects for spatial descriptions were reported by Tversky (1996). Thus, we tested the impact of providing details about cardinal directions through verbal instructions and pointing versus through a compass rose similar to the ones often included on cartographic maps. Consistent with previous findings, we predicted that the frequency of inclusion of cardinal descriptors would be higher when cardinal directions were mentioned verbally during instructions than when they were noted only in a compass rose.

1. Method

1.1. Participants

Data from 64 participants (32 men, 32 women) who were students at a large, public university in the Midwestern United States were extracted from Experiment 1 in Hund et al. (2008) for reanalysis here. Sixty-seven additional students (33 men, 34 women) from the same university in the Midwestern United States participated in the compass rose instruction group (see details below). Data from one additional participant were omitted from analyses due to experimenter error. Participants received credit in psychology courses. In addition, 50 students (23 men, 27 women) from the Netherlands participated (30 in the verbal instruction group and 20 in the compass rose instruction group).

1.2. Apparatus and materials

The study utilized a 1.2 m × 2 m fictitious model town (see Fig. 1) on a tabletop. Seventeen landmarks (e.g., park, hospital) were depicted using wooden blocks with unique labeled pictures on top (approximately 7.5 cm × 7.5 cm). Twenty-nine streets (e.g., Main St., Ridge Ave.) were depicted using blue lines and printed street names. A red toy car was used to mark the starting locations. Street names and landmark labels were provided in English or Dutch (Hund et al., 2008).

1.3. Design and procedure

During the familiarization phase, participants were given 30 s to study the town. Previous research demonstrated that 30 s was sufficient in preparing participants for the tasks that followed (Hund & Minarik, 2006). For half of the participants, the researcher first noted verbally the four cardinal directions, pointing as each direction was mentioned. For the remaining participants, a compass rose (approximately 17.75 cm × 17.75 cm) in the lower left corner of the model town indicated the cardinal directions. The compass rose indicated the four cardinal directions using arrows and labeled them using the first letter of each direction (i.e., N, E, S, W or N, O, Z, W). The experimenter did not mention the compass rose or the cardinal directions in the verbal instructions for these participants.

Following familiarization, participants completed six trials, three in which they imagined giving directions to a person driving in the town (i.e., using a route perspective), and three in which they imagined giving directions to a person looking at a map of the town (i.e., using a survey perspective). The order of routes and the assignment of routes to perspectives were counterbalanced. On each trial, the car was placed at the starting location, and the destination was noted verbally. Participants then were asked to write down the directions they would give to help someone get from the starting location to the destination. The starting locations and destinations were the hospital and mall, post office and library, tavern and lake, courthouse and gym, bank and arena, and church and gas station (see Fig. 1). Participants were allowed to move around and to take as much time as needed to complete their directions.

1.4. Coding and measures

Researchers coded the frequency with which participants mentioned four descriptive features: cardinal directions (i.e., north–south–east–west), left or right, landmarks (i.e., 17 named landmarks in the model town), and street names (i.e., 29 named streets in the model town). Two coders independently assessed the directions provided by 32 (US) and 12 (Dutch) randomly selected participants (24% of both samples) to assess inter-rater reliability. For the US sample, they agreed exactly on 786 out of 832 categorical judgments concerning descriptive features and accuracy (94.47% exact agreement). For the Dutch sample, the inter-rater reliability was 96.6%. For both samples, this indicated a very high level of inter-rater reliability.

1.5. Data analysis

A graphical examination of the data showed that the outcome variables did not meet the preconditions of ANOVA. For example, *cardinal descriptor frequency* was strongly skewed in the Dutch group, and showed much more variance compared to the US group. Hence, the data violated the ANOVA assumptions of normally distributed and homogeneous residuals. An alternative to linear modeling (with normally distributed error terms) is Poisson modeling, which is a member of the family of generalized linear models (GLM).[1] Although GLMs have the advantage of covering a broad range of response types (counts, durations and rates), they have not yet gained much attention in psychological research mostly because they do not accommodate repeated measures. This situation has changed with the recent advent of generalized linear *mixed-effects* models (GLMM). GLMMs combine the flexibility of GLM with the ability to deal with repeated measures (and even more complex clustered designs, such as multilevel sampling), and they relax the assumptions regarding the variance of residuals.

