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## **Mental Imagery in Translation Processes<sup>1</sup>**

### **Abstract**

The use of mental imagery has been claimed in Translation and Interpreting Studies to help students to understand source texts as well as to avoid interferences. The role played by mental images in translation and interpreting has, however, been scarcely investigated. This study explores the use of mental images by translation students, drawing on embodied approaches to language comprehension – in particular, on the Language and Situated Simulation (LASS) theory. Five translation students translated three texts with different contents (respectively focusing on objects, on spatial relations and on abstract concepts). Four kinds of data were collected: (1) a self-report questionnaire about individual preferences in the use of mental imagery; (2) key-logged translation processes; (3) finished translations, and (4) self-reports about mental imaging during the translation processes. The results suggest that there are individual differences in the use of mental images in translation and that the participants' individual imaging profiles, as assessed by the self-report Object-Spatial Imagery and Verbal Questionnaire (OSIVQ), may help to explain these differences.

### **Keywords**

translation process, mental imagery, mental simulation, embodiment, LASS theory, OSIVQ

### **1. Introduction**

Mental imagery – the internal visualization of absent objects and events – is part of most people's everyday experience. Since the 1970s, there has been an ongoing debate in the Cognitive Sciences about the nature of mental images and their functional role in cognition. In the last two decades, embodied approaches to cognition have developed a theory of language comprehension based on the notion of **mental simulation** – or internal (re-) creation – of embodied experiences (Barsalou 1999). According to the theory of mental simulation, people understand language by performing mental simulations of the actions, images, sounds, etc., suggested by utterances. Subjectively, these mental simulations take the form of perceptual or motor experiences, including mental imagery.

In Translation and Interpreting Studies (TIS), Seleskovitch (1968) argued that deliberately producing mental images may help students to understand the source text and to avoid interferences. And yet, very few studies have addressed the actual role, if any, played by mental images in translation and interpreting processes. A better understanding of this role may help us to describe and explain these processes and to develop pedagogic strategies to support learning in this area. The theory of mental simulation provides a rich theoretical basis, supported by strong empirical data, to study mental imagery in translation and interpreting. However, mental images can only be indirectly approached; they are subjective, elusive, and changing. When asked retrospectively, participants can inadvertently further elaborate them, for instance, by adding new details to them. Profiling participants' preferences in the use of mental images can be a way of addressing

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this elusive phenomenon, since it may allow explaining individual differences related to the use of imagery in translation processes and products.

The aim of this paper is to explore the circumstances under which translation students may rely on mental imagery when translating. To this end, an exploratory study with five translation students has been carried out, drawing on four data sources: (1) A cognitive profile of the participants based on the validated self-report Object-Spatial Imagery and Verbal Questionnaire (OSIVQ), (2) recorded translation processes, (3) finished translations, and (4) participants' reports about their mental images during the translation processes. In the next sections, I briefly address the debate about mental imagery in the Cognitive Sciences and present the background of the OSIVQ (§2), introduce the theory of mental simulation (§3), and review the research on mental images in TIS (§4); then, after explaining the goals and design of the study (§5), I discuss the results (§6) and present some conclusions (§7).

## 2. Mental imagery in the Cognitive Sciences

A vigorous debate about the nature of mental representations arose in the 1970s in the Cognitive Sciences. On the basis of the first experiments on mental rotation of geometric figures (Shepard/Metzler 1971), one position argued that representations underlying mental imagery are spatial and analogical like pictorial images (Kosslyn 1973), while the other position held that these representations are propositional, amodal, and symbolic (Pylyshyn 1973). This initial debate centered on behavioral data such as the time required to mentally rotate objects in different degrees. The debate evolved with the introduction of neuroimaging techniques to examine the brain activation patterns underlying the production of mental imagery (review in Kosslyn et al. 2001). In this new phase, the early visual cortex, a brain area involved in visual perception, was claimed to play a functional role in mental imagery, which is strong evidence that imagery relies on spatial, topographically organized representations (Kosslyn 2005).

However, studies on brain-damaged patients with impaired imagery and preserved perception and vice versa show that the overlap between the neural substrates of perception and imagery is only partial (Bartolomeo 2008; Moro et al. 2008). Recent studies about the inability to produce mental imagery suggest that different kinds of cognitive strategies (for example, through imagery or through language) might be available to participants in imaging tasks (Zeman et al. 2010; Zeman et al. 2015). The theory of the availability of different strategies to perform cognitive tasks is not new. For instance, Paivio (1971, 1990) developed a dual-coding theory that depicted cognition as served by two separate subsystems: an imagery system and a verbal system. The Visual-Verbal axis has been one of the most acknowledged cognitive dimensions used to profile individuals as to their cognitive styles (e.g., Paivio 1971; Krutetskii 1976; Richardson 1977; Presmeg 1986). Informants can be classified along this dimension as either *visualizers* or *verbalizers*. When performing certain tasks, the former rely mostly on imagery; the latter rely primarily on verbal strategies.

The idea that knowledge is mentally represented by multiple systems has found strong empirical support (reviews in Paivio 1971, 1990; Barsalou et al. 2008). Nevertheless, in the last decades, the validity of the Visual-Verbal construct has been challenged by a host of studies pointing to its lack of predictive validity and weak internal consistency (for an overview, see Blazhenkova/Kozhevnikov 2008). Furthermore, the Visual-Verbal axis, defined as a bipolar dimension, is inconsistent with current neuroscience findings, in particular, with data suggesting that visual information is processed by two different subsystems: an object imagery system that processes information about color, texture, and shape of objects and scenes; and a spatial imagery system that processes information about spatial relationships and transformations (Kosslyn et al. 2001). Kozhevnikov et al. (2005) proposed a model of cognitive styles with three relatively independent dimensions: object imagery, spatial imagery, and language. Based on this model, Blazhenkova and her team designed and validated a self-report instrument to assess individual differences in these three dimensions, the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ),

which has demonstrated both acceptable internal reliability and predictive validity (Blazhenkova/Kozhevnikov 2008).

### 3. Mental simulations and language comprehension

Traditional theories of cognition depicted mental representations as amodal, abstract symbols similar to language (e.g., Fodor 1975; Pylyshyn 1984). By contrast, embodied approaches to cognition developed an analogical view of mental representations and described them as grounded in situated bodily experience. Some of these approaches have proposed that, in order to represent knowledge, people simulate modal states experienced during perception, action, and introspection (e.g., Damasio 1989; Barsalou 1999; Pulvermüller 1999; Zwaan 1999; Glenberg/Kaschak 2002; Feldman/Narayanan 2004).

