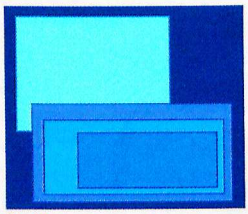

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Contents:

Language-specific information structure in German and Spanish route directions

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Abstract

This paper investigates which linguistic resources speakers use to produce understandable and coherent route directions. These resources include how the information flows from one sentence to the next, how the information is mapped onto the topological route and how this information is encoded linguistically in order to be organized into a text.

The aim of this paper is to show that syntactical differences between Spanish and German (the marking of subordination and the boundary crossing constraint) have consequences for the way the information is structured in route directions. The analyses are based on a corpus of 124 empirically collected route directions. The results include language-specific differences regarding information flow and information packaging.

Keywords: route directions, language specificity, Spanish-German contrast, language relativity, linearization, information structure

Resumen

En este artículo se investigan los recursos lingüísticos que los hablantes utilizan para producir instrucciones de ruta coherentes y comprensibles. Estos recursos incluyen el manejo del flujo de información de una frase a la siguiente, la distribución de las informaciones sobre los tramos de la ruta y la codificación lingüística de la información para ser organizada como un texto.

El objetivo del artículo es demostrar que las diferencias sintácticas entre el español y el alemán repercuten en la microestructura de las instrucciones de ruta, de forma que aparecen patrones característicos para cada idioma. Estas diferencias incluyen

la subordinación y la restricción del cruce de frontera en las lexicalizaciones de eventos de movimiento. Los análisis están basados en un corpus de 124 instrucciones de ruta recogidas empíricamente. Los resultados consisten en patrones diferentes y característicos para cada idioma que afectan el flujo y el empaquetamiento de la información.

Palabras clave: instrucciones de ruta, especifidad lingüística, contraste alemán-español, relatividad lingüística, linealidad, estructura de la información

1. Introduction

Navigation and wayfinding are important skills required to reliably locate food sites and other resources, return home, or migrate between known locations. Even though wayfinding is an essential survival skill, not much is understood about how people organize spatial knowledge to communicate it to others using language.

Modern technological navigation aids, such as GPS navigation devices, are based on visual interactive representations of the surroundings, and although they usually employ spoken instructions, these are meant to complement the visual instructions and can often not be used on their own. Even if only spoken instructions are used, such instructions are not custom-made for individual languages, but are usually translations from English. In addition, directions produced by navigation devices are not part of a (natural) discourse but merely step-by-step instructions not intended to be integrated into a (coherent) text.

Little is known about how people organize spatial information to form a spoken or written text for giving route directions. But even less is understood about if and to what extent languages differ in the way they organize and structure spatial information. This paper attempts to fill this gap by identifying language-specific patterns in route directions produced by German and Spanish native speakers. In particular, it investigates the question of to what extent the processes of selection, linearization and verbalization of information, which are fundamental elements of the speech production process, are brought about by language.

The structure of the paper is as follows: Section 2 describes the theoretical background. Section 3 focuses on the methodology and includes descriptions of the experimental procedure, the route of the experiment, the participants in the study and the coding of the data. This last section also includes the definition of the key terms specially introduced for this study. Section 4 postulates the hypotheses tested in the present investigation. Section 5 presents a visualization of the data base. Section 6 list

the results of the study. In section 7 the results are discussed. Section 8 finishes with a short conclusion summarizing the findings. The paper also includes an appendix in section 9.

2. Theoretical background

Researchers on human navigation have often assumed that spatial knowledge is similar to a cartographic representation, to the point of calling it a *mental map*. However, the question of whether spatial information acquired through experience is really organized like a mental map remains controversial (Eichenbaum et al., 1999). Regardless, a spatial representation of any kind in the mind must be either encoded as 2D or 3D. Both of these are more dimensions than language encoding permits: in translating experiential spatial information to language, a reduction in the number of dimensions has to be made, since language is always one dimensional and linear (with the exception of sign language). The task the speaker faces is known as *linearization* (Ferreira and Henderson, 1998; Habel and Tape, 1999; Levelt and Indefrey, 2000).

When descripting a route direction, there are two *linearization principles* speakers can employ: (1) the temporal principle and (2) the spatial principle. The first principle is the Principle of Natural (or Chronological) Order, which says that normally situations or events are reported in the order in which they occur (cf. Labov, 1972; Clark, 1974; Schmiedtová, 2004). The second principle is the Principle of Topological Order (Delucchi Danhier, 2015b). Following this principle, events, or the state of affairs surrounding them, should be reported beginning with the one taking place closest to the beginning of the route followed by the events/circumstances taking place subsequently further away from the starting point and finishing with the situations occurring at the final goal.

It is difficult to discern for sure which of these two principles a speaker is actually following, since in most cases both render the same ordering of events/circumstances: the imaginary walker has to first do or experience the events/circumstances that are placed near the starting point of the route. This is because space and time are logically bounded in route directions (since people cannot teleport) and because the deictic anchoring is placed with the imaginary walker (Klein, 1982; Delucchi Danhier 2015b). Although the present paper focuses on the results of linearization, it is still important to keep in mind that speakers must follow one of these principles (or maybe a third one still unknown to us) when linearizing information for speaking.

When giving a route direction, speakers have to select the relevant pieces of information from memory (*selection*), put them in an ordered sequence (*linearization*)

and organize them linguistically (*formulation*). These three processes together constitute the task of giving a route direction. While the formulation process is obviously dependent on the language the speaker uses, it is unclear whether or not the selection and linearization processes are also brought about by language.

In line with Levelt's language production model (1989) we assume that conceptual planning (*conceptualization*) has to take place prior to formulating language. Within conceptualization four subprocesses can be differentiated: segmentation, selection, structuring, and linearization. The first two are subprocesses considered to form the *macroplanning* that involves deciding *what to say*. The other two subprocesses, structuring and linearization, form the *microplanning* that operates on the level of *how to say what you have decided to say*. Microplanning is assumed to be language-specific because speakers have to take into consideration grammatical categories that are obligatory in a particular language (Levelt, 1999: 93).

Evidence has shown that these abstract planning stages have already been influenced by the grammar and lexicon of the mother tongue of the speaker (Levinson, 1996; Majid et al., 2004). By solving non-linguistic tasks such as categorization, ordering or remembering, subjects act in ways which are driven by the conceptual categories of their mother tongue.

A number of studies within the "thinking-for-speaking" paradigm compared data based on various linguistic tasks (e.g., retellings, verbalizations) performed by speakers with different language backgrounds. This research has shown that differences in language reflect differences in the underlying grammar, which in turn can be linked to conceptual differences. (cf. Slobin, 1996; Schmiedtová, 2013; v. Stutterheim et al., 2002; v. Stutterheim and Nüsse, 2003).

The present study follows the latter line of research by contrasting two languages that differ with respect to structural features (i.e. syntax) that are expected to play a crucial role in the linguistic task of giving route directions, so that it should be possible to find language-specific patterns in route directions from speakers of different languages. Different patterns are expected to emerge on the level of the microstructure of the texts and not on the macrostructure. The reason is that all participants described the same route and so the information selection on the macrostructure is by and large determined by the task and the route to be described.

This explains why route directions have rarely been investigated from a comparative perspective: the language-specific effects to be found are inevitably going to be very subtle and elusive, since all speakers – independent of the language they speak – have to submit to strong genre-specific requirements (for the most in-depth

comparative investigation of route directions to date see Delucchi Danhier, 2015b). Fixed domains in these cases are for example the agent (the imaginary walker), the temporal anchoring (present or future) and the deictic anchoring (usually by the imaginary walker, seldom by the speaker). As a genre, route directions are well suited to a contrastive study of microstructure because, being texts that arise guided by such strong linearization principles, there is less intralanguage variation of the texts than in other genres such as narrations.

Spanish and German were selected as contrasting languages to study the microstructure of route directions, because these two languages differ with respect to two syntactical features: 1) the way they organize information referring to motion and 2) how they mark subordination.