With count data, the assumptions of ANOVA and linear regression are frequently violated: the residuals show considerable skewness, and heteroscedasticity occurs. In addition, the linear parameters range from $-\infty$ to ∞, which may result in a meaningless prediction of negative counts. The appropriate model for count data is the Poisson-type GLM, which neither assumes homoscedasticity nor a normally distributed error term. Also, the Poisson parameters are estimated on a logarithmic scale, which prohibits negative values. Note, however, that the Poisson-type GLM is not a relaxation of the Gaussian model. It makes different but comparably strict assumptions regarding the variance structure. One remarkable property of the Poisson statistical distribution is the equality of variance and mean. This strict requirement is only met in the ideal case when all variance-generating variables have been measured and are included in the model (Winkelmann, 2008, pp. 127–142). Typically this is not the case, and the residuals of the

[1] Note the difference between *general* and *generalized* linear models. The former unify ANOVA and linear regression. The latter, in addition, cover a greater variety of response variables.

Fig. 1. Overhead view of the model town in the US (top) and Netherlands (bottom) without the compass rose.

estimated model are *overdispersed* – variance is larger than the mean. Ignoring overdispersion may lead to overoptimistic confidence limits of parameters.[2]

Here, we used GLMM, more specifically Poisson-type mixed-effects regression to model the counts of spatial descriptors, thereby accounting for repeated measures and potential overdispersion. Mixed effects models generally relax assumptions on variance of residuals, which is achieved by explicit modeling of the random effects, in addition to the fixed effects. In the Poisson case, the variance between individuals is captured as a random effect, and thereby overdispersion is treated correctly. At the same time, the correlation between measures within a subject is regarded by the model. This is necessary to avoid violating the assumption of independent observations.

[2] Several methods for handing overdispersion have been suggested in the literature, most notably quasi-Poisson models, negative binomial regression, and mixed effects models (Hardin & Hilbe, 2007, pp. 165–182).

The analyses for each outcome variable were guided by the protocol of Zuur, Ieno, Walker, Saveliev, and Smith (2009, pp. 209–243). First, we modeled the random effects. In particular, the model containing all fixed effects (including all possible interactions) and a random intercept for *Subject* was estimated. Then, we introduced a slope random effect for the within-subject factor *Perspective*, which allowed the treatment effect to vary between subjects (Zuur, Ieno & Smith, 2007, pp. 125–142). Note that the introduction of treatment slope differences may have allowed a change of dispersion between treatments, which can be examined by the correlation between the intercept and slope random effects. Next, to find the best fixed effects structure, all possible combinations of main factors and interactions were added to the chosen random intercept structure, resulting in a set of 18 models. For both steps of model selection – random effects and fixed effects structure – the Akaike Information Criterion (AIC) was employed. The AIC is an established criterion for model selection that takes model parsimony into account by imposing a penalty term on the number of parameters. The penalty term reduces the risk of overfitting. Effects arising from sampling error are essentially blocked (Burnham & Anderson, 2004). Unlike the usual omnibus tests (*F*-tests for ANOVA or likelihood ratio tests for GLMs), the AIC also applies when comparing models that are not hierarchically nested.[3]

Model selection by AIC is fundamentally different from null hypothesis significance testing. Whereas null hypothesis testing seeks to reject one model in favor of another, the AIC measures the predictive value of several models relative to each other.[4] Burnham and Anderson (2002) recommend not mixing both approaches. Here, inference was strictly based on strength and precision of estimated coefficients in the selected optimal model. Still, Type 1 error rates are reported in the tables, but without any correction for multiple comparisons.[5]