Mental simulations are top-down activations of sensorimotor brain areas in the absence of perceptual stimuli or motor actions; they are isomorphic with perceptual information and specific to sensory modalities (Barsalou 1999). Subjectively, they take the form of perceptual, motor, or introspective experiences. Moreover, mental simulations are situated in the context of likely background situations and prepare agents for situated action, providing relevant information to produce inferences about objects, affordances, and actions (Barsalou 2008, 2016). The construct of situated simulation draws on the framework of grounded cognition. From this perspective, cognition emerges in the interaction of brain, sensory-motor systems, body, and physical and social environment (Barsalou 2016: 13-14). Thus, situated simulations are not conceived of as static internal representations, but rather as dynamic, complex cognitive processes that play a key role “in coupling the individual with their physical and social environment, managing the interface between them, and controlling their situated actions” (Barsalou 2016: 19).

The present study draws on simulation-based approaches to language comprehension, which suggest that, during text comprehension, situated, modality-specific mental simulations are incrementally constructed, allowing the interpreter to make inferences and predict further developments of the text (e.g., Zwaan 1999; Glenberg/Kaschak 2002; Feldman/Narayanan 2004; Bergen/Chang 2005). These approaches are supported by strong experimental evidence, for instance, on the details of visual simulations (e.g., Stanfield/Zwaan 2001; Richardson et al. 2003; Bergen et al. 2007) and motor simulations (e.g., Glenberg/Kaschak 2002; Bergen et al. 2005; Taylor/Zwaan 2001). One of these approaches, the Language and Situated Simulation (LASS) theory (Barsalou et al. 2008; Simmons et al. 2008), is particularly relevant to the purposes of the present study, since it assumes that knowledge is represented by multiple systems, which is coherent with the theoretical background of the OSIVQ.

LASS theory focuses on two kinds of systems, namely, the language systems and the modal systems.<sup>2</sup> Language systems represent linguistic forms in an auditory, visual, or tactile form. Modal systems perform mental simulations of perceptual, motor, and introspective experiences. According to LASS theory, when language is processed, it first activates other associated linguistic forms, and then, very quickly, it activates a situated simulation to represent its meaning in brain modal systems for perception, action, and mental states (Simmons et al. 2008). Linguistic strategies are superficial; they are based on statistical information about the frequency of words and the associations between them, as well as about their relations to syntactic structures (Barsalou et al. 2008). Participants adopt a fast linguistic strategy when it suffices for adequate task performance (Solomon/Barsalou 2004). On the contrary, when deeper conceptual processing is required, participants resort to situated simulations that represent the meanings of linguistic forms. Linguistic forms and situated simulations interact in different degrees, depending on task conditions. As the process evolves, the degrees of activity of both systems cycle in an interdependent way. Lin-

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<sup>2</sup> These systems are not understood as modular, but as highly complex structures that are distributed throughout the brain (Barsalou et al. 2008: 252; Barsalou 2016: 16).

guistic forms activate simulations, which, in turn, activate other linguistic forms (Barsalou et al. 2008).

From the perspective of LASS theory, individual differences in text comprehension could be explained by the different use of the two systems. In this view, people who need to invest much effort in processing linguistic forms may have less capacity to construct integrated simulations of their meaning. If they can construct some simulations, they may concentrate on the meaning of individual words and fail to integrate these fragmented simulations into a coherent global simulated situation, thereby allowing only minimal, superficial inferences. On the contrary, people with higher linguistic ability may spend more time simulating and integrating meaning into a coherent whole and, thus, they can produce a richer variety of inferences (Barsalou et al. 2008: 269).

#### 4. Mental images in Translation and Interpreting Studies

Since the pioneering work of Seleskovitch (1968), several TIS scholars have claimed that deliberately producing mental images may help novice interpreters and translators to understand the source text, to avoid interferences from the source language and to elaborate a coherent target text (for a review, see Martín 2017). Seleskovitch (1968) developed her *théorie du sens* as an alternative to the propositional theories of meaning prevailing at that time in translation studies, and this theory was successfully applied to interpreting training (Seleskovitch/Lederer 1989). However, the initially promising *théorie du sens* was not developed systematically, nor did it find much empirical support and, eventually, it stagnated (Gile 1988, Pöchhacker 1995). More recently, Gile (2003) and Rydning (2005) have proposed to revitalize this theory as a pedagogical framework. Gile (2003) claimed that, although the *théorie du sens* had been challenged as a descriptive theory, it enjoyed wide support as a prescriptive paradigm, and he proposed to apply it in the classroom. However, didactic approaches should be theoretically coherent, and they also should be consistent with current empirical evidence, so systematic empirical research is also necessary to support them.

Seleskovitch/Lederer (1989: 40) claimed that, in interpreting, language forms disappear and leave behind a state of consciousness about their sense that can then be spontaneously and naturally re-expressed in the target language. Novice translators and interpreters, however, tend to adhere to the forms of the source language and to produce word-for-word translations. Seleskovitch/Lederer (1989: 24-26) recommended novice interpreters to visualize the images suggested by the source text in order to understand its sense and to forget its words. Although the *théorie du sens* could be successfully applied to training interpreters, its view of translation and interpreting processes was somewhat idealized, with languages neatly separated in the interpreter's mind. The assumption that there is no contact between the source and target languages has been challenged by psycholinguistic studies on the architecture of the bilingual memory (for a review, see Halverson 2013: 38-41). Furthermore, Muñoz (1995, 2010) and Toury (1995) argued that translators tend to produce direct, proceduralized renditions that in many cases imitate the source text structures, and only resort to problem-solving and other deeper mental strategies when they find these first renditions unsatisfactory. Mossop (2003) considered implausible that professional simultaneous interpreters can get the wording of the source text out of their minds, because they start interpreting a few seconds after hearing the source text, and even translators very frequently begin writing immediately after reading.