The two languages have different ways of marking subordination syntactically: in German, subordinate clauses are introduced by a subordinating conjunction (*dass, ob, weil, wenn,* etc.) or in the case of relative clauses, a relative pronoun (*den, der, welche,* etc.). The conjugated verb is placed at the end of a subordinate clause. This movement of the conjugated verb to the postposition in subordinate clauses contrasts with the SVO order of German main clauses. Main and subordinate clauses are separated by commas in German (Example 1).

In Spanish, subordinate clauses can be annexed to main clauses by simply using the conjunction *que* (Example 2). When other conjunctions are used, some of them require that the verb in the subordinate clause be conjugated in the subjunctive mood (Example 3). Main and subordinate clauses are not graphically marked in written Spanish. The syntactic word order of main and subordinate clauses does not differ in Spanish.

(1) Gehe durch die Tür,

Go through the door

die du am Ende des Ganges siehst.

that you at the end of the corridor see

(2) Cruza la puerta

Cross the door

que ves al final del pasillo.

that you see at the end of the corridor

(3) 5 {Cuando llegues al final} (Subject SPA13)

When you come (subj.) *to the end (of the corridor)*

6 {...} tuerce a la derecha.

turn to the right

In the domain of the expression of motion, Spanish belongs to the verb-framed language group, while German is a satellite-framed language. This means that the information referring to the direction of movement is encoded differently: in Spanish the direction of movement is generally encoded in the verb (*subir, entrar, cruzar, avanzar, ir*), while in German it is frequently encoded in a satellite to the verb (as a verb particle or prepositional phrase, e.g., *entlang, vorbei, zum Ziel*) with the verb used to encode manner of motion (cf. Slobin, 1996; Talmy, 2000).

(4) Er rennt die Treppen hinauf.

He runs the stairs upwards

(5) Sube las escaleras corriendo.

(He) ascends *the stairs running*

These lexicalization patterns reflect preferences in the packaging of information rather than obligatory structures for the expression of motion. However, in the specific case of motion by crossing a (conceptualized) boundary (such as a door, a street or some other limitation), this structure is obligatory in Spanish. This is known as the *boundary crossing constraint* (Slobin and Hoiting, 1994). The crossing of a boundary can only be expressed in Spanish using verbs specialized for this function such as *cruzar, entrar* or *salir* (Example 8). In cases where verbs not specialized for crossing a boundary are used, the movement takes place inside the boundary (Example 7).

(6) Laufe ins Haus hinein.

Run into the house

(7) * Corre adentro de la casa.

Run inside the House

(8) Entra en la casa corriendo.

Enter the house running

Route directions are a genre in which motion verbs are used extensively. Contrasted with the event verbalizations that are often used to study lexicalization patterns, route directions have the added complexity that the motion information has to be integrated into a whole coherent text. Route directions have been studied with respect to their linguistic content and dialogue structure (Habel, 1988; Klein, 1979, 1982; Wunderlich and Reinelt, 1982; Meier et al., 1988), but not many studies have looked at the information structure of route directions, even though some others have studied the information structure of texts using other kinds of instructions (Kohlmann, 1992) or descriptions of urban areas (Carroll, 1993; Chuang, 2010).

The term information structure is used here to describe how sentences are linked to each other to form a coherent text. In a coherent text, the interpretation of any given sentence in the text has to consider the content of the preceding sentence (and sometimes the following sentences as well). A text can be considered a structured whole that answers a (not always explicitly stated) *quaestio* or question (Klein and v. Stutterheim, 1991). The sentences of a text can be divided into those that directly answer the *quaestio,* advance the theme of the text and convey information belonging to the skeletal structure of the discourse; and those sentences that only play a secondary role in the text because they do not directly advance the action. These sentences merely amplify or comment on the information of the foreground. This differentiation has been called foreground/background (Hopper 1979) or main structure/side structure (cf. Levelt, 1989; v. Stutterheim and Klein, 1987).

In complex texts, subordination is one of the structures used to maintain coherence and to differentiate between foreground and background. As a rule, main clauses are considered to express foreground information while subordinate clauses express background information. The reason for this is that subordinate clauses are presupposed, and hence should contain given information (Givón, 1979). Subordination is understood in this paper to cover both embedding (e.g., relative clauses) as well as the combining of clauses by connectives (a distinction from Matthiesen and Thompson, 1988). Independent clauses code foreground information while dependent clauses code background information (Tomlin, 1985: 85). These correlations have, however, been put into question. Thompson (2002) for example studies complement clauses found in conversations that semantically contain the main assertion of the utterance, even though they are grammatically subordinate. In these cases, the main clause merely provides the speaker's stance to what is said in the subordinate clause (Thompson, 2002:134). A study by Schmiedtová and Sahonenko (2012) on tense switching in written narratives has also shown that the distinction between foreground and background does not always coincide with the syntactic division between main and subordinate clause, and that foreground information can appear in subordinate clauses. McGloin (2014) also investigated subordinate constructions in Japanese

(complement clauses that use *to* and *koto*) and postulated that subordinate clauses can present different degrees of subordination: the more syntactically independent clauses are, the more foregrounding effects they project.

The task of giving a route direction comprises the selection of the relevant pieces of information from memory, the linearization of this information and the formulation of the linguistic material. We assume that these three processes are brought about by language. This is why we compare route directions by Spanish and German speakers by searching for language-specific patterns in the microstructure. Differences are expected to be found in the lexicalization pattern of motion events and in the marking of subordination.

3. Methodology

To investigate the research questions an experiment was conducted to gather a large database of 124 written route directions. This section explains the experimental procedure, the specifics of the participating subjects and the coding and analysis of the data.

3.1. Experimental procedure

All effort was made to make the experimental design as natural and near to a real world experience as possible.

Participants read instructions in their native language (Spanish or German) which said that they were participating in a wayfinding experiment. The task was to first familiarize themselves with the surroundings and then to guide a person who had never been in the building to a predetermined goal by giving written route directions. The instructions were also explained to the participants orally. In both modalities, participants were told that another person would have to follow their written instructions afterwards. The stimulus question and all instructions to the participants were given in their native language.

The participants had as much time as they needed to explore the surroundings and were told in advance what the final destination of the route was. This goal was a bulletin board on a wall approximately 50 meters away. After the participants decided they were familiar with the surroundings, the experimenter took them to the beginning of the route and oriented them facing the final goal. The experimenter then asked: ¿Cómo llego al tablón de anuncios? / Wie komme ich zum Schwarzen Brett? (English: *How do I get to the bulletin board?*). The participants then wrote down the directions

on a sheet of paper. All participants gave written route directions for the same route. All participants were paid for taking part in the study.

3.2. The route

The route that participants had to describe had a length of about 50 meters. Participants were placed at the starting point (see Figure 1 – marked as 0 at the bottom left). The final goal was a bulletin board (see Figure 1 – marked as 14 in the middle at the top). The shortest way to get from the fixed starting point to the goal was by crossing through a series of corridors and doors. It was also necessary to change directions several times: twice clockwise (see Figure 1 – at the points marked 3 and 9) and once counterclockwise (see Figure 1 – marked as 12).

