

Decision-making processes in direct and inverse translation through retrospective protocols

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Metacognitive aspects of decision-making processes were investigated in eight professional translators who translated related and unrelated texts from L2 English into L1 Portuguese and also from L1 into L2. Retrospective protocols were recorded after each translation task. Verbal utterances were classified into two categories (problem identification and prospective solution) and each one was divided into several subcategories. The data analyses evaluated metacognitive activities during decision-making processes. Results suggest that noteworthy differences between direct and inverse translation can be assessed via retrospective protocols and that translator performance and behavior might be closely related to the source text.

Keywords: direct translation, inverse translation, metacognitive activities, retrospective protocols, translation problems

1. Introduction¹

Verbal protocols have been used to investigate translation processes (Jääskeläinen 2017). For instance, data analyses from various studies have indicated that verbalizations can be systematically analyzed, in terms of both content and production (e.g., Tirkkonen-Condit 1997; Jääskeläinen 1999; Englund Dimitrova 2005). Verbal protocols may be introspective (concurrent think-aloud) or retrospective. Retrospection builds on the assumption that during a translation task, parts of the

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information in the subject's short-term memory will be stored in the long-term memory and can be retrieved afterwards by the subject (Ericsson & Simon 1984).

Retrospective protocols have been used in translation studies in combination with other methods, often with keylogging (Alves 2003; Alves & Gonçalves 2003; Jakobsen 2003; Buchweitz & Alves 2006; Pavlović 2007b; Ferreira 2013, 2014), eye tracking (Carl, Gutermuth, & Hansen-Schirra 2015), and screen recordings (Massey & Ehrensberger-Dow 2013). Several studies have systematically used retrospective protocols alongside other methodological approaches to analyze differences in translation-related decision-making processes among a spectrum of participants. For example, Pavlović (2007a, 2010) compared direct and inverse translation in novice translators. Following Pavlović, here we refer to L2-into-L1 translation as *direct translation*, or DT, and L1-into-L2 translation as *inverse translation*, or IT. Ferreira (2013, 2014) did so among professional translators, and Englund Dimitrova & Tiselius (2014) compared interpreters and translators with and without professional experience.

The current study adds to this line of work and presents an analysis of retrospections in DT and IT. It focuses on reporting problems and solutions, and also on instances of problem indicators when translating in either direction. The goal of our analysis is to describe and contrast the metacognitive activities related to the decision-making processes in DT and IT. We assume that in both tasks “there is not *a priori* only one ‘correct’ solution, in which the cognitive steps can be reliably predicted by a task analysis” (Englund Dimitrova 2005, 70). Furthermore, there are lower-level operations that are non-conscious (review in Chesterman 2016). The first step in this process involves monitoring basic comprehension of the texts to identify the problems and find a solution. However, a translation task involves translation strategies, defined as “potentially conscious procedure[s] for the solution of a problem” (Lörscher 1991, 76). Decision-making processes are responses to the way translators face a problem, because they must set their own goals based on several solutions that can be equally satisfactory for the task at hand. The selection of the solutions, thus, is the result of conscious deliberation and therefore of the translator's task awareness—defined here as the way translators understand the task at hand (Muñoz 2014, 33). This selection might be related to the translation direction. The present study assumes that task awareness has a strong impact on how professional translators solve problems in both translation directions.

In the next section, we present views and critical arguments on translation directionality. Section 3 focuses on metacognitive activities within translation studies and Section 4 offers a discussion of the use of retrospective protocols in empirical-experimental research. The experimental design, data collection procedures and analyses in the current study are summarized in Section 5. Section 6 presents a discussion of the results on how the production of the retrospective

protocols is related to factors intrinsic to the task, and how translators perceive the task at hand. Finally, Section 7 closes the paper with some conclusions.

2. Translating into the L2

Despite the assumption that translators should only translate into their L1 (Beeby 1996; Pokorn 2005), translation is commonly carried out into an L2, especially in countries with languages of limited diffusion (Pavlović 2007a). Researchers based in countries with major world languages (Hansen 1998) seem to underestimate the importance of translation into a foreign language. In some countries, the official language is only mastered by its own residents. In larger linguistic communities without a ‘central status’ (Pokorn 2005, 36), translating into an L2—into English in most cases—is a common practice. Those countries, as well as small language communities, are impacted by the global distribution of power and must provide translation services into the more powerful languages. Such is the case, for instance, in Brazil and China, where translation into English is a customary practice due to its “special position as a *lingua franca* of the global world” (Pavlović 2007a, 81). Translation from and into English “occupies a legitimate space in the translation enterprise” (Campbell 2005, 29). In academia and translator training programs, “market forces ensure that texts written by foreign academics need to be thoroughly domesticated to ensure acceptance by international journals” (Bennett 2013, 169).