The hypothesis that the linguistic structure of the source text influences the translation process found empirical support, and a 'monitor model' was proposed, according to which translators apply a 'literal default' translation procedure that is only interrupted when an inner monitor detects a problem and triggers conscious decision making (e.g., Tirkkonen-Condit 2005, 2006; Tirkkonen-Condit et al. 2008; Carl/Dragsted 2012; Schaefer/Carl 2014). Muñoz (2016) related this monitor model to classical computational approaches to cognition and to a modular, mechanistic view of the mind, inspired by the computer metaphor, and proposed an alternative account for the default translation procedure departing from Levy's (1967) *minimax* strategy. Since translation tasks

often demand more cognitive resources than those available, it is only natural that translators seek to obtain a maximum effect with a minimum effort (Muñoz 2016: 371).

LASS theory may offer a complementary explanation to the use of minimum-effort, default translation procedures. According to LASS theory, when a translator or interpreter perceives the linguistic forms of the source text, other associated linguistic forms become activated immediately, including words and expressions in the target language. This faster, shallower linguistic processing may be the main support to default procedures, which can suffice if they provide a satisfactory rendition. However, when translating, situated mental simulations are also quickly activated, even though they may remain unattended by conscious deliberate reflection until deeper conceptual processing is required. In fact, mental simulations typically remain at least partly unconscious, while they causally influence cognition and action (Barsalou 2016: 15). Default, shallow procedures might be applied when translators do not detect mismatches or inconsistencies in their first renditions, but also when they are tired or prefer to leave the perceived problems to a later review.<sup>3</sup> When translators feel that they need a deeper understanding of the text, their attention may focus on mental simulations as an alternative source of relevant information, and mental imagery may become experienced (Barsalou 2016: 15).

LASS theory can also shed light on some of the typical differences observed between novice and experienced translators' processes and products. Novice translators may need much effort to process linguistic forms, and their simulations may be fragmented and focused on the meaning of individual words, which can foster incoherent renditions and inadequate translations. Experienced translators, by contrast, may spend more time producing coherent, situated and action-oriented simulations, which allow them to create situation-adequate target texts. The pedagogical recommendations of the *théorie du sens* could successfully encourage novice interpreters to go beyond the fast, shallow linguistic processing and to dwell on the mental images suggested by the source text, deliberately integrating their simulations into a coherent, situated whole, and producing more adequate renditions.

In the 1980s and 1990s, the deliberate production of mental images to support translation learning was also advocated by researchers from functional approaches, who applied prototype theory and scenes-and-frames semantics to translation (Vannerem/Snell-Hornby 1986; Vermeer/Witte 1990; Kußmaul 1995, 2000, 2005). In particular, they focused on the concept of scene, initially developed by Fillmore (1977) as a means to analyse the temporal development of text comprehension processes. Kußmaul (2005) proposed to use mental images deliberately as a means to solve problems of meaning in translation. In his view, these problems appear when direct equivalences and routines do not produce a satisfactory translation, when "there is no direct path from source-text word to target-text word" (Kußmaul 2005: 382). In these cases, novice translators were guided to remember relevant knowledge and to produce a mental picture of a situation, until they spontaneously came up with an adequate solution. This solution was considered creative by Kußmaul (2005), because the students had avoided the translation that sprang immediately to their minds and had followed a second, more indirect path to find a satisfactory translation. Kußmaul's (2005) observations may also be explained by LASS theory's proposal about the availability of a shallow, linguistic response and a deeper, situated-simulation procedure when performing cognitive tasks.

Rydning/Janyan (2008) found empirical evidence of mental simulations of movement of different speeds in reading and translating tasks by professional translators. LASS theory offers a coherent and plausible framework to discuss some questions posed in the research of translation and interpreting processes and may help throw new light on the role played by mental imagery in this area.

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3 Halverson (2015) and Muñoz (2016) argue that default procedures are not necessarily 'literal' (an ill-defined, problematic concept), but faster, easier, and/or more routinized responses, the first to come to mind.



## 5. The study

The aim of this work is to explore the circumstances under which translation students may use mental imagery to support their comprehension and translation processes; in particular, I shall try to answer the following questions:

- Can any individual differences about the use of mental imagery be identified in the participants' processes, products, and/or reports?
- If there are some differences, can they be accounted for by the profiles obtained with the OSIVQ?

### 5.1. Design

The study is exploratory in nature and it relies both on quantitative and qualitative analysis. While quantitative data should provide a basis for identifying correlations between the participants' profiles and translation processes, qualitative analysis may allow for a detailed description of their procedures and experiences. The purpose of the study is to explore and describe the use of mental imagery in the translation processes of five translation students, relying on four kinds of data:

1. A profile of the informants' cognitive strengths and preferences, provided by the three-dimensional *Object-Spatial Imagery and Verbal Questionnaire* (OSIVQ).
2. The translation processes recorded with Inputlog.
3. The finished translations.
4. The informants' answers to a brief open questionnaire about their subjective experiences with mental imagery during the translation processes.

The analysis focused on intra-subject variations, although the subjects' profiles and action patterns were also globally compared.

### 5.2. Participants

The volunteers, all of them female, did not receive any reward for taking part in the study. They were all registered students at the Bachelor's Degree in Translation and Interpreting at the University of Las Palmas de Gran Canaria, with Spanish as their mother tongue. I shall call them Ana, Blanca, Carmen, Diana, and Eva, which are fictive names. Ana, Blanca, Diana, and Eva were 20 years old, and in their second year at university. Carmen was 22, and in her fourth year. All participants were right-handed, except for Diana, who was left-handed.

In the first session, they filled in a sociolinguistic questionnaire about their linguistic background, their college status, and their reading habits. All informants had English as their L2. Ana, Carmen, and Eva learnt German as their L3, while Blanca and Diana were enrolled in a double degree track, with German and French as L3 and L4. They all enjoyed reading as a habit, except for Eva. All informants reported that they produced mental imagery while reading.

### 5.3. Setting

Each participant translated three texts in three sessions (one each), with no time constraints. They worked in individual sessions in an office at the university, where they could use their own laptops and their usual applications. The sessions extended through March and April 2015. In the first session, the participants were briefly informed about the goal of the current research project. They filled in the socio-linguistic questionnaire and the OSIVQ. Then, they received a translation brief that described the general (fictitious) constraints of their task: they were expected to translate three texts from English into Spanish, and their translations were going to be part of the Spanish version of a web page about cultural differences. The processes were recorded with Inputlog 6.0,

a logging tool that registers keyboard and mouse data from writing processes in text processors and other Windows programs, like web browsers (Leijten/Van Waes 2013).