Figure 1: map of the route with the numbered segments in which the way was divided

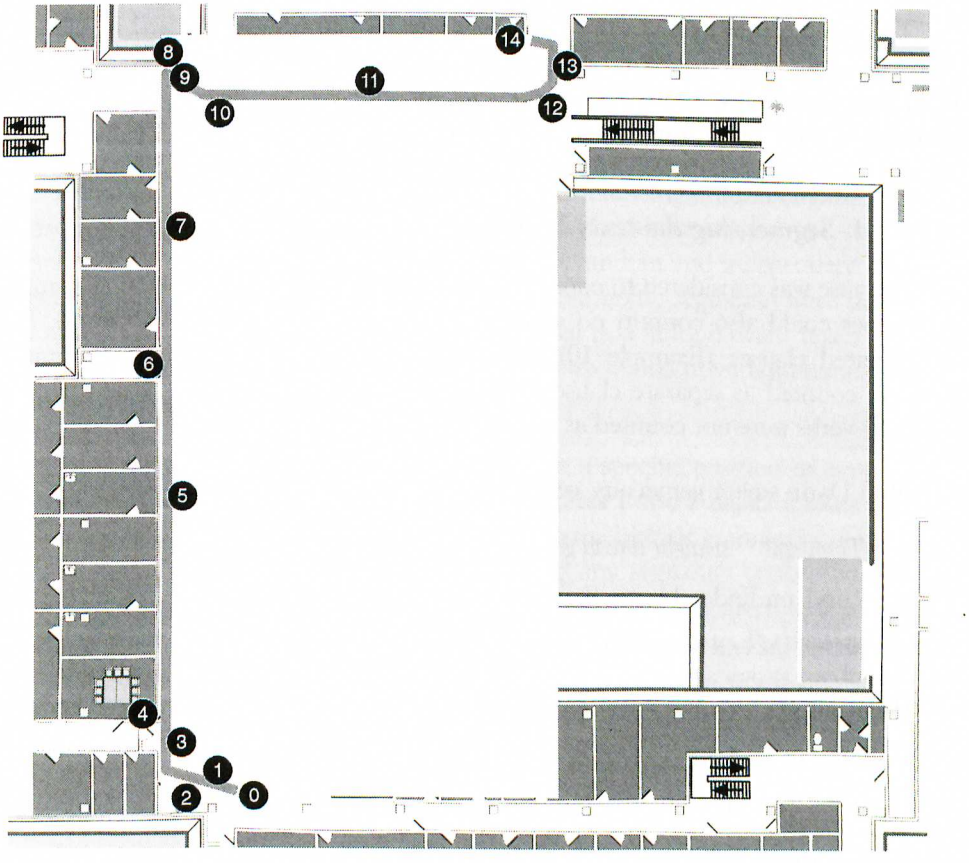


Table 1: Gender distribution of participants

Language	Participants
Spanish	32 f and 30 m, N = 62
German	32 f and 30 m , N = 62

All participants were unfamiliar with the surroundings of the route before the experiment took place. Directions provided in such an experimental setup were therefore based on short term memory. This was important, because when participants already know the route they have to describe, different strategies for information retrieval are activated (Atkinson et al., 1968).

3.3. *Data coding*

The hand written route directions were transcribed and segmented in clauses. Each clause was coded for the following aspects: (1) information category (action, localization, landmark and specification – for more details see below); (2) particular segments of the route; (3) information status (+/-subordination).

3.3.1. *Segmenting the texts in clauses*

A clause was considered to contain no more than one conjugated verb (Example 9). Clauses could also contain no verb (Example 10). Elliptical uses (Example 11), subordinated clauses (Example 10), and embedded subordinate clauses (Example 12) were counted as separate clauses (as marked with curly brackets). Clauses with nonfinite verbs were not counted as separate clauses (Example 13).

(9) 3 Dann weiter geradeaus gehen (Subject GER20)

Then still straight ahead go

4 und am Ende biegen Sie rechts

and at the end turn (imp, formal) to the right

(10) 1 Direkt hier durch die Tür, (Subject GER61)

Directly here through the door

2 über die 345 steht.

over which 345 stands.

3 Dann sofort rechts durch die Tür

Then immediately to the right through the door

(11) 1 Du gehst durch diese Türe (Subject GER55)
You go through this door

2 und dann rechts durch die nächste Türe.
and then to the right through the next door

(12) 7 und gehst weiter geradeaus bis {...} (Subject GER04)
and (you) go further straight until

8 {du zu einer Treppe kommst}. *you to some stairs come*

(13) 3 sigue el pasillo pasando entre dos puertas. (Subject SPA14)
follow the corridor passing through two doors

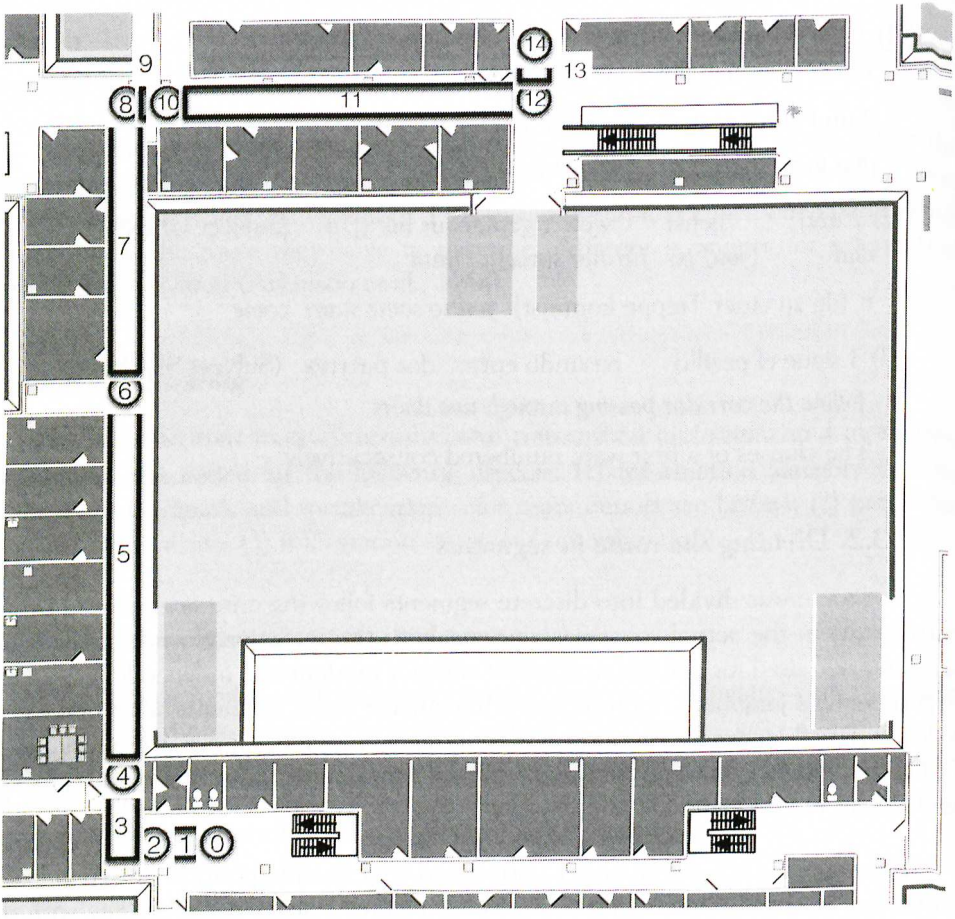
The clauses of a text were numbered consecutively.

3.3.2. *Dividing the route in segments*

The route was divided into discrete segments following criteria employed by the participants in the actual route descriptions, with the intention that the conceptual segmentation used for defining a segment was not random and independent from the experimenter's judgment. Considering all available texts, segments were defined as follows: (1) All landmarks conceptualized as a goal in a motion event (even numbers in Figure 1 and 2); (2) The distance separating two consecutive landmarks (uneven numbers in Figure 1 and 2).

Segments can therefore either correspond to a specific position or expand over a distance of several meters in the real world. Figures 1 and 2 depict a route with the highest possible number of segments and therefore the highest granularity of the route. This segmentation provides a tool for capturing any segments conceptualized and verbalized by the participants. The degree of granularity of any given text is therefore either as dense as in the depictions in Figure 1 and 2 or less dense. Participants were of course not aware of this segmentation tool. Hence not all participants produced texts that referred to each of the segments.

Figure 2: Even numbered segments are defined by landmarks used as goals; uneven segments by the distance between two consecutive landmarks



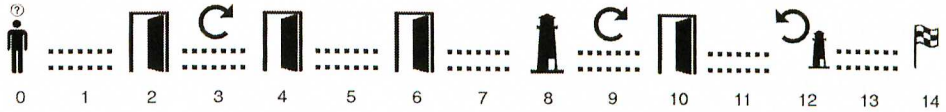
The segments have different physical properties. This leads to differences in how people talk about them. Figure 3 shows the principal physical characteristics for each segment of the route. The physical makeup of every segment is a necessary piece of information for the understanding and the interpretation of the visualizations of the data (cf. Section 5).