Ferreira (2010) pointed out that in Brazil, independent (freelance) translators regularly translate into English simply because clients have difficulty finding local English-native speakers who would be interested in becoming translators, and looking for translators outside Brazil could be more expensive to clients. Long-distance English-native freelancers are available but, ultimately, clients tend to choose the option with the best price. Furthermore, finding English native speakers with solid comprehension skills in Portuguese may also be challenging. Hence, in many countries, the question of whether professionals should translate into the foreign language is not an option (Pavlović 2007b), but rather an everyday reality. Due to the *rapid globalization* of the world’s economies, translation is in high demand and there is no reason to believe that this will change (US Bureau of Labor Statistics 2016).

Research on inverse translation has been rather scant. Pavlović (2007a) administered an online survey to discern the attitudes of professional translators and interpreters towards translating into the L2. When asked about the difference in difficulty between DT and IT, 44% of the respondents stated that DT was easier than IT ; 33% said that IT was easier than DT ; and 23% did not report any differ-

ence. Pavlović argued that DT “falls short of gaining an absolute majority when it comes to how easy the respondents perceive it to be” (90). However, when the professional translators and interpreters were asked whether direct translation was the only way to translate “naturally, accurately and with maximum effectiveness” (Newmark 1988, 3), 42% of the participants agreed or strongly agreed. Although the translators preferred direct translation, the questionnaire revealed that inverse translation reflected their reality. Empirical studies on the nature of inverse translation may help us to understand what aspects impact its perceived higher difficulty compared to direct translation.

3. Metacognition, decision-making, and retrospective protocols

Metacognition refers to “one’s knowledge concerning one’s own cognitive process” (Flavell 1976, 232). In translation studies, metacognition is frequently associated with a monitoring process—“a component of metacognition that involves the ability to reflect on, plan for, and exercise deliberate and strategic control over the progress of a problem solving sequence” (Angelone 2010, 19). Translation may be seen as a sequence of decision-making activities that rely on “multiple, interconnected sequences of problem solving behaviors for successful task completion” (Angelone 2010, 17). Translators need to comprehend the source text (ST) and produce the target text (TT) while constantly monitoring their own processes. Monitoring is described as a crucial step in the process of comprehension: without successful comprehension monitoring, a translator does not know if ST comprehension has succeeded or failed (Yang 2006). When translators face difficulties, the smooth translation process is interrupted and, in many cases, translators experience *uncertainty*, or a “cognitive state of indecision” (Angelone 2010, 18). When this happens, translators often engage in problem solving, looking for solutions and weighing one option against others.

Problem-solving behavior has been analyzed by looking at decision-making processes in experimental conditions. These have been mapped with means such as retrospective protocols, which elicit verbal indicators of problems and solutions during translation tasks. For instance, Tirkkonen-Condit (1997), Jääskeläinen (1999), Künzli (2003), and Buchweitz & Alves (2006) conducted retrospective protocol studies to assess the differences between professional translators and translation trainees regarding their conscious awareness of textual features, global strategies, and the communicative purpose of the TT. The general findings indicate that professional translators are able to verbalize significantly more translation problems, potential solutions, and strategies than students.

Mapping the decision-making process is possible through retrospection, although it does not elicit participants' full recall of the information (Englund Dimitrova 2005). Verbal reports are a valuable and reliable source of recording and analyzing cognitive processes if interpreted "with full understanding of the circumstances under which they were obtained" (Ericsson & Simon 1980, 247). Englund Dimitrova & Tiselius (2014, 196) argue that research must be "precise and exhaustive in reporting the use of retrospective data to allow the reader to fully understand how the collection, analysis and interpretation of the data were carried out." The current study is informed by previous work and recognizes the limitations and constraints imposed by retrospective verbalizations, such as the impossibility of providing the complete recall of the information to which translators have access.