Another issue to consider was that differences in descriptor frequency could be evident either in an absolute or a relative sense. The problem with absolute frequencies is that there could have been variation in the total number of statements. For example, an experimental condition could have increased the overall number of descriptors, regardless of descriptor type. In addition, differences in wordiness may have existed between individuals. For the research questions addressed here, the relative frequency was more appropriate. Following the suggestion of Zuur et al. (2009, pp. 209–243), we added to the model a fixed term for the total number of spatial statements at each observation, the so-called *offset*. Since the parameters of our Poisson models were on a logarithmic scale, the offset used here was the natural logarithm (base e) of an observation's total sum of descriptors. Accordingly, when in the following sections we mention a *tendency* to employ a certain descriptor, this denotes the tendency relative to all descriptors used. All statistical analyses were computed in the statistical computing environment R (R Development Core Team, 2011) using the library LME4 (Bates, Maechler, & Bolker, 2011) for mixed effects models.

2. Results

The primary goal was to investigate how culture and perspective affected the descriptive features people provided when giving wayfinding directions. Another goal was to specify the impact of noting cardinal directions verbally or using a visible compass rose. Fig. 2 shows an overview of the data for the entire study.

2.1. Cardinal descriptors

For the mixed-effects Poisson regression, we started by modeling the intercept random effects on the full fixed effects model. Adding the slope random effect improved the model fit (lower AIC). Model selection on fixed effects using the AIC arrived at a model comprising all three main factors (i.e., culture, perspective, instruction), an interaction between culture and perspective, and an interaction between culture and instruction.

The tendency to use cardinal terms was higher in the US sample, in the survey condition, and with verbal instruction (see Table 1). The interactions in the model indicated that the increased use of cardinal terms in the survey condition and the condition with cardinal priming was more pronounced in the Dutch sample.

Irrespective of these fixed effects, participants varied in their tendency to use cardinal terms. The inclusion of a random slope in the model suggests that there may be unobserved variables that moderate the effect of perspective. The correlation indicated that participants already having a strong tendency in the route condition to mention cardinal terms showed a lower increase toward the survey condition.

2.2. Landmark descriptors

For landmark descriptors the random slope on perspective did not improve model fit, and an intercept only random effect was chosen. The full model yielded the best fit, comprising all three factors and the two and three way interactions.

Moreover, as can be seen from Table 2, all explanatory variables affected the use of landmark descriptors to a varying degree. Regarding landmark descriptors, one could state that they are complementary to the cardinal descriptors. Specifically, the tendency to use them is much stronger in the Dutch group. The use of landmark descriptors also decreases with verbal instruction and in the route condition. These last two effects are less pronounced for the Dutch participants as can be seen from the interaction effects. The three-way interaction is hard to explain in a meaningful way, was not part of our predictions, and thus will not be discussed further.

The intercept random effect shows that there are unobserved variables that influenced the use of landmark descriptors. This random effect, however, was much smaller than what we found for the cardinal descriptors. Also, the within-subject effect of perspective was mostly determined by the main effect and the three interaction effects, since a random slope did not further improve the model.

2.3. Left-Right descriptors

The random slope on perspective improved the fit over a random intercept only model. Using combined intercept and

[3] The capability of comparing non-nested models is an advantage when several (possibly correlated) explanatory variables are available, and one seeks the optimal combination of predictors. The 2 × 2 × 2 design presented here already features eight coefficients (intercept, three main effects, three two-way and one three-way interactions) in 17 possible combinations. Although Burnham and Anderson (2004) recommend using the small sample corrected version of the AIC (AIC_C) when the number of observations divided by the number of parameters is smaller than 40, application of AIC_C for GLMMs is not routine. Shang and Cavanaugh (2008) present AIC_C for mixed models with Gaussian error terms; however, we could not find support for using AIC_C in Poisson-type GLMMs. As a result, we used the uncorrected AIC.

[4] Rao, Wu, Konishi, and Mukerjee (2001, pp. 1–64) show how to select models by hypothesis testing and discuss the limitations thereof. Cohen (1994) pointedly criticizes the practice of null hypothesis significance testing.