The segments can be described as follows:

Table 2: definition and physical properties of the segments of the route

Nr.	Description of segment	physical properties
0	beginning of the route	corridor
1	corridor to the first door	corridor
2	Door	door (boundary)
3	Corridor	corridor, place to turn
4	open glass door	door
5	corridor with open labs at the left side	corridor
6	two fire doors one after another	door (boundary)
7	Corridor	corridor
8	closed glass door, not to be crossed	landmark
9	perpendicular corridor	corridor, place to turn
10	Door	door, boundary
11	continuation of corridor 9	corridor
12	staircase and display cabinet	landmarks, place to turn
13	short corridor	corridor
14	bulletin board	landmark, final goal

Figure 3: Main characteristics of each segment of the route.



3.3.3 *Mapping of linguistic information onto the segments*

The descriptions were linked to the segments they referred to. As explained above, the route was segmented into segments using the highest possible granularity filter. In the majority of cases, there was a one-to-one mapping of sentences to segments. In some cases, however, one sentence contained information that had to be mapped onto two segments (see Example 6 and 7). The reason for this was the lower granularity of such texts.

Table 3: In example (14) the door defining segment 6 is named, so the first part of clause 1 is assigned to segment 5 and the second part to segment 6. In example (15) the door is not named, so the whole clause is assigned to segment 5, even though the door in segment 6 is located at "the end" of corridor 5.

Example		Segment
(14)	1 Sigue derecho *go straight*	5
	hasta la puerta *as far as the door*	6
(15)	2 Sigue derecho hasta el final del pasillo *Continue straight up to the end of the corridor*	5

The criteria used when linking a sentence (linguistic information) to one, two or more segments were as follows: (1) A sentence was only considered to refer to an even segment if a landmark defining the segment was named (Example 6). (2) If no reference to a landmark was made, the imaginary walker was considered to be located in the previous segment (Example 7).

3.3.4 Assigning the clauses to one category of information

The utterances in the route directions were found to express four main categories of information: actions of the imaginary walker (Example 16 and 17), localizations of the imaginary walker (Example 18), introduction of landmarks (Example 19, 20 and 21), and specification of landmarks (second sentence of Example 21). In the vast majority of cases, each utterance was clearly assigned to one (and just one) of these categories, judging by the meaning of the conjugated verb. In cases where more than one category could apply, a ranking was applied and the higher ranked category was taken: actions > localizations > introduction > specification.

(16) 6 Du läufst auf eine Tür zu (Subject GER8)
You walk in direction of a door

(17) 1 Abra la puerta (Subject SPA12)
Open the door

(18) 1 Du stehst vor einer Tür (Subject GER8)
You are standing before a door

(19) 4 Links sind Labore zu sehen (Subject GER11)
To the left are laboratories to be seen

(20) 5 und nach zwei Metern kommt

nochmals eine Tür (Subject GER30)

and after two meters comes once again a door

(21) 16 Gegenüber der Glasvitrinen ist das schwarze Brett (Subject GER36)

Opposite of the glass cabinet is the bulletin board

17 (was eigentlich grün ist).

That actually green is

3.3.5. *Marking subordination*

In order to code subordinate clauses, syntactic criteria were used. It must be noted that subordination works differently in Spanish and German, so that different criteria must be used for both languages. Table 4 show the criteria used (based on Davidson 1979:106).

Table 4: Syntactic criteria used to recognize subordinated clauses in each language

Criteria	Spanish	German
Non-finite Verb	sometimes	sometimes
Conjunction or relative pronoun	YES	YES
Special word order	NO	YES
Inclusion within another clause	sometimes	sometimes
Non indicative grammatical mood	sometimes	NO

4. Hypotheses

The following hypotheses are proposed:

1. Because of the text type, the speakers will use either the Principle of Natural Order or the Principle of Topological Order as the underlying linearization principle when giving route directions. As a consequence, the order of the sentences in the produced text should mirror the numerical order of the segments.

2. The physical properties of the segments of the route will to a great degree

determine which information category has to be expressed. Since all speakers described the same route, no big differences between languages are expected here.

3. As a consequence of the boundary crossing constraint (Slobin and Hoiting, 1994) there will be a difference between Spanish and German in terms of information flow, specifically in the segments containing doors because these are likely to be conceptualized as boundaries.

4. Since the use of subordination in German is syntactically more laborious, German speakers are expected to employ this resource more sparingly than Spanish speakers.

5. It is expected that the actions of the imaginary walker and the introductions of landmarks will be treated as foreground information (encoded as main clauses) since these two information categories contribute directly to getting the listener to the final goal, answering the posed *quaestio*. Specification of landmarks and localizations of the imaginary walker will to be treated as background information (encoded as subordinate clauses), since these categories merely provide information enhancing the understanding of the given direction and can be omitted.

5. Visualization

Since the data consists of whole texts which are highly complex, a visualization was designed that shows the interaction between the investigated categories in a more intuitive way. The processes of information selection are represented by the colors, the process of linearization by the numbering of the utterances (above each utterance-line) and the subordination of structures is shown by dashed lines (in contrast to the solid lines indicating main structures). Figures 3 and 4 visualize the data collected for each language and show how the sentences of the text are used by the speakers to describe the route. Texts from different speakers are represented separately above one another. To help interpreting the visualization, reference is made to Figure 4, which shows how to read it. The appendix also contains a few examples that help to clarify the process of visualizing one text.

The visualization shows how the information contained in the texts is mapped onto the segments of the route. In general, and because of the criteria used for linearizing the texts, speakers go through the segments of the route in ascending order. Exceptions happen sometimes when speakers begin the text by referring to the

final goal, or when speakers forget some important information and have to go back in space to specify it. The categories of information more often chosen for expression at utterance level are actions and introductions of landmarks. From these visualizations it is also evident that which segments receive little or a lot of attention from the speakers depends mainly on the physical characteristics of each segment.

Figure 4: How to read the visualization. Investigated categories are coded by color, line type and special placement