Direct and inverse translation processes are assumed to be fundamentally different; for instance, ST comprehension is more difficult in direct translation (Campbell 1998). On the other hand, inverse translation is assumed to be more cognitively demanding. The metacognitive activities involved in direct and inverse translation should be investigated to describe cognitive effort in translation. Although several factors play a role in the cognitive effort involved in translation, in the present study we will focus on whether there are differences in metacognitive activities between direct and inverse translation.

4. Classifying verbalizations during retrospective protocols

Pavlović (2007b) proposed a classification system for retrospective protocol data.² In the study, the nature and distribution of arguments used by translation students was analyzed to gather tentative solutions during direct and inverse translation tasks. Using collaborative translation protocols, Pavlović found that novice translators had more to say about tentative solutions in the direct translation task compared to the indirect translation task. In both directions, reliance on internal and external resources is necessary but in direct translation subjects might rely more on their internal resources, as they are translating into their stronger language. On the other hand, there might be a tendency to articulate more about the use

2. Some of the categories in Pavlović (2007b) were adapted because of participant characteristics, resulting in the exclusion of some subcategories, as well as grouping and creating another (the subcategory *comparison between the two tasks*, in the *verbalizations* category). In the *actions* category, the subcategories *slash*, *highlighting*, *leaving a gap*, *highlighting*, *typing TT*, *joking*, *seeking or offering opinion or information*, and group profiles were excluded. In the 'solutions' category, the subcategories *tentative solutions* and *optimization quotient* were excluded.

of external support in inverse translation. In any case, further research is needed to test these predictions among professional translators. The present study seeks to fill this gap by quantitatively analyzing the informants' verbalizations in each direction regarding problems and solutions.

4.1 Identifying problems

In translation studies, there is no uniform concept of what constitutes a translation problem (see PACTE 2003 for a discussion). The present study adheres to Krings' (1986) operationalization of translation problems that was expanded by Livbjerg & Mees (2003, 129): "any word or phrase in the text, or any aspect of such a word or phrase, which is verbalized to express any degree of doubt about its proper translation." In our study, we identify translation problems as instances in which the informants overtly state that they are unsure about a specific part of the ST. We also classify verbalizations as devoted to either identifying problems or finding solutions. *Identifying problems* refers to instances where the informants clearly mention that they are facing a type of problem but do not mention any possible solution for it. *Finding solutions* categorizes instances in which the informants describe how they will solve a problem instead of simply identifying a problem.

During their decision-making processes, individuals develop *problem representations*, understood as the "manner in which the information about a problem is mentally organized" (Pretz, Naples, & Sternberg 2003, 6). Participants' comments pointing to problems without mentioning tentative solutions were classified into the following subcategories:

- Reading the ST
- Reading the TT
- Postponing the final decision regarding a translation problem
- Personal preference regarding a solution
- Pragmatic and text-linguistic notions (e.g., cohesion, coherence, consistency, redundancy, style, or register)
- Considering the TT reader to be essential when deciding about a particular solution
- Differences between the DT and IT tasks
- Orthographical
- Morphological
- Lexical
- Syntactic
- Textual
- Other

4.2 Finding solutions

Verbalizations in which the informants make a decision regarding a translational solution, even when they feel as though they were dissatisfied with the solution, are classified as finding solutions in the present study. Oftentimes, such verbalizations may reveal the strategies the informants used. As such, in our data, participants' comments related to finding solutions were further broken down into the following subcategories:

- Spontaneous solutions vs. solutions supported by external resources
- Fluency in the production (e.g., plain comments on when text production goes smoothly or when they get stuck in a passage)
- Selected solutions (e.g., those identified as the appropriate solution for a translation problem)
- Target text vision
- Consulting electronic external resources (e.g., internet browser)
- Standard linguistic rules (e.g., spelling, morphological, and syntactic rules)

5. Materials and methods

In this study, metacognitive aspects of professional translators' ($n=8$) decision-making processes were examined. The participants were recruited from a translation company in a large city in Brazil. They completed a language questionnaire in which they reported regularly translating in both directions for at least the last six years. Although these bilinguals can be expected to have mastered both languages, the connections between lexicon and the conceptual system of both languages might be asymmetrical (Schwieter & Ferreira, 2014). It might be the case that the preferred path of mediation from word to concept depends on developmental factors (e.g., proficiency; see Kroll & Stewart, 1994) or task-based (e.g., translation direction), especially when faced with lexical problems.