Following each translation, they answered a brief open questionnaire, where they reported on the subjective difficulty of the text and on the mental imagery experienced during the translation process (see Appendix). As commented in the introduction, self-reports cannot be taken as accurate reflections of participants' mental imagery; rather, they give us an insight into the participants' experience with their own images, in particular, into the way they remember having interacted with them. This information can be valuable, but it should be completed and contrasted with data from other sources in order to obtain a more accurate picture of the participants' use of mental imagery. In this study, the self-report data obtained with the open questionnaire and the OSIVQ were contrasted with data from the processes and the finished translations.

#### 5.4. Object-Spatial Imagery and Verbal Questionnaire (OSIVQ)

The OSIVQ is a self-report instrument developed to assess individual differences in object imagery, spatial imagery and verbal cognitive abilities (see section 2). It evaluates subjective aspects of mental imagery (such as detail, vividness, brightness and colorfulness), and verbal thinking (such as awareness of linguistic structures). Since the questionnaire was not available in Spanish, a computerized English version was used, which was installed on a laptop. In order to fill it in, the participants had to read 45 statements and rate each one on a 5-point scale, with 5 indicating 'absolute agreement', and 1 indicating 'total disagreement'. The OSIVQ automatically generated a quantitative three-dimensional profile and a reference baseline that allowed classifying participants as predominantly object visualizers, spatial visualizers, or verbalizers (see §6.1). Object visualizers tend to create detailed, vivid images of objects, persons and situations, and rely primarily on related strategies to perform cognitive tasks. Spatial visualizers prefer to construct schematic representations of spatial relations and transformations, and rely mainly on visual-spatial strategies. Finally, verbalizers tend to use verbal strategies when performing cognitive tasks.

#### 5.5. Texts

The participants translated three texts from English into Spanish. The texts were similar in length and shared a broad thematic field (cultural differences). The main criterion for the selection of the texts was that each of them posed clear cognitive demands related to one of the assessed cognitive procedures (object imagery, spatial imagery, and language).

- Text A was centered on the depiction of objects, actions and situations. It narrated the arrival of some foreigners to an Irish house where they found several unusual objects, such as separate water taps and round soup spoons. Cultural differences were thematized through the depiction of these objects from the viewpoint of the newly arrived.
- Text B described the historical developments that led to drive on the left-hand side of the road in different countries, and depicted spatial dynamic configurations, like those of swordsmen riding a horse on the left in order to have their right hand nearer to a potential enemy.
- Text C provided information about cultural differences, focusing on abstract concepts in a concise, at times schematic way. It had two errors that generated inconsistencies: in two cases, the term *low context culture* appeared in the place of *high context culture*.

Table 1 below provides a quantitative description of the texts aimed at determining their potential difficulty.

		TA	TB	TC
	<i>Length in words</i>	839	856	820
	<i>Length in paragraphs</i>	7	11	13
LEXICON	<i>Average frequency of all full words (1–10k)</i>	153	124	119
	<i>Average frequency of single full words (1–10k)</i>	152	147	145
	Percentage of unrecognized words	7	6	8
	Average frequency of repeated full words (>3)	3	3	4
	Percentage of abstract words	1	1	1
	Percentage of cognates	5	10	5
	Percentage of false friends (English / Spanish)	1	1	1
	Percentage of nouns minus percentage of verbs	3	8	2
SYNTAX	Lexical density	5	6	7
	Within sentence cohesion	5	6	4
	Between sentence cohesion	6	4	4
	Verbs per sentence	7	6	5
	Sentence length in full words	6	7	4
	Clauses per sentence	8	6	5
	Percentage of modifiers	13	11	8
TEXT	Type token ratio	4	4	5
	Text cohesion	7	8	4
	Density of quantification	2	2	1
	Propositional density (per 100 words)	4	5	5
	Negated verbs	8	2	4
	Percentage of vague words	2	2	2
	<b>Average</b>	<b>5,1</b>	<b>5,15</b>	<b>4,15</b>

Table 1. Quantitative characterization of experimental texts A, B and C according to CodyWeb (Amigo 2014)

In order to characterize the average difficulty of the texts, I used CodyWeb, an online tool for text analysis and profiling developed by the PETRA research group (Amigo 2014)<sup>4</sup>. CodyWeb evaluates text difficulty along 21 dimensions (8 lexical, 7 syntactic, and 6 textual, as depicted in Table 1). From these dimensions, some correspond to well-established parameters (e.g. sentence length, lexical density, verbs per sentence), while others seem good indicators of text difficulty for translators (such as the percentages of unrecognized words, cognates, and false friends). The average frequency of full words and the average frequency of single (unique) full words are evaluated on a 1–10,000 rating scale; 1 corresponds to the most frequent word in a list of 10,000 words. The other 19 dimensions are evaluated on a 1–20 rating scale, with 1 indicating ‘easiest’, and 20 indicating ‘most difficult’. There are some interesting differences between the scores of the texts in some of the individual parameters (for example, Text B was the most difficult in the dimension ‘percentage of nouns minus percentage of verbs’, which means that contained more nominal style, while Text A was the most difficult in the dimension of negated verbs). However, differences compensated each other, and the average values obtained for the three texts in these dimensions did not diverge significantly, although text C was slightly easier.

4 The application was developed by the PETRA-lead CÓDIGO research project (Spanish Ministry of Science and Innovation research grant FFI2010-15724).



## 6. Results and discussion

### 6.1. Cognitive styles

Blazhenkova/Kozhevnikov (2008) found statistically significant differences between the scores obtained in the OSIVQ by three professional groups, with scientists scoring the highest on the spatial imagery scale, visual artists on the object imagery scale, and humanities professionals on the verbal scale. In order to interpret the profiles generated by the OSIVQ, the questionnaire provides the mean scores obtained by these three professional groups and by the general population in different large-scale studies. These scores were taken as reference values to elaborate the participants' cognitive profiles (see Table 2): the highest score of each group was taken as reference value to obtain the main cognitive style(s) of each participant (in bold in Table 2), and the mean scores of the general population (*italics*) were used as thresholds to classify the rest of the participants' scores as above average (>) or below average (<).

	ability	visual-object	visual-spatial	verbal
Scientists and engineers		3.28	<b>3.28</b>	2.81
Visual artists		<b>4.14</b>	2.84	2.69
Linguists and historians		3.28	2.81	<b>3.48</b>
<i>General population</i>		<i>3.59</i>	<i>2.93</i>	<i>2.90</i>
Ana		4.07 >	1.2 <	<b>4.33</b>
Blanca		3.87 >	2.6 <	<b>3.6</b>
Carmen		3.8 >	<b>3.47</b>	3.33 >
Diana		3.47 <	2.47 <	<b>3.6</b>
Eva		<b>4.53</b>	1.73 <	<b>3.8</b>

Table 2. Mean OSIVQ scores of professional groups and general population, and individual scores of participants

Carmen obtained a higher score than scientists and engineers in visual-spatial ability, and was classified mainly as a spatial visualizer. Eva scored higher than the corresponding professional groups on both visual-object ability and verbal ability, and was considered to be both object visualizer and verbalizer. Ana, Blanca and Diana were classified mainly as verbalizers (perhaps an expected profile for students of Translation and Interpreting).