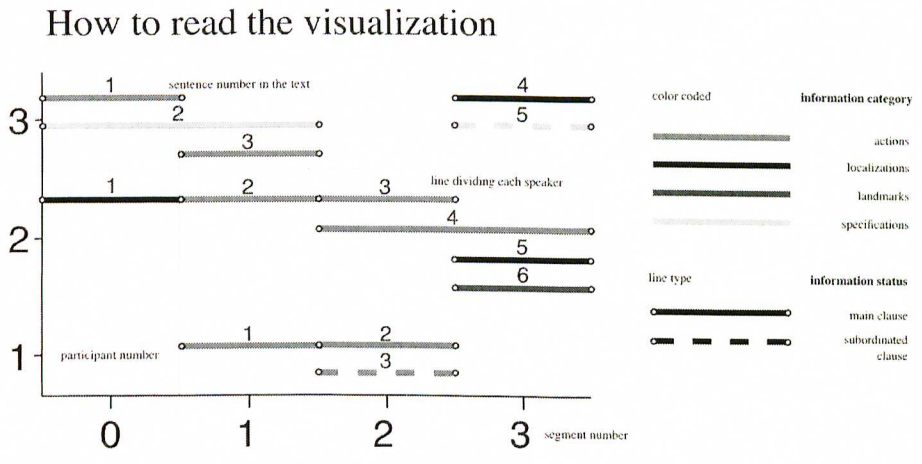


Figure 5: *Visualization of the Spanish data.*

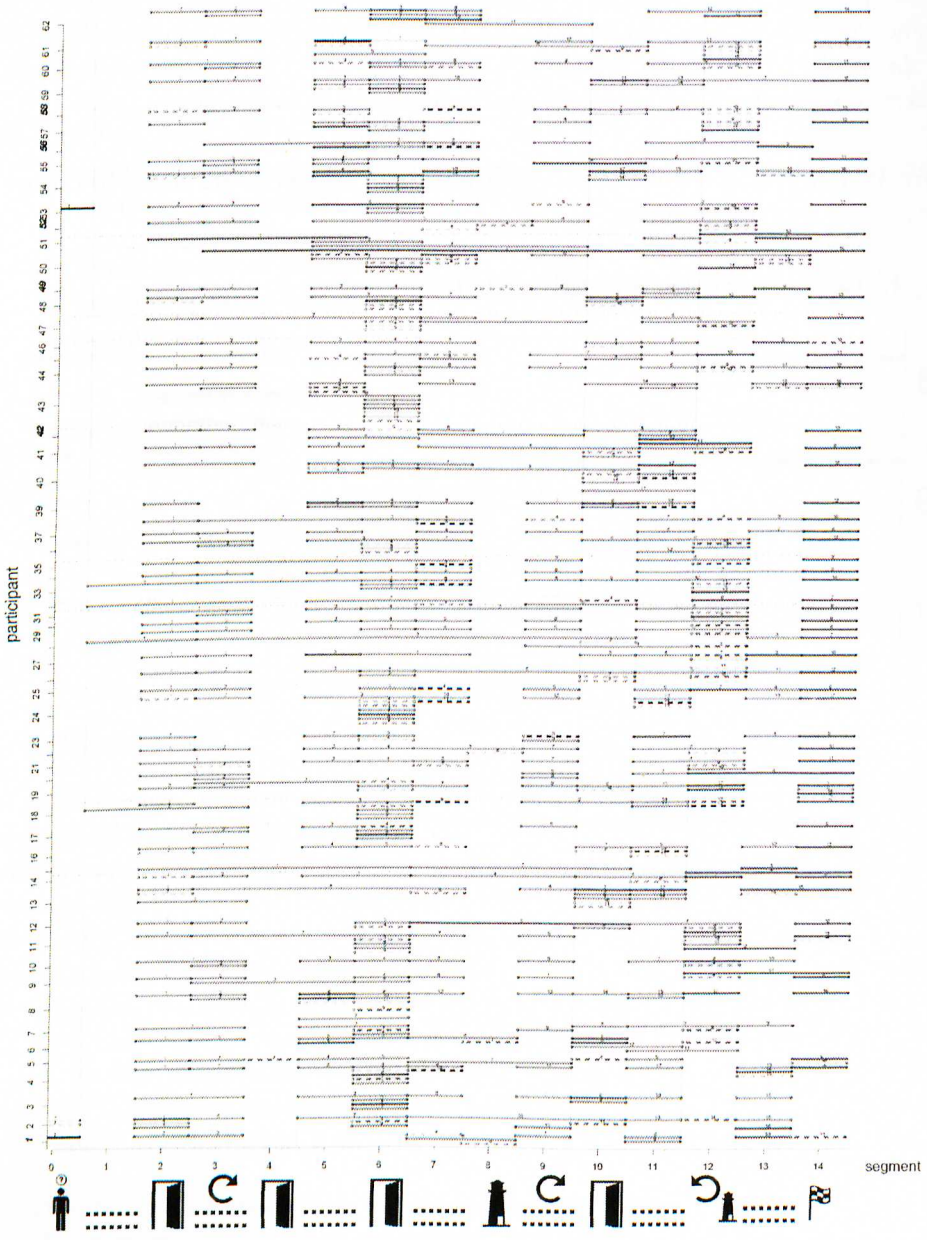
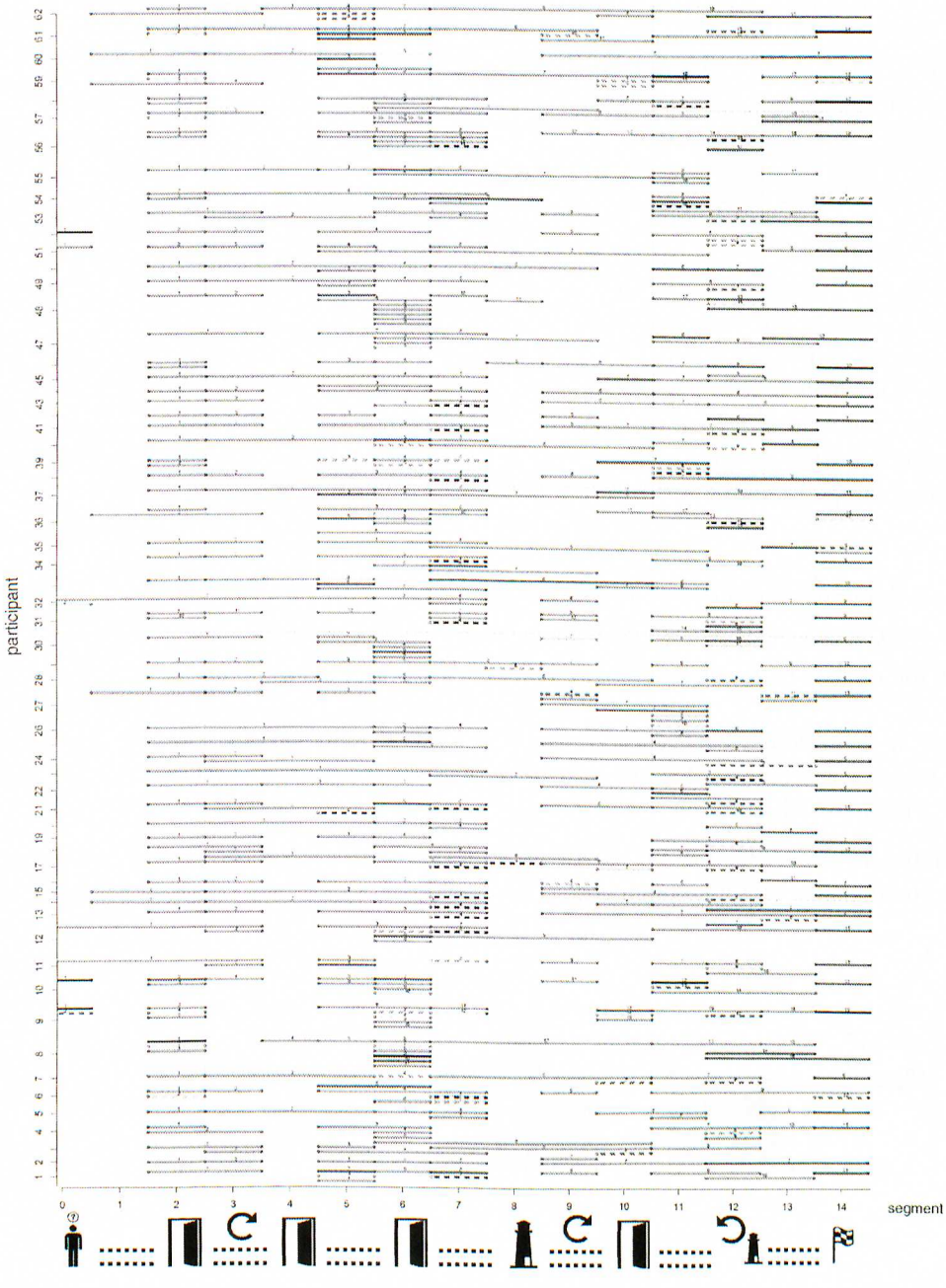


Figure 6: Visualization of the German data



6. Results

The results are derived from the visualization themselves, or directly from the data used for making the visualizations. The analysis of the data yielded a mixture of predominantly quantitative and some qualitative results.