Their decision-making processes were analyzed when translating related STs (i.e., on the same topics) and unrelated STs (on different topics) from English into Portuguese (DT) and from Portuguese into English (IT). Data were collected in two different sessions. In the first one (S1), participants translated two related scientific STs (DT and IT) on sickle cell disease. The STs were of similar length (English = 237 words; Portuguese = 243), structure, and coherence (see Appendix). Here, *coherence* was defined as 'smaller textual units combining into larger ones and every part of a text having a role with respect to other parts in the text' (Taboada & Mann 2006). In the second data collection session (S2), ca. six months later, the informants carried out DT and IT of two popular science texts. The texts

were on different topics, yet similar in length (English = 187; Portuguese = 189), structure, and coherence. The English ST described how a crumpled sheet changes its size in relation to the applied force used to compress it and the Portuguese ST dealt with the development of a device that could taste flavors more accurately than the human tongue.

Given that data were collected in two different sessions, task order may have affected the number of verbalizations elicited; that is, we anticipated that the first task would affect the number of verbalizations in the second task. The DT task would be more demanding than the second task regarding ST comprehension. In participants who started with the DT task, this was expected to induce a facilitation effect in the second task (IT). Also, in the first task, the informants would be warming up to writing, and this was also expected to have a facilitatory effect on the second task, independently of the direction.

Strauss & Corbin (1998, 11) argue that qualitative methods can be used to “obtain the intricate details about phenomena such as feelings, thought processes, and emotions.” Because we expected that participants would naturally show different levels of verbalizations, we verified post-hoc whether the informants had more verbalizations in the IT. Our analyses of the results explore these descriptive statistics along with the distribution of metacognitive activity in DT and IT tasks.

5.1 Objectives

The primary objective of this study was to investigate the nature and distribution of the verbalizations by professional translators as manifestations of decision-making and problem-solving processes in DT and IT tasks. Our hypotheses were:

1. The type of verbalizations will be similar in both directions, but the number will be higher in IT.
2. Texts on the same topics will generate more verbalizations than texts on different topics.

IT was expected to yield more problems and more solutions than DT. We anticipated that the types of problems and solutions, however, would be similar in both tasks (e.g., subcategories would occur in both tasks). We further expected that the type of text—STs on the same topic vs. STs on different topics—would influence the results, because the informants would have more time to critically think about their translations, as determined by the number of verbalizations in the tasks.

5.2 Experimental design

The tasks were carried out in a controlled laboratory environment. No time constraints were set during S1 and S2 for translating and retrospection, and participants were free to stop at any time. In S1, four participants carried out the DT task first and then the IT task. The other four participants followed the reverse order. In S2, all informants completed the DT task followed by the IT task, for the sake of consistency. The retrospective protocols were immediately recorded after both DT and IT tasks. Once the TTs were complete and saved in Translog 2006, the informants were interviewed. The Translog replay function was used to review the recorded translation session.³ The informants were asked to freely comment at any time on their difficulties during the tasks while watching their production, but they were not prompted to speak.

6. Results and discussion

6.1 The distribution of the verbalizations: Descriptive analyses

Data were coded so as to allow for quantitative and qualitative analyses of the retrospective protocols. The instances of the subcategories outlined above were counted in S1 and S2 for both DT and IT. Table 1 presents totals for each subcategory as well as overall means and standard deviations. In S1, the number of verbalizations for DT was significantly higher than for IT. Due to the large number of observations for a small number of participants, we turn to our descriptive statistics to further elucidate this observation. Overall, seven of the eight informants made more comments in the DT task than in the IT, while one produced the same number in both tasks. Within the category *identifying problems*, the subcategory most mentioned was *personal preference*, showing the informants' concerns about their own knowledge when making a translation decision, especially in the DT. From the descriptive data, one participant noted:

I think I decided to change it a bit and talk about the 'repeated episodes' and this generates a bit of [...] I did not put anything related to 'organic damage to the body', or whatever the translation for 'wide range of clinical problems' was. It was a personal matter of me not wanting to translate something that was weird.