[5] Note, that in virtually all our regressions, the Type I error on the main factors of interest is low enough to withstand even the most conservative adjustment for experiment-wise error on a 5% level, if we would have followed the null hypothesis testing philosophy.

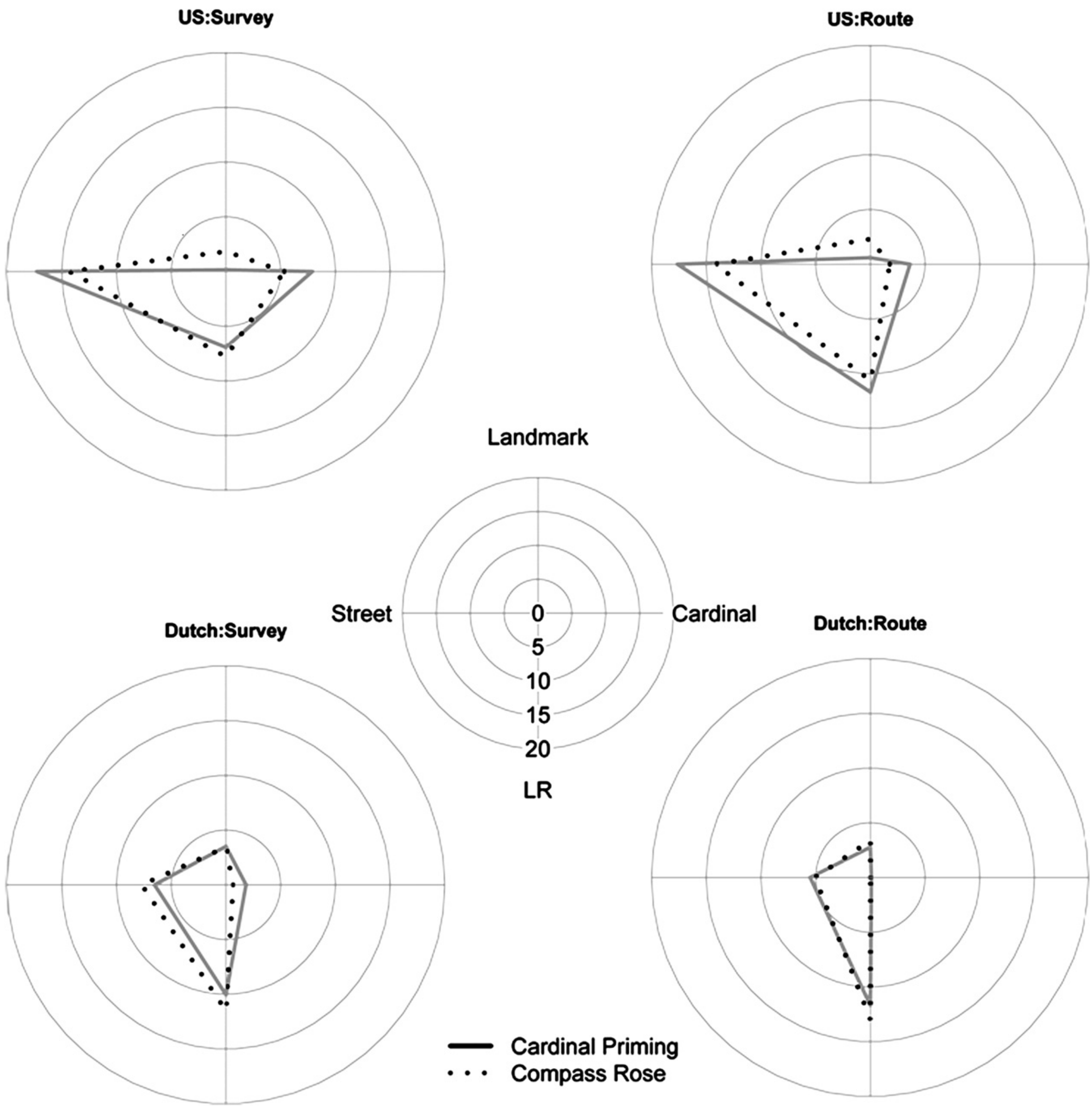

Fig. 2. Radar charts showing the mean for the four different descriptors (Cardinal descriptors, Left/Right, Street names, and Landmarks). Each radar chart refers to a particular combination of Culture and Perspective. The solid (gray) lines represent the data from the condition with cardinal priming. The dashed (black) lines show the data from the condition with only a compass rose. The scale (for the mean frequency) and legend for the radar charts are depicted in the center.