6.1. Linearization of information

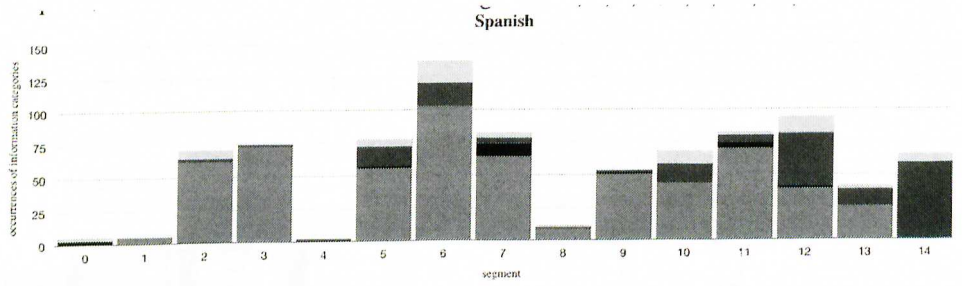
To investigate the linearization of information in the texts, the mapping of sentences to segments of the route was analyzed. As expected, a strong correlation was found between the order of sentences and the order of the segments (visualizations in Figures 5 and 6). Only one participant in each language contravened the Principle of Natural Order (or the Principle of Topological Order): Subjects GER54 und SPA19 began the route direction by directly mentioning the end of the route (segment 14) before referring to the first few segments and then continuing from the beginning. One example of such a verbalization can be found in the Appendix.

6.2. Selection of information categories for each segment of the route

We counted how often every information category was selected for every segment of the route. The results in absolute numbers are presented in Figure 7.

It is evident from Figure 7 that certain segments attract more information categories than others: Information corresponding to segments 0, 1, 4, 8 and 13 are less frequent, while the most sentences refer to segments 2, 3, 5, 6, 7, 9, 10, 11, 12 or 14.

Figure 7: Occurrences of the information categories in each segment of the route for both languages (absolute numbers)



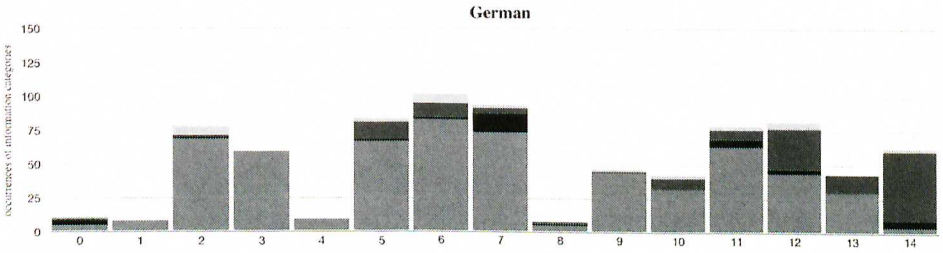
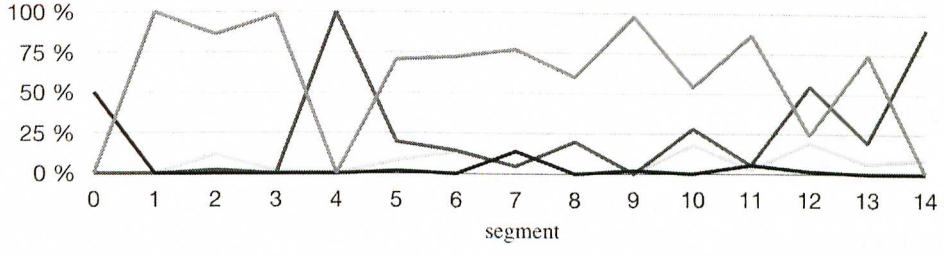


Figure 7 also shows the frequency with which a sentence was used in each of the four information categories referring to every segment of the route. In order to determine whether these differences were significant, the number of speakers who used each of the information categories in each segment were compared. The analysis yielded significant results for the information category *action* in segments 4 and 5: In segment 4, no Spanish speakers produced sentences corresponding to the category *action* while seven German speakers produced them (Fisher's Exact test, $p = 0.013$). For segment 5, there were 47 Spanish speakers and 56 German speakers who produced actions. This difference was statistically relevant (^{2} (1) = 4.64, $p = 0.031$).

We also looked at the proportion of sentences corresponding to each of the four information categories for every segment (Figure 8). The same general pattern was found in both languages: most utterances communicated *actions*, the second most common information communicated was the introduction of *landmarks*, followed by *specifications* and expressions of the position of the *imaginary walker*. The proportion of sentences introducing *landmarks* tended to rise in even numbered segments, since these segments were defined by very salient landmarks (e.g., stairs).

Figure 8: Proportion of sentences corresponding to each information category for each segment



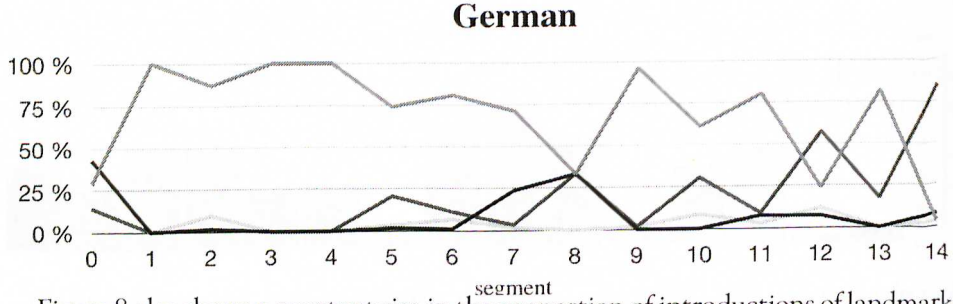


Figure 8 also shows a constant rise in the proportion of introductions of landmarks and a decrease in the proportion of actions from segment 9 onwards, when abstracting for the corresponding decreases in the proportion of landmarks in uneven numbered segments.

6.3. Flow of information

The flow of information, i.e. how different pieces of information in the texts correspond to the route, is depicted in the visualizations above. To quantify the information flow, two measurements were calculated: 1) How many segments the speakers captured in each sentence; 2) How many sentences speakers needed in order to describe each segment. These two measurements correspond to the horizontal and vertical dimensions of the visualization.

The number of segments a given sentence refers to (horizontal dimension) can be calculated by subtracting the segment where each sentence begins from the segment where the same sentence ends. The mean number of segments that a sentence encompasses was calculated separately for each text. The means corresponding to both languages were aggregated and compared. They differed significantly: In German one sentence covers more segments of the route ($M = 1.52$, $SD = 0.31$) than in Spanish ($M = 1.31$, $SD = 0.40$; $t(114) = 3.21$, $p = 0.00085$, *one tailed*). In other words, German speakers advanced the imaginary walker further with each sentence than Spanish speakers.

To calculate whether the languages showed a different granularity (vertical dimension), the maximum number of sentences referring to a single segment of the road was counted for each text (it was possible that the segment showing a higher granularity was a different segment for different texts). In the visualization this measurement corresponds to how many sentence-lines are accumulated above each other. The maximum number of sentences that accumulate on one segment of the route was higher in Spanish than in German route directions: Spanish ($M = 3.19$, $SD = 1.33$) vs. German ($M = 2.77$, $SD = 1.12$; $t(118) = 1.90$, $p = 0.03$, *one tailed*). This

means that Spanish speakers produced more sentences that refer to the same segment of the route than German speakers.

6.4. *Subordination*

In the Spanish route directions 15.11% subordinate clauses were used (160/711) versus 22.5% in German (94/622). Out of the total 62 Spanish speakers, 57 used subordination in their texts. Out of the total 62 German speakers, 48 applied subordination when giving route directions. The average number of subordinate clauses was higher in Spanish ($M = 2.58$, $SD = 1.71$) than in German ($M = 1.52$, $SD = 1.38$; $t(116) = 3.81$, $p = 0.00011$). Note that the total number of clauses was higher in the Spanish corpus.

6.5. *Foregrounding and Backgrounding*

To investigate which information categories were treated as foreground or background information, the interaction between subordination and information category was correlated. The clauses corresponding to all four categories were coded as subordinate or main clauses. Table 5 shows the proportion of the sentences expressing each information category coded either as main or subordinate clause.

Table 5: Percentage of sentences of each information category encoded as main or subordinate clauses

Refers to	Category of Information	Spanish		German	
		Main clause	Subordinate clause	Main clause	Subordinate clause
the imaginary walker	Action	89%	11 %	95%	5%
	localization	17%	83%	35%	65%
landmarks	introduction	77%	23%	79%	21%
	specification	12%	88%	25%	75%

Both languages showed a similar pattern: actions and introductions of landmarks are more likely to be encoded as main clauses, localizations of the imaginary walker and the specification of landmarks are more likely to be encoded as subordinate clauses.