3. Introductory description of Translog 2006 (text only) at <http://www.translog.dk/default.asp?id=23>

Table 1. Totals, means, and standard deviations for verbalizations in S1 and S2

Problem identification	S1		S2		
	DT	IT	DT	IT	
reading ST	4	3	2	2	
reading TT	6	2	1	1	
postponing the final decision	4	2	1	0	
personal preference	22	15	10	18	
pragmatic/textual reasons	11	13	15	9	
TT reader	0	2	1	1	
what the author wanted to say	0	0	1	0	
comparison between DT and IT	4	4	1	2	
orthography	3	5	0	0	
morphology	2	1	0	0	
vocabulary	21	10	18	25	
syntax	15	3	1	3	
textual problems	0	0	2	0	
other problems	6	7	3	1	
	<i>subtotal</i>	98	67	56	62
	<i>mean</i>	7.0	4.8	4.0	4.4
	<i>standard deviation</i>	7.2	4.6	5.7	7.4
Potential solutions					
spontaneous vs solutions from external resources	39	28	12	14	
consulting external resources	12	9	2	4	
fluency	10	6	1	2	
rule	3	2	0	0	
selected solutions	5	5	11	9	
target text vision	5	3	0	1	
	<i>subtotal</i>	74	53	26	30
	<i>mean</i>	12.3	8.8	4.3	5.0
	<i>standard deviation</i>	12.3	8.9	5.1	5.0
total	172	120	82	92	
mean	86	60	41	46	
standard deviation	12	7	15	16	

The patterns of results in S2 were distinct from those in S1. This was expected, given that we were testing directionality effects on texts with different topics. In S2, the informants produced similar numbers of verbalizations across subcategories in both the DT task (82) and the IT task (92). In the category *identifying problems*, they made more comments in the subcategory *personal preference* in DT (22) than in IT (15). Unlike S1, the number of comments in *personal preference* was higher in the IT (18) than in the DT (10). The type of text in S1—an excerpt from the introduction of a scientific paper—might have led to a more rigid approach to the construction of the TT in the IT task. If the informants had been more critical in their construction of the ST in the DT task, they might have performed more questionings than in the IT task. Their writing processes can potentially involve more flexibility, when feeling that they should be more restrictive in the IT task in S2.

In S2, on the other hand, the text topic and structure may have prompted less criticism in the DT task than in the IT task. *Textual/pragmatic reasons* were also common in the DT task (15), which might point to a high level of awareness of the informants regarding “textual competence”—defined as “the ability to generate coherent, grammatically correct texts that are stylistically and pragmatically adequate regarding the purpose of the translation and the addressee” (Rodríguez & Schnell 2003, 185). In S2, the informants might have been able to show their textual competence in a more critical way because they might have been more aware of their writing processes. As in S1, the subcategory *consulting external resources* was the most mentioned in the IT task (4) and DT task (2), and the subcategory *reading the ST* was also mentioned twice for the DT task. Unlike in S1, *syntax* was barely mentioned in S2: one instance in the DT task and three in the IT task. This could have been due to the informants’ lexicon awareness—the structures were similar and the topics of the texts were different in S2.

The verbalizations allow us to better understand how differences in the way the tasks are carried out may impact the results. For example, the number of verbalizations was higher in S1; this was expected, since the STs in S1 were longer. Nouri (2011) points out that translators of scientific texts need to possess some knowledge (at least general notions) of the subject matter they translate. As can be seen in Table 2, when S1-S2 were compared, the increase in the number of instances in subcategories and in the level of complexity (e.g., STs in both directions were on a highly specific topic and followed an academic structure) led to more time spent in each translation task, more segments, longer pauses, and more recursiveness.

In S1, a facilitation effect in the second task was evident. Not only were the informants faster at the second task, but they also produced longer segments and less recursive movements in the second task, regardless of translation direction.

Table 2. Time, segments, pauses, and recursiveness in S1 and S2

Variable	S1L1	S1L2	S2L1	S2L2
Time (in seconds)	26,788	25,553	9,396	11,113
Number of segments	1,012	913	406	527
Time spent in pauses (in seconds)	17,412	17,297	9,396	11,133
Number of recursive movements	3,223	3,144	1,979	2,661

A few instances of retrospection show that the first task helped the second task, especially in terms of lexical problems, as presented in the subcategory *comparison between the DT and IT* tasks. Four of these retrospective examples include: (1) “Part of the vocabulary I had already learned, and it was easier to translate from Portuguese into English”; (2) “Some terms I just had seen, so the second task was easier”; (3) “Translation of some terms was a bit more automatic, since I had already found them previously”; and (4) “I found it easier especially because I used the knowledge I had acquired in previous translation.”