Blazhenkova/Kozhevnikov (2008) found negative correlations between visual-spatial ability and the other two dimensions. This suggests that the visual-spatial cognitive style might interfere with both visual-object and verbal cognitive styles. Such interferences may be due to competition for limited cognitive resources when performing complex tasks. Kozhevnikov et al. (2005) obtained evidence suggesting that object visualizers tend to generate detailed pictorial images of individual objects, which may overload visual working memory and hamper spatial transformations, whereas spatial visualizers tend to create more schematic, abstract mental images in order to concentrate on spatial relations. On the contrary, Blazhenkova/Kozhevnikov (2008) argued that, rather than competing for cognitive resources, visual-object and verbal abilities support each other, as assumed by dual coding models (Paivio 1971, 1990). The cognitive style profiles of the five participants are coherent with this pattern. While visual-object and verbal abilities seem not to interfere with each other – one participant, Eva, scored above the professional groups in both cognitive styles –, visual-spatial ability seems to maintain a mutually exclusive relation with the other abilities. The four participants classified as verbalizers – including Eva – scored below average in visual-spatial ability. Carmen was the only spatial visualizer, with comparatively low scores (although above average) in both object and verbal abilities.

## 6.2. Quantitative analysis

Since, according to LASS theory, text comprehension processes rely on the production of mental simulations, it was expected that participants would tend to work more fluently when the potential imaging demands of the text fitted their profile. In order to test if there were some correlations between the participant's profiles and the fluency of their translation processes, the 15 translation log files were analyzed with inbuilt Inputlog tools (Leijten/Van Waes 2013) to obtain:

- a pause/word ratio (number of pauses divided by number of words of the target texts)
- an option/word ratio (number of typed options divided by number of words of the target texts)
- and a search/word ratio (number of web pages consulted divided by number of words of the target texts).

The pause/word, option/word, and search/word ratios were taken as operative indicators of process fluency. To determine the number of pauses, a minimal pause of 200 ms was first established. Shorter time spans were discarded as 'delays,' for they may be related to typing micro strategies, and were assumed not to be so relevant for the study of cognitive phenomena unrelated to typing (Muñoz/Martín forthcoming). Then, pauses so defined, and with the aim to single out those pauses potentially related to the translation process, a lower threshold was set at 1.5 times the median pause within words obtained in each case, following Muñoz/Martín (forthcoming) who, in turn, drew from Rosenqvist (2015).

Table 3 shows the data obtained for each participant and each process. Since the study was exploratory and focused on a low number of subjects, only descriptive statistical analyses were performed. The intra-subject differences were very small, and the fluency of the processes, as indicated by the three ratios, did not show a systematic pattern that could be related to the participants' cognitive profiles, although, in the case of Blanca and Eva, the translation process of Text B was the less fluent, as could be expected from two verbalizers, while Carmen, the only spatial visualizer, had the lowest fluency in the translation of Text C.

<b>Ana</b>	<b>Text A</b>	<b>Text B</b>	<b>Text C</b>	<b>Mean</b>	<b>Median</b>	<b>s.d.</b>
<i>Median pause within words in seconds</i>	0.25	0.25	0.25	0.25	0.25	0
<i>Lower threshold in seconds</i>	0.375	0.375	0.375	0.375	0.375	0
Pause/word ratio	2.4	2.12	2.4	2.3	2.4	0.161
Option/word ratio	0.14	0.11	0.12	0.12	0.12	0.009
Search/word ratio	0.14	0.11	0.12	0.12	0.12	0.009
<b>Blanca</b>						
<i>Median pause within words in seconds</i>	0.25	0.25	0.25	0.25	0.25	0
<i>Lower threshold in seconds</i>	0.375	0.375	0.375	0.375	0.375	0
Pause/word ratio	2.33	2.67	2.42	2.47	2.42	0.176
Option/word ratio	0.15	0.18	0.16	0.16	0.16	0.012
Search/word ratio	0.03	0.07	0.06	0.05	0.06	0.015
<b>Carmen</b>						
<i>Median pause within words in seconds</i>	0.25	0.25	0.27	0.25	0.25	0.011
<i>Lower threshold in seconds</i>	0.375	0.375	0.405	0.385	0.375	0.017
Pause/word ratio	1.69	2.05	2.19	1.97	2.05	0.257
Option/word ratio	0.19	0.19	0.26	0.21	0.19	0.033
Search/word ratio	0.06	0.09	0.1	0.08	0.09	0.018
<b>Diana</b>						
<i>Median pause within words in seconds</i>	0.28	0.28	0.28	0.28	0.28	0
<i>Lower threshold in seconds</i>	0.42	0.42	0.42	0.42	0.42	0
Pause/word ratio	2.06	2.59	2.69	2.44	2.59	0.338
Option/word ratio	0.1	0.1	0.1	0.1	0.1	0
Search/word ratio	0.02	0.04	0.05	0.03	0.04	0.012
<b>Eva</b>						
<i>Median pause within words in seconds</i>	0.27	0.25	0.27	0.26	0.27	0.011
<i>Lower threshold in seconds</i>	0.405	0.375	0.405	0.395	0.405	0.017
Pause/word ratio	1.71	2.06	1.99	1.92	1.99	0.185
Option/word ratio	0.13	0.13	0.13	0.13	0.13	0.003
Search/word ratio	0.07	0.1	0.05	0.07	0.07	0.02

Table 3. Quantitative process data

### 6.3. Qualitative analysis

A detailed qualitative analysis of each participant's key logs, target texts, and reports was carried out and related to the cognitive profiles obtained with the OSIVQ. The following sections summarize and discuss the main relevant results.