7. Discussion

Four of the five proposed hypotheses could be confirmed. In this section, each proposed hypothesis will be discussed.

7.1 Linearization of information

When giving route directions, speakers of both languages proceeded in an orderly fashion, progressing through and along the route to be described. This is in line with Hypothesis 1, which states that the sentences should be produced in the same order as the segments occur.

Interestingly, in a few cases speakers chose to begin the route direction by referring to the final goal, violating the PNO/PTO, and only then proceeding with the route description from the starting point. In this manner, they created a framing statement. This strategy shows a startling resemblance with the *holistic strategy* found in conceptual and linguistic encoding of goal-oriented motion events (v. Stutterheim et al., 2012).

7.2 Selection of information categories for each segment of the route

The selection of the information categories in the different segments was similar for both languages, which confirms Hypothesis 2. This was the case for the absolute number of sentences corresponding to each information category (Figure 7) as well as for the proportion of each information category to the total number of sentences in every segment (Figure 8). This means that the type of information that speakers verbalize is in general dependent on the physical characteristics of the route. Small (not statistically relevant) differences can be traced back to different segmentations of the route by different speakers and are therefore only an artifact of the investigation method used. The only significant exception was found for the segments 4 and 5. The explanation for this is grounded in the boundary crossing constraint and will be outlined in the next section.

The proportion of sentences that express the different information categories varies from one segment of the route to another. This was to be expected because different segments of the route have different physical characteristics. Nonetheless, for both languages the relative number of actions decreases in the last few segments, while the introduction of landmarks increases: It seems that speakers of both languages assume that when the final goal is very near it is almost impossible for the imaginary walker to get lost. Even if the instructions towards the end of the route were missing altogether,

the imaginary walker should be able to find his way on his own. This is probably the reason why a simple enumeration of the most important landmarks often replaces detailed instructions of how to move from one landmark to another (*actions*). Such descriptions are evidently less explicit and precise, but from the speakers' point of view enough for the listeners to deduce the implied route.

7.3 The Flow of information

Sentences in German route directions encompassed more segments of the route than in Spanish. It is conspicuous that Spanish speakers used more sentences to refer to a specific segment of the route than German speakers, which points to a greater granularity in the Spanish texts, as exemplified in 22. The higher granularity degree is especially obvious in segments characterized by doors (2 and 10), and even more so in segment 6, which consists of two doors.

(22) 07 Siga recto hasta {X} (Subject SPA8)

Continue straight until

08 {ver una puerta con 346 en la parte superior frente a usted}

seeing a door with 346 on the upper part in front of you

09 Atraviese esa puerta

cross that door

10 y la

and the one

11 que viene a continuación

that comes after it

12 (unos dos metros tras la primera).

approximately two meters after the first one.

13 Siga recto hasta el final del pasillo

continue straight until the end of the corridor

The correlation between the segments characterized by a door and a high granularity in Spanish can be explained by the boundary crossing constraint (Slobin and Hoiting, 1994). Spanish speakers encode the boundary crossing in a path verb and end up writing more sentences to convey the actions to perform at a door.

German speakers, by contrast, are not restricted by the boundary crossing constraint. Consequently, they can combine the segments before and after a door, including the door itself, in only one sentence (Example 23).

(23) Dann gehe weiter geradeaus den Gang entlang durch die offenstehende Tür mit Nummer 346. (Subject GER08)

Then go still straight along the corridor through the open door with the number 346.

The boundary crossing constraint is also the underlying principle for explaining the increased use of actions by German speakers in segments 4 and 5. Segment 4 corresponds to an open glass door, so this door does not block the progress of the imaginary walker and it is not very visible. This makes it possible to not conceptualize the door as a boundary crossing. This is what Spanish speakers choose to do: they do not refer to this door at all. Contrary to this, German speakers, who mention the glass door, must logically make a reference to the next segment. This is the basis for the significant increase of actions verbalized in segment 5 by the German speakers.

7.4 Subordination

Confirming our Hypothesis 4, German speakers used less subordination in their texts than Spanish speakers. This holds true for the total number of speakers, the total number of subordinate clauses, and the average number of subordinate clauses per text.

The less frequent use of subordination in German does not necessarily go hand in hand with less background information in the texts. Moreover, this has to do with differences in how subordination is used in German and Spanish for structuring and packaging information. This topic is discussed extensively in the following Section.

7.5 Foregrounding and Backgrounding

Of the four information categories speakers use in the route directions, two of them refer to the imaginary walker, and the other two to the points used as orientation along the route. As predicted in Hypothesis 5, speakers treated actions of the imaginary walker and introductions of landmarks as foreground information, while specifications of landmarks and localizations of the imaginary walker were treated as background information. This shows that subordination is used in both languages as a tool for distinguishing both foreground and background information.

Obviously, there is a mismatch between the selection of information (information categories) and the syntactic packaging: The reason behind this is that background information in German is not always packaged as a separate subordinate clause. The same piece of information that Spanish speakers place in a subordinate clause is often included in the main clause in German (Example 23):

(24) a. Cruce la puerta,

Cross the door

que tiene el número 305 arriba.

that has the number 305 above

b. Gehen Sie durch die Tür mit der Nummer 305.

Go through the door with the number 305

In this way, background information in German can be mentioned without having to rely on a separate clause. Possibilities for doing this include encoding background information in a phrase or even a word within a sentence. Example 25 shows the three syntactic variations used by the speakers for encoding specifications, where (25a) shows the use of two separate sentences, (25b) the use of a modified phrase, and (25c) the use of a modified phrase with a compound.

(25) a. Gehe durch die Tür.

Go though the door

Die Tür ist aus Glas.

The door is made of glass

b. Gehe durch die Tür aus Glas.

Go through the door of glass

c. Gehe durch die Glastür.

Go through the glass door

Information regarding the localization of the imaginary walker can also be either packaged as a complete sentence (Example 26a) or as a phrase inside a sentence (Example 26b).

(26) a. Wenn Sie am Ende des Ganges sind,

When you are at the end of the corridor

wenden Sie sich rechts

turn right

b. Am Ende des Ganges wenden Sie sich rechts.

At the end of the corridor turn right

Following the analysis of syntactic levels in Delucchi Danhier (2015a), we looked at the syntactic distribution of background information in both languages. Table 7 shows the total number of information category localizations of the imaginary walker and landmark specifications (i.e. the information categories corresponding to the background information) and their encoding in the texts.

Table 6: Syntactical distribution of background information (* means statically significant)

Information category / syntactic level	Sentence		Phrase		Word		TOTAL	
	SPA	GER	SPA	GER	SPA	GER	SPA	GER
Localizations	18	34	56 *	99	0	0	74 *	133
Specifications	65 *	28	149	159	33 *	104	247	291

When considering all possibilities of syntactic encoding, the number of items of information regarding specifications is similar for both languages. The difference is therefore not in the selection of information to be communicated, but rather in the syntactic packaging (Fabricius-Hansen, 1999).

It remains to be explained why some information referring to actions to be taken by the imaginary walker and introductions of landmarks (both of which we have established to be foreground information) are nevertheless sometimes encoded as subordinate clauses. A careful observation of these cases reveals that subordinate clauses that communicate a landmark tend to follow their main clause (and concentrate on the final segments of the route). This construction is used to introduce a landmark as the goal of an action encoded in the main clause (27). Actions encoded as subordinate clauses on the other hand, can also follow their main clause. When this is the case, the information expressed by the subordinate clause describes an action to be performed by the imaginary walker at the goal of the movement encoded in the main clause (28). Actions are encoded as subordinate clauses and syntactically put before their main clauses if the action expressed by the subordinate clause is to be performed at the starting point of the movement expressed by the whole sentence (29).