Interestingly, in S1, the informants produced more comments on lexical and syntactic problems in the DT task than in the IT task. This may have been due to a higher level of critical appraisal when translating into the L1. The difficult topic of S1 might have also called for more cognitive effort.

In S2, verbalizations classified within the subcategory *vocabulary* were the main kind in both DT and IT tasks (18 and 25, respectively), which may be an indication of lexical knowledge in L1 and L2. It indicates that the informants struggled more with lexical selection than with other aspects of the texts (e.g., syntax). The distribution of the category *finding solutions* shows that the informants also presented a relatively high number of verbalizations in both directions in the subcategory *spontaneous solution vs. external solutions* (12 in DT vs 14 in IT). Based on the number of verbalizations related to lexicon (*vocabulary and spontaneous solution vs. external solutions*), we can assume that in S2 effects of directionality were stronger, with more verbalizations in the IT. For instance, in terms of decisions related to vocabulary, idioms, and collocations, the informants faced more problems in the IT task, which involved translating texts on different topics.

6.2 Comparisons by category and by group: Inferential statistics

The sample size was limited due to the difficulty in locating and obtaining data from professional translators highly proficient in both Portuguese and English. Therefore, the results of the statistical analyses below should be interpreted with caution. In order to reduce the number of variables compared across items and

across subjects, data were collapsed across two categories: *identifying problems* and *finding solutions* at two time points, namely S1 and S2. This resulted in four key variables: DT identifying problems, DT finding solutions, IT identifying problems, and IT finding solutions.

Item-level analyses examined all statements by time point for each translation task. Because DT and IT and S1 and S2 were compared among the same participants, paired-samples *t*-tests were conducted for the following pairs: (1) DT versus IT at S1; (2) DT versus IT at S2; (3) total DT versus IT responses; and (4) total S1 versus total S2. As shown in Table 3, results revealed significant differences for the first, third, and fourth pairs. Table 3 also shows the large variability in responses as illustrated by the large standard deviations, which affected significance levels.

Table 3. Analyses of coding categories by item, paired samples *t*-tests

Variable pairs	Variable 1	Variable 2	<i>t</i> -value, Sig.
S1 DT vs. S1 IT	15.25 (10.1)	8.37 (6.3)	3.96**
S2 DT vs. S2 IT	6.00 (3.3)	6.88 (6.0)	-0.50
Total DT vs. total IT	21.25 (12.9)	15.25 (9.7)	2.39*
Same (S1) vs. different (S2) topic	16.06 (5.7)	8.23 (2.9)	2.27 ⁺

Correlations were calculated for each of the four variables (i.e., DT identifying problems, DT finding solutions, IT identifying problems, and IT finding solutions). Although significant correlations were found among the variables, it was apparent that the data could be best characterized by dividing participants into two groups of four participants based on whether they had high and low number of verbalizations. Comparisons confirmed differences between the two groups for the four variables (see Table 4). Effect sizes were moderate to high for the group comparisons, $\eta^2 \leq .585$.

Table 4. Comparison across DT and IT tasks for participants showing high and low verbalizations

Variable		Low verbal	High verbal	<i>F</i> -value, Sig.	η^2
identifying problems	DT	10.50 (4.9)	31.50 (13.6)	8.45*	.585
	IT	7.00 (2.5)	25.00 (4.1)	57.18***	.905
finding solutions	DT	6.75 (5.1)	18.25 (4.3)	11.89*	.665
	IT	4.00 (0.8)	16.50 (6.6)	14.31**	.705