Table 1
Parameter estimates of the Poisson regression on use of cardinal terms.

Fixed effect (target group)	Beta	Std error	*z*-value	Pr(>|z|)
(Intercept)	−1.693	0.147	−11.519	<0.001***
Dutch culture	−1.607	0.326	−4.935	<0.001***
Compass rose instruction	−0.631	0.202	−3.13	0.002**
Route perspective	−1.266	0.145	−8.71	<0.001***
Dutch culture: compass rose instruction	−1.302	0.716	−1.818	0.069+
Dutch culture: route perspective	−2.024	0.864	−2.342	0.019*
Random effect (target group)	Var	SD	Corr	
Intercept	1.288	1.135		
Route perspective	1.630	1.277	−0.405	

Table 2
Parameter estimates of the Poisson regression on use of landmark terms.

Fixed effect (target group)	Beta	Std error	*z*-value	Pr(>|z|)
(Intercept)	−5.625	0.347	−16.22	<0.001***
Dutch culture	3.674	0.38	9.663	<0.001***
Compass rose instruction	2.624	0.368	7.123	<0.001***
Route perspective	1.291	0.375	3.439	0.001**
Dutch culture: compass rose instruction	−2.642	0.442	−5.973	<0.001***
Dutch culture: route perspective	−1.448	0.404	−3.588	<0.001***
Compass rose instruction: route perspective	−1.055	0.395	−2.671	0.008**
Dutch culture: compass rose instruction: route perspective	1.291	0.456	2.831	0.005**
Random effect (reference group)	Var	SD		
Intercept	0.412	0.642		

Table 3
Parameter estimates of the Poisson regression on use of left-right descriptors.

Fixed effect (target group)	Beta	Std error	*z*-value	Pr(>|z|)
(Intercept)	−1.534	0.05	−30.823	<0.001***
Dutch culture	0.719	0.066	10.932	<0.001***
Compass rose instruction	0.168	0.062	2.708	0.007**
Route perspective	0.467	0.055	8.534	<0.001***
Compass rose instruction: route perspective	−0.12	0.069	−1.751	0.08+
Dutch culture: route perspective	−0.187	0.073	−2.558	0.011*
Random effect (target group)	Var	SD		
Intercept	0.048	0.219		

slope random effects, the model selection procedure arrived at a fixed effects structure comprising the three main effects and an interaction of culture and perspective. There were, however, two issues with this model (Table 3).

First, although the chosen model had the lowest AIC, the Instruction effect was very small (*Beta* = 0.065). Indeed, the AIC value only increased marginally by 0.22 when removing the Instruction factor. Whereas in general, the absolute difference between AIC values cannot be interpreted, the relative differences within a set of models can be interpreted. In this case, for example, removing the Culture x Perspective interaction increased the AIC by 4.04.

The second issue regards the correlation of intercept and slope random effects. The random slope indicates the degree of participants' variation on how much the perspective treatment influences their tendency to employ left-right descriptors, and here, however, the correlation was exactly −1, denoting that the slope variation was completely determined by the random intercept. We can think of two reasons why this may have happened: Either the model was over-parameterized or the numerical optimization was trapped in a local maximum. We cross-checked the results using another implementation for GLMMs that follows the Bayesian paradigm (Hadfield, 2010). Using uninformative priors, this program terminated with an error. To be on the safe side, we decided to proceed by dropping the random slope from the model.