#### 6.3.1. Ana

Ana was classified as a strong verbalizer, with an above average score in visual-object ability, and a rather low, below average score in visual-spatial ability (see Table 2). As commented in section 6.1, visual-object and verbal abilities tend to support each other, which could also be the case for Ana. Indeed, she reported having created a lot of mental images during the three translation sessions. Her imagination seemed to be much more focused on details than on spatial relations, and she remembered even details that were not mentioned in the source texts or that were wrong. For instance, during the translation of text A, she reported having visualized a restaurant where she situated a scene that in the source text takes place in the house: “Besides, I could visualize the scene of the travellers going to the bathroom in the restaurant where they ate [...]. I imagined the restaurant, the waiter bringing the soup, the ‘awkward spoon’ and the reaction of the text’s author and her companions.”<sup>5</sup>

Ana seemed to focus on the details of her mental images – such as colours, materials, and actions –, elaborating the scenarios and filling up the gaps with her imagination: “I could also visualize the burglary alarm and the reaction of all the travellers when they had to endure this annoying noise, loaded with the luggage. I imagined a wide house, with dark brown wooden floors, and the group of persons covering their ears and leaving the bags on the floor.” This attention to details may have hampered her ability to concentrate on more schematic configurations like the spatial disposition of spoon, hand, and mouth when eating soup, which in her translation shows some inconsistencies:

##### (1) Text A, 4<sup>th</sup> paragraph

**Source text:** As it seems, while in Spain, and other countries of Europe, *soup should always be taken from the end of the spoon*, in Britain –and thus, also in Ireland– the proper way of eating soup, is *taking it from the side of the spoon*.

**Ana’s translation:** Según parece, mientras en España, y en otros países de Europa, *la cuchara para tomar sopa debe cogerse siempre por el extremo*; en Gran Bretaña, y por consiguiente también en Irlanda, la manera correcta de comerse un plato de sopa es *agarrando la cuchara por un lado*.

[As it seems, while in Spain, and other European countries, *the soup spoon should always be hold by the end*; in Britain, and thus also in Ireland, the proper way of eating a plate of soup is *holding the spoon by one side*].

She reported having imagined also very detailed, colourful scenes during the translation process of text B, which again may have hampered the visualization of coherent spatial relations. Her translation of text B shows two incoherent depictions of spatial configurations:

##### (2) Text B, 3<sup>rd</sup> paragraph

**Source text:** Furthermore, a right-handed person finds it easier to mount a horse from the left side of the horse, and it would be very difficult to do otherwise if wearing a sword (which would be *worn on the left*).

**Ana’s translation:** Por otra parte, a alguien diestro le resulta mucho más sencillo montar a caballo desde el lado izquierdo del animal, y sería realmente complicado hacerlo de otra manera si llevara una espada (que normalmente *se lleva en el brazo izquierdo*).

5 All citations from the informants’ reports have been translated by me.

[Furthermore, somebody who is right-handed finds it much easier to mount a horse from the left side of the animal, and it would be really difficult to do otherwise if carrying a sword (which normally is carried in the left arm)].

(3) **Text B, 10<sup>th</sup> paragraph**

**Source text:** American cars were designed to be driven on the right by locating the drivers' controls on the vehicle's *left side*.

**Ana's translation:** Los coches americanos se diseñaron para conducirlos por la derecha al situar los controles del conductor en el *lado derecho* del vehículo.

[American cars were designed to be driven on the right by locating the driver's controls on the vehicle's *right side*].

This second inconsistency seems to have been utterly missed. The translation process of the tenth paragraph was relatively fluent, with low ratios of pauses, options, and searches by word (all below the mean). Moreover, in her description of the scene she visualized when translating this part of the text, she reproduced the same spatial incoherence: "I had detailed images in my head when the author of the text depicted American cars with their new designs (the driver's control system was on the right, they were more modern cars)."

Although text C was the most abstract one, Ana reported having imagined many details, and asserted that these images had been a support in the translation process. In this process, the sixth paragraph had the highest ratio of pauses and options by word, which suggests that it was difficult for Ana to find a satisfactory translation. This paragraph contained a metaphor that depicted time as water in a bathtub, gradually disappearing down the drain. Ana reported having imaged how the water ran down the drain, which may have helped her to eventually achieve a successful translation.

The data collected from Ana's translations and reports are coherent with her cognitive profile in the predominance of visual-object over spatial-object procedures, and suggest that the great detail of her mental images may have hampered her ability to understand and to translate successfully some passages related to spatial relations and movements, although it also may have helped her to understand and translate other text passages describing objects, including the metaphorical bathtub.

### 6.3.2. Blanca

Blanca was also classified as a strong verbalizer. Like Ana, her visual-object ability score was above average and her visual-spatial ability score was below average, although she scored lower than Ana in verbal and visual-object abilities, and higher in visual-spatial ability, showing a less polarized cognitive style profile (see Table 2). Once the translation of text A was finished, Blanca reported having imagined some of the objects, and having related the text to her own experience in a British home: "The spoons, the plugs, the power adapter, and the British home where I lived some years ago." She felt that these images had been a support to understanding and translating the text. After translating text B, she reported having used mental images to try to understand the spatial relations described in the source text. "I tried to situate myself in space to understand the reasons for driving on one or the other side, and I imagined the horse wagons, a person mounting a horse and the old roads." She thought that these mental images had been a support to understand the reasons for driving on each side. However, her translation of text B showed a spatial incoherence in the second paragraph.

(5) **Text B, 2<sup>nd</sup> paragraph**

**Source text:** Since most people are right-handed, swordsmen preferred to keep to the left in order to have *their right arm* nearer to an opponent and their scabbard further from him.

**Blanca's translation:** Dado que la mayoría de las personas eran diestras, quienes tenían espada preferían ir por ese lado [el izquierdo] para tener *su brazo izquierdo* más cerca de sus oponentes y estar más lejos de las fundas de sus espadas.

[Since most people were right-handed, those wearing a sword preferred to keep to that side (the left) in order to have *their left arm* nearer to their opponents and to be further from their scabbards].