6.3 Discussion

In this project, we analyzed the metacognitive activities in DT and IT tasks by studying the number and the types of verbalizations in two data collection sessions. In S1, the two STs dealt with the same topic; in S2, with different topics. We expected that in S1, the informants might experience a facilitation effect which would decrease in S2, when STs were on different topics. This would potentially indicate that some cognitive aspects might depend on the task at hand (e.g., that the number of verbalizations is related to the thematic continuity). However, results showed that in S1 the informants produced significantly more verbalizations in the DT task than in the IT task, regardless of the task order. In S2 they also produced more verbalizations in the IT, although this difference was not statistically significant. The analysis with inferential statistics shows that there were significant differences between DT and IT and also between S1 and S2. In S1, all participants but one produced 30% more comments in the DT task than in the IT task. In S2, however, participants tended to produce a similar number of verbalizations in both directions, and the number of verbalizations in each category was slightly higher in IT. Half of the participants produced more verbalizations in the DT task, one translator produced the same number in both directions, and three participants presented more verbalizations in the IT task. Overall, more verbalizations were produced in S1 than in S2 potentially because the STs were longer and the higher difficulty of the topic might have required more metacognitive effort.

The present study sought to test whether differences in DT and IT tasks could be assessed through the verbalizations in the tasks. Results showed that in S2, when participants translated texts on different topics, they had more difficulty with IT. In S1, the informants produced more verbalizations in the DT task. It might be the case that translation into the L1 involves more metacognitive activity and allows translators to express themselves better as a result of a higher awareness towards the TT in the L1. This may especially be the case after having translated the same topic. In S2, the opposite was supported, perhaps because the informants' main concern might have been the lexical decisions. More importantly, the difference in S1 and S2 is likely related to the type of ST.

7. Conclusion

This study aimed to explore directionality in translation by analyzing instances of metacognition through retrospective protocols of translation tasks with different STs. The kind of the STs played a crucial role in the informants' behavior. The level of difficulty of the STs may play an important role when producing a translation,

whether into the L1 or the L2. The informants might have been more concerned with some ST aspects (e.g., style or vocabulary) in the DT task than in the IT task, since production into their stronger language (La) might have prompted a higher level of self-criticism, as evidenced in the number of verbalizations in S1. When working with STs with different topics, however, the informants' behavior was also different (see also Ferreira 2013) in terms of time, pause length, recursiveness, and segmentation.

Even though it was not the focus of this study, we speculate that bilingual skills might play a fundamental role in translation directionality. In most translators, information regarding pragmatic, socio-linguistic, textual, grammatical, and lexical knowledge may be differentially represented in their bilingual minds. Individual differences and performance variations in bilingual processing may be the products of L1 and L2 lexical asymmetries. Our study shows how difficult the search is for balanced, highly-proficient bilingual translators to participate in experimental research. It also shows the difficulties in finding speakers of a major language such as English who achieve native or near-native competence in a language of limited diffusion like Portuguese and who subsequently become professional translators working in both directions. Factors related to individual differences in verbalization during the retrospective protocols were not explored in detail due to sample and space limitations. More studies, including experiments with different linguistic pairs and similar STs translated by native and non-native translators, could offer further insights into the translation process, leading to a better understanding of translational behavior in experimental conditions.

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Appendix Source texts

S1—English source text

Coagulation activation and inflammation in sickle cell disease-associated pulmonary hypertension

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Pulmonary hypertension (PHT) is a common complication in patients with sickle cell disease (SCD), with a reported prevalence of approximately 30%.^{1, 4} Multiple studies have shown that PHT is associated with increased mortality in SCD patients.^{2, 4, 7} The pathogenesis of PHT in SCD is probably due to a variety of factors. Recent evidence suggests a central role for chronic intravascular hemolysis, with associated scavenging of nitric oxide by cell-free plasma hemoglobin.^{4, 8, 9} Arginase, which converts L-arginine (the substrate for nitric oxide synthesis) to ornithine, is also released following hemolysis.¹⁰ Elevated arginase activity, and the resultant decrease in the arginine/ornithine ratio, is associated with PHT in SCD.^{4, 11} Although various studies have found no association between PHT and a history of acute chest syndrome,^{3, 4} chronic lung injury resulting from repeated episodes of acute chest syndrome may lead to the development of PHT due to chronic fibrotic pulmonary parenchymal damage, altered vascular tone, vascular proliferation, hypoxia and consequent pulmonary vasculopathy. Finally, pulmonary thromboembolism^{12, 13} and progressive endothelial damage with concentric pulmonary vascular intimal hyperplasia and *in situ* thrombosis^{13, 14} may also contribute to the pathogenesis of PHT in SCD. The aim of the present study was to determine whether coagulation activation and inflammation are associated with PHT in SCD. Furthermore, we aimed to assess correlations between measures of coagulation activation and inflammation with markers

of hemolysis. To address these questions, we evaluated a cohort of patients followed at an adult Sickle Cell Clinic.