Using the intercept-only random effects structure, the selection procedure arrived at a model comprising all three main effects and two two-way interactions: Dutch participants used far more left-right descriptors; and the route perspective had a strong stimulating effect, which was more pronounced in the US group. Verbal instructions slightly dampened the use of these descriptors, but with verbal instructions the stimulating effect of the route perspective was slightly stronger.

2.4. Street names

The random slope for street names did not improve the model fit. The best model according to the AIC included the three main effects and an interaction between culture and perspective to predict use of street names. Dutch participants had a lower tendency to use street names, whereas cardinal instruction slightly stimulated the use of street names. There was no general effect of perspective, but there was an interaction: for Dutch participants the route perspective slightly inhibited the use of street names but stimulated it in the US group. It was noteworthy that due to the very small random effect, virtually no further individual differences seemed to exist. A person's tendency to use street names in the present experiments appeared fully determined by the predictors (Table 4).

Table 4
Parameter estimates of the Poisson regression on use of street names.

Fixed effect (target group)	Beta	Std error	*z*-value	Pr(>|z|)
(Intercept)	−0.635	0.027	−23.592	<0.001***
Dutch culture	−0.509	0.059	−8.648	<0.001***
Compass rose instruction	−0.069	0.031	−2.253	0.024*
Route perspective	−0.009	0.031	−0.297	0.766
Dutch culture: route perspective	−0.178	0.087	−2.04	0.041*
Random effect (target group)	Var	SD		
Intercept	0.004	0.060		

3. Discussion

The primary goal was to examine how culture and recipient perspective affected the descriptive features people provided in wayfinding directions. As predicted, participants provided cardinal descriptors, landmarks, left-right descriptors, and street names with varying frequencies depending on recipient perspective and culture. First, participants from the United States have a far stronger tendency to mention cardinal terms than Dutch participants. In particular, the number of people who mentioned cardinal terms was much higher in the US sample than in the Dutch sample. In the condition with the compass rose (thus without verbal cardinal instruction), only one out of 20 (5%) Dutch participants ever mentioned a cardinal term, whereas in the US sample, 58% (Route condition) and 69% (Survey condition) of the sample mentioned cardinal terms. In the spatial cognition literature, effects of this magnitude typically are described in relation to differences between Western and Non-Western cultures (Levinson, 2003). This study demonstrates these types of categorical differences in spatial language use between two Western cultures, whereas previous spatial language research has been reported involving either Dutch or US participants ignoring this cultural factor. These cultural details will be discussed further below.

Second, participants from the United States and the Netherlands included more cardinal descriptors when addressing someone looking at a map of the town (survey perspective) than when addressing someone driving in the town (route perspective). This finding replicated and extended the findings presented in Hund et al. (2008). The behavior of the US participants is replicated here (in the compass rose group), while we show for the first time that the Dutch adapted their use of cardinal terms to the perspective of the recipient. An interaction indicated that the tendency to mention more cardinal terms in the survey condition was even more pronounced for the Dutch participants.

Third, participants provided cardinal descriptors more frequently when primed by verbal instructions noting the cardinal directions than when viewing a compass rose. This cross-cultural effect replicated a study by Ward et al. (1986), who also showed strong increases in the use of cardinal terms after explicit mentioning of these terms at the start of the experiment. In everyday interactions, priming of cardinal terms by pointing and verbal labels seems rare, whereas reading a map that includes a compass rose seems more common and thus more ecologically valid. In these situations, it is clear that the Dutch very rarely use cardinal terms. Additional research probing the impact of problem-solving context would be helpful, particularly specifying the impact of problems and solutions involving global positioning devices that provide details utilizing survey and route perspectives.