(27) MAIN CLAUSE action – SUBORDINATE CLAUSE landmark

(13 cases total in German Texts)

Weiter geradeaus bis linker Hand die grüne Informationstafel steht.

Still (go) straight until to your left stands the green information board

(28) MAIN CLAUSE action – SUBORDINATE CLAUSE action:

(8 cases total in German Texts)

Du gehst weiter ein Stück geradeaus bis du zu einer Treppe kommst.

You go still a bit straight until you come to some stairs

(29) SUBORDINATE CLAUSE action – MAIN CLAUSE action

(4 cases total in German Texts)

Hier angekommen, gehst du nochmals rechts.

Having arrived here, you go again to the right

It can be concluded that subordination in route directions is used in a similar way as in other texts types such as instructions or narrations, where it is used to differentiate foreground from background information. Our results provide evidence that subordination is also used to organize foreground information in a causal or topographical relation to other foreground information. This additional text structuring function of subordination seems to be specific for the genre of route directions. The topographical structuring seems to function in the same way for both languages used, although the usage is somewhat more widespread in Spanish.

8. Conclusion

For both languages at stake, a general principle for the structuring of information in route directions was identified: Actions and the introduction of landmarks are foreground information and are encoded as such in the main clause. Localization of the imaginary walker and the specification of landmarks are background information, encoded as subordinate clauses. Approaching the final goal, foreground information can be increasingly expressed using only the introduction of landmarks. Subordination is not only used to mark background information, but also to signal topological-logical connections between two pieces of foreground information.

Because of the boundary crossing constraint, Spanish texts show higher granularity in segments with doors. German speakers, not constrained by this, produce sentences that can encompass more segments of the route at once. The more cumbersome subordination clause structure in German makes speakers of this language prefer to package background information below the sentence level, i.e. at the level of phrases and/or words. Spanish speakers make more use of subordination, because doing so does not add any syntactical complexity to the text in Spanish.

The present paper identifies language-specific differences in the information structure of Spanish and German route directions. These differences are very subtle and had not been identified so far. The visualization techniques used in this study have enabled the identification of these language-specific differences for the first time.

9. Appendices

9.1 Examples of the texts contained in the corpus with their visualization

9.1.1 Subject SPA19

1 Creo que es en el edificio de al lado,

I think it is in the next building

02 pero debes pasar por otro.

but you have to go through another

03 Cruza la puerta (número 325),

Cross the door (number 325)

04 al tiro dobla a mano derecha,

immediately turn right

05 cruza la puerta

cross the door

06 que dice, creo, 346

that says, I think, 346

07 y sigues hasta el final,

and continue until the end

08 dobla a mano derecho

turn to your right

09 y cruzas la puerta

and you cross the door

10 que dice 306

that says 306

11 y sigues.

and you continue

12 Vas a ver unas escaleras.

You will see some stairs

13 A mano izquierda de las escaleras vasa ver unos estantes con microscopios.

To the left of the stairs you will see some cabinets with microscopes

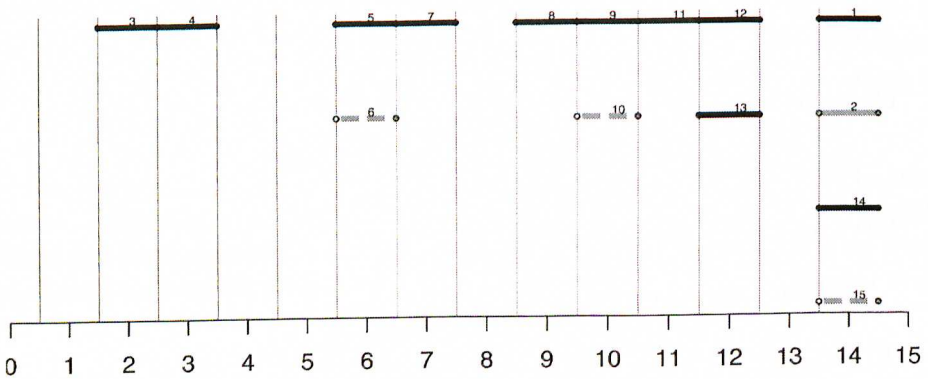
14 Al frente de esos estantes está el fichero

Opposite those cabinets is the board

15 que buscas.

you are looking for

Figure 9: Visualization of the route direction of Subject SPA19



9.1.2 Subject GER33

1 Du gehst hier gleich durch die Feuertür

You go here immediately through the fire door

2 und in den Gang nach rechts durch eine Tür.

and into the corridor to the right through a door

3 Das ist ein langer Gang mit Labors links.

This is a long corridor with laboratories to the left

4 und rechts kann man den Hof sehen.

and to the right you can see the yard

5 Am Ende des Ganges durch zwei Feuertüren wieder in den nächsten Gang.

At the end of the corridor through two fire doors again into the next corridor

6 Am Ende dieses Ganges ist wieder eine Feuertür.

At the end of this corridor there is again a fire door

7 Durch die gehst du durch

You go though it

8 und danach gleich rechts wieder

and then immediately again to the right

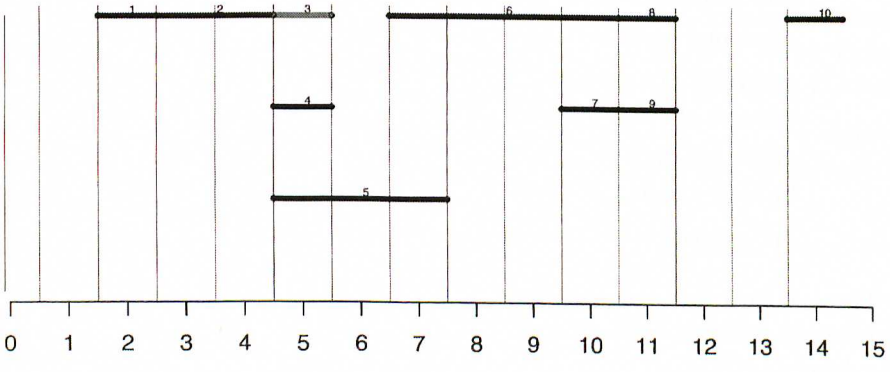
9 Dann noch ein Stückchen den Gang entlang

then still a bit along the corridor

10 und direkt um die Ecke auf der linken Seite ist das Schwarze Brett.

And directly around the corner to the left there is the bulletin board

Figure 10: Visualization of the route direction of Subject GER33



9.2 Validation of the coding categories

Each of the coded categories were checked by a layperson who was instructed in the use of the categories by means of a coding manual with definitions and examples. The coders were native speakers of the language in which they were coding. The percentage of the corpus coded is shown on table 7. For measuring the agreement between coders, Scott's pi index was used. Table 7 lists the inter-coder agreement for each coding category and data set.

For the interpretation of the validation results, Landis and Koch's (1977) benchmarks for assessing the relative strength of agreement for Cohen's kappa were adopted (this is possible since Landis and Koch's benchmarks are arbitrary, meaning they have no mathematical base). The benchmarks use are: Poor (<0), Slight (.0 - .20), Fair (.21 - 0.40), Moderate (.41 - .60), Substantial (.61 - .80) and Almost Perfect (.81 - 1.0). In line with this classification, the average coders' agreement is almost perfect or, in two cases, at least substantial.

Table 7: *Results of the validation of the coding categories.*

Data set	Coding category	# Texts validated (% of corpus total)	Scott's Pi
Spanish	segmentation of texts in utterances	20 (32.30%)	94,05%
	assignment of utterances to a segment of the route	20 (32.30%)	76,86%
	main information category expressed by each sentence	20 (32.30%)	92,47%
	Subordination	20 (32.30%)	83,51%
German	segmentation of texts in utterances	20 (32.30%)	92,39%
	assignment of utterances to a segment of the route	20 (32.30%)	83,83%
	main information category expressed by each sentence	20 (32.30%)	93,34%
	Subordination	20 (32.30%)	70,24%

The very high agreement rates across all categories show that the coding criteria were transparent for the coders to follow. This ensures ecological validity and reliability of the data.

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