After translating text C, Blanca reported that she had involuntarily produced some mental images that were neither a support nor an obstacle for her translation process. “Without intending it, I imagined the bathtub with water and the offices.” Some of these images, although unintended, might have helped Blanca to understand and translate some passages such as that of the bathtub metaphor, in the sixth paragraph. The translation process of this paragraph had the lowest ratio of pauses, searches, and typed options, which suggests that it was produced in a pretty fluent way. The data collected from Blanca's translations and reports suggest a certain versatility in the use of object and spatial strategies, which could correspond to her less polarized cognitive style profile when compared to Ana, although she did not always succeed at translating the passages about spatial relations.

### 6.3.3. Carmen

Carmen was the only strong spatial visualizer, with comparatively low scores in both object-image and verbal abilities (but above average, see Table 2). Her translation of text B did not show any spatial incoherence, and her mental images seemed more focused on spatial relations than on details about objects or people. After translating text A, Carmen reported having imagined “the protagonists of the story directly in front of the house after arriving”, and remembered having visualized “quite clearly the round spoon and the way people eat with it”, and “the differences between bipolar and tripolar plugs.” Most of these images seem quite schematic and focused on spatial dispositions. Carmen reported that they had given her “a clear vision of the different elements”, which allowed her to “understand why they are a cultural problem.”

The images described by Carmen after completing her translation of text B also seemed more centered on spatial dispositions and relations than on visual details about objects or persons.

[...] I remember having imagined how people traveled on the left or on the right side, depending on their circumstances, like swordsmen, which traveled on the left in order to use their right hands. I could see quite clearly on which side traveled each person, what objects they carried and in which side they carried them.

She considered that these images helped her to translate and, in particular, to understand text B. Carmen reported that during the translation of text C she could not produce so many mental images as in the other cases, although she imagined some scenes and the bathtub full of water. Although she found text C to be the most abstract of all three, Carmen considered that these images were a support also in this case, in particular, to facilitate comprehension. “The comparison of time with the bathtub full of water that is gradually becoming empty was also very easy to see and to understand.” The data collected from Carmen's translations and reports – and, in particular, her successful rendition of the passages describing spatial relations and the schematic character of her mental images – are coherent with her profile as a spatial visualizer.

### 6.3.4. Diana

Like most participants, Diana was classified as a strong verbalizer. However, her case was different in that she scored below average not just in spatial-image, but also in object-image ability, which may indicate that she relied more strongly than other participants on her verbal ability (see Table 2). Interestingly, she was the only participant who detected and corrected the incoherencies of text C, while her translation of text B showed three incoherencies related to spatial relations. Diana reported having imaged “almost everything” described in text A, and found mental imag-



es helpful to avoid word-by-word translations. She remembered having imagined a sound, which might be coherent with her strong profile as a verbalizer, since language tends to be represented in an auditory form. The translation of text B showed three incoherencies related to spatial-image ability.

(6) **Text B, 3<sup>rd</sup> paragraph**

**Source text:** Furthermore, a right-handed person finds it easier to mount a horse from the left side of the horse, and it would be very difficult to do otherwise *if wearing a sword (which would be worn on the left)*. It is safer to mount and dismount towards the side of the road, rather than in the middle of traffic, so if one mounts *on the left*, then the horse should be ridden on the left side of the road.

**Diana's translation:** Otra ventaja era que para un diestro es más fácil montarse en el caballo desde la izquierda; de hecho, *llevando una espada a la derecha*, era muy difícil hacerlo de otra manera. Es más seguro montar y desmontar hacia el lado de la carretera que en medio del tráfico, así que si uno monta *por la derecha*, se conduce el caballo por el lado izquierdo de la carretera.

[A further advantage was that, for a right-handed person, it was easier to mount the horse from the left side; in fact, it was very difficult to do otherwise *if wearing a sword on the right*. It is safer to mount and dismount towards the side of the road, rather than in the middle of traffic, so if one mounts *on the right*, then the horse should be ridden on the left side of the road].

(7) **Text B, 4<sup>th</sup> paragraph**

**Source text:** These wagons had no driver's seat; instead the driver sat on the left rear horse, so he could keep *his right arm* free to lash the team.

**Diana's translation:** Estos carros no tenían asiento para el conductor; este se sentaba en el último caballo de la fila izquierda, con el fin de que *su brazo izquierdo* estuviera libre para dar latigazos a toda la cuadrilla.

[These wagons had no driver's seat; he sat on the left rear horse, so he could keep *his left arm* free to lash the whole team].

Diana reported having imaged many things during the translation of text B, and she seemed to focus more on objects and people than on spatial relations. She remembered having imagined details that were not explicit in the text ("the roads of dirt and rubble"). She considered that these images had helped her to translate, although in the case of the spatial inconsistencies they might really have hampered the visualization of the spatial relations. Diana was the only left-handed participant, which might also be related to some of the inconsistencies; for example, it could be more natural for her to lash the horses with her left arm, and she could spontaneously simulate the action in this way, as mental simulations are assumed to be embodied and based on experience.

Diana detected the incoherencies of text C and corrected them in her translation. From a total of 51 searches in the whole process, 21 focused on the concepts implied in those incoherencies, *high context culture* and *low context culture*. These 21 searches were made during the translation of the second paragraph, which showed the first incoherence in the source text, and had the highest density of pauses, searches, and typed options. In almost half of the cases (13 of 30), the reworded terms were *high context culture* and *low context culture*. Most rewordings of the third paragraph (10 of 14) focused also on the terms *high context culture* and *low context culture*. Diana reported that she produced very few mental images during the translation of this text, and that these images were not a great help to her.

The data collected from Diana's processes, products, and reports are coherent with her profile of strong verbalizer. She detected the inconsistencies of text C, which were related to the definitions of the concepts *high context culture* and *low context culture*. Although a metaphorical mapping may be implied in their conceptualization (signaled by the opposition high-low), they are quite abstract, and verbal-analytical abilities could be required to detect the incoherencies related

to them. Diana seemed to rely more on her abilities as object visualizer than on spatial strategies, which is also coherent with her profile; although she scored below average in both abilities, her score as object visualizer was higher and nearer the average (see Table 2). This is also coherent with the idea that visual-object and verbal abilities support each other.

### 6.3.5. Eva

Eva scored higher than the professional groups as both verbalizer and object visualizer (see Table 2). However, after translating text A, Eva reported only of fragmented, schematic images; she remembered having visualized some “dark images” related to the Irish cold weather and some colors in the house. She explained that she was “concentrated on syntax and linguistic structures” and that, for that reason, the images were abstract and blurred. Eva’s translation of text B showed some inconsistencies, two of which may be related to spatial relations.