As expected, participants from the United States and the Netherlands mentioned left-right descriptors more frequently when addressing someone driving in the town (route perspective) than when addressing someone looking at a map (survey perspective). In contrast, participants mentioned cardinal descriptors more often in the survey than in the route perspective. These findings reveal that adults flexibly adapt their directions to the needs of their recipients, consistent with a growing body of literature demonstrating such adaptability (Hölscher, Tenbrink, & Wiener, 2011; Newman-Norlund et al., 2009). The findings also reveal important cultural similarities and differences. Overall, participants living in the Midwestern United States evinced a pattern favoring cardinal descriptors for the survey perspective and left-right descriptors and landmarks for the route perspective. Participants from the Netherlands evinced a similar pattern with the important distinction that they mostly ignored cardinal terms, unless explicitly primed and in a survey condition. In addition, this low usage of cardinal terms seemed to be replaced by using more landmark and left-right descriptions. Finally, participants in the US mentioned more street names but fewer left-right descriptors than participants from the Netherlands. This difference was not predicted, but usage of these two types of terms is clearly related. When a participant mentioned many left-right terms the description tended to become very procedural, omitting precise street names ("turn left at the first street, and then right at the third street, etc…"). We contend that psychological, social, and physical aspects of communities and cultures impact wayfinding, as well as verbal descriptions to facilitate finding one's way. For instance, topography, landmarks, and the layout of property boundaries and road patterns impact people's experiences with the environment, as well as their knowledge about and descriptions of their surroundings (Davies & Pederson, 2001; Evans, 1980; Lawton, 2001). Linguistic differences related to reference frames and other communicative conventions also are important (Levinson, 2003).

Overall, the present findings are an important demonstration that communicators adapt their message depending on the recipient. What processes might underlie this adaptive process? It is possible that the differences in feature frequency across recipient perspectives and cultures resulted from participants' shifts in perspective in light of recipient task demands (Golledge, 1999; Hirtle & Hudson, 1991; Pazzaglia & DeBeni, 2001; Shelton & McNamara, 2004; Siegel & White, 1975; Taylor & Tversky, 1996). To avoid confusion, direction givers and receivers must coordinate their efforts by selecting an appropriate reference frame, assessing the familiarity of the environment, understanding their individual skills and preferences, and making use of communicative conventions for providing directions (Allen, 2000; Carlson-Radvansky & Radvansky, 1996; Golding et al., 1996; Levinson, 1996; Lloyd, 1991; Taylor & Tversky, 1992; Ward et al., 1986; Wright et al., 1995). For instance, Golding et al. (1996) found that when approached by a student requesting wayfinding directions, participants asked clarifying questions to be sure they were describing the correct destination and to assess the requester's knowledge of the campus. In another recent study, Newman-Norlund et al. (2009) found that participants adapted their non-verbal communication during game playing in response to their beliefs that they were interacting with a child or an adult (i.e., moving more slowly, particularly pausing at target locations, when they believed they were interacting with a child), demonstrating nuanced abilities to tailor their messages for specific partners (see also Clark & Carlson, 1982; Levinson, 2006; Ozyurek, 2002). Together, these findings illustrate the importance of recipients in shaping communication. Broader sociocultural factors also impact communication. For instance, one recent analysis suggests that Japanese tourist books include many maps, whereas US tourist books include linguistic descriptions (Suzuki & Wakabayaski, 2005). Clearly, pragmatic considerations are important during communicative exchanges.

Wayfinding using verbal directions is a complex, dynamic process that depends on features of the direction giver, the direction recipient, and the environment and task at hand. For example, our findings indicate that direction givers appreciate the perspective of the recipients of wayfinding directions—the descriptive features they provide depend on the recipient's perspective (see also Galea & Kimura, 1993; Hund & Minarik, 2006; Lawton & Kallai, 2002; Saucier et al., 2002). The structure of the physical environment also shapes wayfinding processes. For instance, participants from the Netherlands provided more landmarks than did participants from the United States, whereas participants from the United States provided more street names than did participants from the Netherlands. These findings generally are consistent with reliance on unique landmarks when layouts and vistas are irregular (as in much of Europe) in contrast to reliance on street names (and numbering) when layouts and labeling are more regular (as in the Midwestern United States). The nature of the wayfinding task faced by direction givers and receivers affects their interactions. For instance, providing verbal labels for the cardinal directions during familiarization increased the frequency of mention of cardinal descriptors, as expected.