S1—Portuguese source text

Hidroxiuréia em pacientes com síndromes falciformes acompanhados no Hospital Hemope, Recife-PE

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Introdução

As síndromes falciformes (SF) constituem um conjunto de moléstias qualitativas da hemoglobina, nas quais herda-se o gene da hemoglobina S.¹ Destas, a mais freqüente é a anemia falciforme (homozigose SS) cujos pacientes apresentam danos orgânicos desde a infância, resultantes dos episódios vaso-oclusivos repetidos.² Vários estudos em adultos vêm demonstrando a eficácia do uso da hidroxiuréia (HU), cujo efeito principal é a elevação dos níveis de hemoglobina fetal (HbF) em pacientes portadores de SF com pouco ou nenhum efeito colateral.^{3, 4, 5, 6} A HU é um agente quimioterápico bastante conhecido e utilizado para tratamento de síndromes mieloproliferativas como leucemia mielóide crônica e policitemia vera. Sua função principal encontra-se no bloqueio da síntese de DNA através de inibição da ribonucleotídeo redutase, mantendo as células em fase S.¹ É de fácil utilização, com poucos efeitos tóxicos e com um efeito mielosupressor facilmente revertido. O uso da hidroxiuréia nos protocolos de tratamento da anemia falciforme (AF) teve seu início na década de 80, nos pacientes adultos, sendo o seu uso posteriormente autorizado em crianças.⁷ Ao longo dos anos, estudos em crianças têm demonstrado igual eficácia de HU sem grandes efeitos colaterais.^{2, 7, 8, 9, 10} Assim, o presente estudo teve como objetivos, a partir de uma série de casos, investigar a eficácia e a tolerabilidade ao uso de HU por pacientes portadores de SF nas faixas etárias pediátrica e adultos jovens, bem como avaliar variações de parâmetros hematológicos em ambos os grupos etários e dos valores da Hb F, no grupo pediátrico.

S2—English source text

Crumpling a sheet of paper seems simple and doesn't require much effort, but explaining why the crumpled ball behaves the way it does is another matter entirely. Once scrunched, a paper ball is more than 75 percent air. Yet, it displays surprising strength and resists further compression, a fact that has confounded physicists. A report in *Physical Review Letters*, though, describes one aspect of the behavior of crumpled sheets: how their size changes in relation to the force they withstand.

A crushed thin sheet is essentially a mass of conical points connected by curved ridges, which store energy. When the sheet is further compressed, these ridges collapse and smaller ones form, increasing the amount of stored energy within the wad. Scientists at the University of Chicago modeled how the force required to compress the ball relates to its size. After crumpling a sheet of thin aluminized Mylar, the researchers placed it inside a cylinder equipped with a piston to crush the sheet. Instead of collapsing to a final fixed size, the height of the crushed ball continued to decrease, even three weeks after the weight was applied.

S1—Portuguese source text

Avaliar um bom café ou um bom vinho é para os degustadores uma tarefa relativamente simples, mas quantificar de forma precisa o resultado dessa avaliação é outra história. A apreciação feita por esses profissionais baseia-se em habilidades adquiridas com formação, prática e experiência. Contudo, seus veredictos distam de ser considerados precisos, fato que dificulta a avaliação de bebidas em grande escala. Uma notícia publicada na Fapesp online, todavia, apresenta um produto desenvolvido por pesquisadores brasileiros que promete resolver esse problema: a ‘língua eletrônica’, aparelho que permite avaliar sabores com precisão muito maior que a humana.

Partes da superfície da língua humana são constituídas por receptores sensoriais denominados papilas gustativas, as quais identificam sabores. Cientistas da Embrapa projetaram um sensor gustativo, capaz de avaliar nuances de sabor e a presença de impurezas em bebidas com um maior grau de sensibilidade em relação às papilas existentes na língua humana. Os pesquisadores utilizaram microeletrodos revestidos com uma camada fina de polímeros condutores para obter uma resposta elétrica específica para cada substância. O dispositivo atua como o cérebro humano e fornece uma resposta sempre que encontra correspondência com tipos de paladar previamente registrado.

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