#### (8) Text B, 3<sup>rd</sup> paragraph

**Source text:** Furthermore, a right-handed person finds it easier to mount a horse from the left side of the horse, *and it would be very difficult to do otherwise if wearing a sword* (which would be worn on the left).

**Eva’s translation:** Es más, una persona diestra encuentra más fácil montarse a caballo desde la parte izquierda del caballo, *y le sería muy complicado hacerlo si lleva una funda* (la cual se llevaría en la izquierda).

[Furthermore, a right-handed person finds it easier to mount a horse from the left side of the horse, *and it would be very difficult to do if wearing a scabbard* (which would be worn on the left)].

#### (9) Text B, 4<sup>th</sup> paragraph

**Source text:** These wagons had no driver’s seat; instead the driver sat *on the left rear horse*, so he could keep his right arm free to lash the team. Since he was sitting on the left, he naturally wanted everybody to pass on the left so he could look down and make sure he *kept clear of* the oncoming wagon’s wheels.

**Eva’s translation:** Estas carretas no tenían asiento del conductor, en lugar de eso, tenían un asiento *en la parte izquierda trasera del caballo*, así que él podía mantener su mano derecha libre para dar latigazos con el tiro. Dado que estaba sentado en la izquierda, quería naturalmente que alguien pasara por ese lado para así poder bajar la vista y asegurarse de que *mantenía cristalinas* las ruedas del carro que venía en dirección contraria.

[These wagons had no driver’s seat, instead they had a seat on the *left rear side of the horse*, and so he could keep his right hand free to lash with the team. Since he was sitting on the left, he naturally wanted somebody to pass on that side so he could look down and make sure he *kept crystal clear* the oncoming wagon’s wheels].

Also, in this case, Eva considered that mental images had little relevance during the translation process. She seemed to concentrate more on the demanding task of translating the text than on the images that spontaneously arose in her mind, although she recognized that they could have helped her to find the words she was looking for. Eva’s translation of Text C showed many inconsistencies.

#### (10) Text C, 6<sup>th</sup> paragraph

**Source text:** It’s like having a bathtub full of water which can never be *replaced*, and which *is running down the drain*. You have to use it as *it runs down the drain* or it’s wasted.

**Eva’s translation:** Esto es como tener una bañera llena de agua que no se pueda *mover* y por la que *se desprestigia el desagüe*. Tienes que usarla *aunque se desprestigia el desagüe* o se gaste.

[It's like having a bathtub full of water which cannot be *moved*, and through which *the drain is discredited*.  
You have to use it, even if *the drain is discredited* or wasted].

The data collected from Eva's translations and reports do not correspond to her profile as verbalizer and object visualizer. Not only did she reproduce the incoherencies of Text C; she also produced new inconsistencies, and reported not having paid attention to the few schematic images created while translating. Eva seemed to be more concentrated on linguistic structures than on mental images, which she remembered as abstract and blurred. LASS theory may help to explain this lack of correspondence between Eva's profile and the patterns suggested by the data. Since she needed much effort to process the linguistic forms, she was unable to concentrate on the elaboration and integration of coherent mental simulations. As Eva's attention was not focused on her mental images, these may have remained largely unconscious, with her experience of mental imagery reduced to general impressions of light and color or to images of isolated objects. This would also explain the general lack of coherence of her translations.

## 7. Conclusion

The quantitative analysis of the participants' processes did not yield very significant results. In particular, no systematic correlation was found between the participants' cognitive profiles and the indicators of process fluency, although in three cases the less fluent process corresponded to the participant's less salient ability. However, the small scale of the study did not allow for the search of statistical correlations. By contrast, the qualitative study of the participants' translations and reports did show individual differences in the use of mental imagery. A particular pattern of preferences was detected for each participant, and in four out of the five cases such patterns could be related to their individual cognitive profiles.

Target text data were particularly informative in this respect, suggesting some correlations between individual cognitive preferences and the results obtained when translating texts with different kinds of cognitive demands. The four participants who scored under average in visual-spatial ability produced inconsistencies in their descriptions of spatial configurations, while the only participant with a profile as a strong spatial visualizer did not produce any incoherence of this kind. With respect to verbal ability, the participant with the strongest profile as verbalizer was the only one to detect and correct the inconsistencies of the source text C in her translation, which concerned the definitions of two abstract concepts.

The reports of the participants on their experiences with mental imagery during the translation processes suggested a preference for schematic relations in the case of Carmen, the only spatial visualizer, and for details in the case of the verbalizers Ana, Blanca, and Diana. As verbal and visual-object abilities tend to support each other, it is to be expected that verbalizers will also be object visualizers to some degree, and will focus their attention on details, imaging colorful scenarios, objects, people, and actions.

Eva was the only subject whose ways and results did not seem to correspond to her profile as verbalizer and object visualizer. Even though her translation of text B showed some spatial inconsistencies – matching her low score in visual-spatial ability –, she also produced many other kinds of inconsistencies in her translations – in particular, in text C –, and she could only report of a few schematic images while translating. This lack of correspondence could be explained by her low linguistic proficiency, which, according to LASS theory, would have brought Eva to exert much effort in processing isolated linguistic structures, and not to pay much attention to her mental images.

Due to the small scale of the study, the findings are indicative, and not representative, but, at the same time, the reduced scale has allowed to carry out a detailed, in-depth analysis, which may offer a guide to future research in this area. The self-report Object-Spatial Imagery and Verbal Questionnaire has proved useful as a tool to profile participants in relation to their use of mental imagery, and it can be applied in larger scale studies with translators as well as interpreters to fur-

ther investigate the role played by mental images in translation and interpreting processes. A better understanding of this role could provide further insights into the cognitive processes involved in these tasks, and would be a basis on which to develop didactic strategies and scaffoldings to support learning in this area.

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**Appendix*****Cuestionario final***

**Participante:**

**Sesión:**

**1. ¿Cómo valoras la dificultad del texto, en una escala de 1 (muy fácil) a 5 (muy difícil)?**

**2. ¿Recuerdas haber imaginado algo mientras traducías?**

**3. En caso afirmativo, ¿dirías que estas imágenes han sido un obstáculo o un apoyo para el proceso de traducción?**