As mentioned above, US and Dutch participants differed in their use of cardinal terms. The Dutch typically did not make much use of the cardinal terms. Anecdotally, there were a number of Dutch participants who were quite frustrated by the switch from the route perspective to the survey perspective. They realized there might be a more effective way of describing the route on the map, but never came up with the idea to switch from left-right descriptors to cardinal terms. Yet, there is something very odd about the Dutch reluctance to produce cardinal terms. As mentioned in the Introduction, survey descriptions are defined (amongst other things) by the fact that they contain cardinal terms. A number of recent studies have involved asking Dutch people to listen to and remember survey (and route) descriptions (Noordzij & Postma, 2005; Noordzij, Zuidhoek, & Postma, 2006). These studies consistently show that Dutch participants have better spatial memories from survey descriptions containing cardinal terms than from route descriptions containing left-right terms! At first sight, this finding might seem to be in direct contradiction to the present findings, but there is an obvious explanation, which might actually have strong applied value. In the spatial memory studies, participants were tested on their knowledge of the cardinal directions before the learning began, and what Dutch participants typically seemed to do was a rapid recoding of the cardinal directions in the following manner: "*OK, so North is above, South is below, East is to the right and West is to the left*." If this mental mapping is repeated during the actual listening or reading of a spatial survey text, then one could argue that the depth of processing of survey texts is more pronounced than is the depth of processing of route texts. In addition, one could argue that in learning a survey text, Dutch people form some kind of dual code in that a relation is memorized both in terms of a cardinal and a relative term. Apparently memories containing these dual codes (from survey texts) are superior to memories containing single codes (route texts; see the seminal work of Allan Paivio (1971, 1983) on dual coding and Meilinger, Knauff, & Bülthoff, 2008 for details related to wayfinding).

In a recent study, this idea was put to the test by finding out the most effective way to describe census data to people who are blind (Thomas, Sripada, & Noordzij, 2012). Census data often contain information about the frequency distribution of demographic variables (i.e., incidence of crime in different regions in a country). These data typically are illustrated using a map with different colored regions. For people who are blind, these maps are inaccessible, and therefore spatial descriptions are an obvious alternative. The recent study included single descriptions (e.g., "crime was highest to the east") and composite descriptions containing two different spatial terms (e.g., "crime was highest to the east and to the right"). As expected, participants who were blind always favored the composite descriptions over the single descriptions. For the Dutch, these composite descriptions may be forced when they are confronted with cardinal terms (i.e., they have to recode it), but in general, it might be effective to provide spatial terms from different categories (e.g., cardinal and relative) to describe one spatial relation. For example, spatial descriptions for critical everyday tasks could incorporate multiple cues (e.g., the hospital is to the east/to the right). Additional research is needed to test the impact of providing multiple descriptions to facilitate later recall and problem solving in everyday contexts.

In summary, the present findings show that wayfinding directions depend on culture and recipient perspective. In particular, adults are skillful in adapting the descriptive features they provide to match the needs of their listeners attempting to find their way through an environment. These findings confirm that direction giving and following are dynamic processes that depend on interactions between those providing directions, the recipients of such directions, and their experiences giving and following directions to navigate through environments (Hirtle & Heidorn, 1993; Montello, Hegarty, Richardson, & Waller, 2004; Newcombe & Huttenlocher, 2000; Plumert, Carswell, DeVet, & Ihrig, 1995, Plumert, Spalding, & Nichols-Whitehead, 2001; Schober, 1993, 1995; Shelton & McNamara, 2004; Taylor, Naylor, & Chechile, 1999). One limitation of the present project was its reliance on a tabletop model town. It is not clear whether the present results would generalize to larger spaces, though a previous report revealed similar patterns of features in wayfinding directions involving this model town and a familiar city provided by the US participants (Hund et al., 2008). Additional cross-cultural research is warranted to further specify the nature and locus of similarities and differences in wayfinding and spatial thinking more broadly. These findings will add to our growing understanding the dynamic processes involved in skillful communication and wayfinding.

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