Chapter 7
Investigating Translator-Information Interaction: A Case Study on the Use of the Prototype Biconcordancer Tool Integrated in CASMACAT

Julián Zapata

[R]egardless of how our universe got to be the way it is, we can start our story with a world based on information.
— Ray Kurzweil, How to Create a Mind (2013)

Abstract This chapter introduces translator-information interaction (TII) as the field of study that investigates translators' interaction with (digital) information and information tools. In particular, the current chapter examines translators' interaction with a prototype biconcordancer (BiConc) tool integrated in the CASMACAT workbench. The BiConc was introduced in the third CASMACAT field trial (The data of the third CASMACAT field trial is stored in the TPR-DB under the study name CFT14, cf. Chap. 2, this volume.) a post-editing experiment involving seven English-to-Spanish professional translators. In addition to external online tools, the BiConc was one of the informational resources that participants could use while post-editing two machine-translated texts under two different conditions: (1) traditional post-editing and (2) interactive post-editing with online learning (A description of the CASMACAT online-learning mode is provided in Chap. 3 in this volume). In the case study reported in this chapter, only the segments in which participants used the CASMACAT BiConc tool were examined. On the basis of screen recordings, the present study analyses the way translators interacted with the BiConc and other informational resources in order to solve a particular problem while post-editing. Overall, the chapter argues that human-centered research is essential not only in the understanding of the cognitive processes involved in translation activity, but also in the development and the improvement of tools intended to better address the professional needs of translators. Thus, this case study and subsequent TII investigations can be used to inform the efficient integration of the BiConc tool and other informational resources to CASMACAT and other future-generation (web-based) translation environments.

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7.1 Introduction

In our day, translation is essentially both a computer-interaction task and an information-interaction task. Indeed, throughout history, human translators have used an array of tools not only to write their translations but also to search and store information. In the digital age, information and communication technologies (ICTs),[1] and in particular language technologies (LTs),[2] are integral parts of the translation field, and have decidedly had a significant impact on translation research, practice and teaching.

The current chapter introduces the notion of translator-information interaction (TII) as the field of study that investigates translators' interaction with (digital) information and information tools. This new notion complements that of translator-computer interaction (TCI), coined by Sharon O'Brien in 2012. TII and TCI represent logical extensions of the fields of human-information interaction (HII) and human-computer interaction (HCI) respectively. Now, although TII and TCI are emerging fields of research, the interaction of translators with computers and digital information is not a recent phenomenon, as O'Brien (2012, pp. 103–104) explains:

> Already with the introduction of the electronic typewriter, with only two lines of memory, and the use of dictaphones, translation became a computer-interactive task. This was followed by the introduction of word-processing software [. . .][,] a development that would have required some translators to interact with a computer for the first time. Not long after the mass embracing of word processing, came the introduction of Translation Memory tools [and] terminology management programs, which are [. . .] not restricted to the [parallel] storage of terms [in two languages], but also store phrases and sometimes even sentences or larger chunks of text [. . .].

In sum, in the age of ICTs, translators have adopted different types of computer tools in an effort to facilitate their work and carry out their tasks effectively (Austermühl 2001; Bowker 2002). For instance, parallel bilingual resources, as

[1]ICTs are defined as the bulk of technological applications based on computing, microelectronics, telecommunications and multimedia, the combination and interconnection of which allow people to search, capture, process and transmit data of different nature (text, audio, image, video, etc.); to interact with each other and with machines; to access information; and to spread and share information (Touré et al. 2009, p. 35).

[2]LTs are defined in this chapter as the bulk of natural language processing (NLP) applications that facilitate the active or passive use of a natural language. Certain LTs are developed for the general public, while others are developed for language professionals (e.g., writers, translators, terminologists, etc.). LTs may be divided in two categories: spoken-language-based and written-language-based. Each one of these categories may be divided into two types: passive applications (e.g., unchangeable information on the web or electronic/online dictionaries and term banks) and active applications (e.g. text processing software, spellcheckers and speech recognition systems).

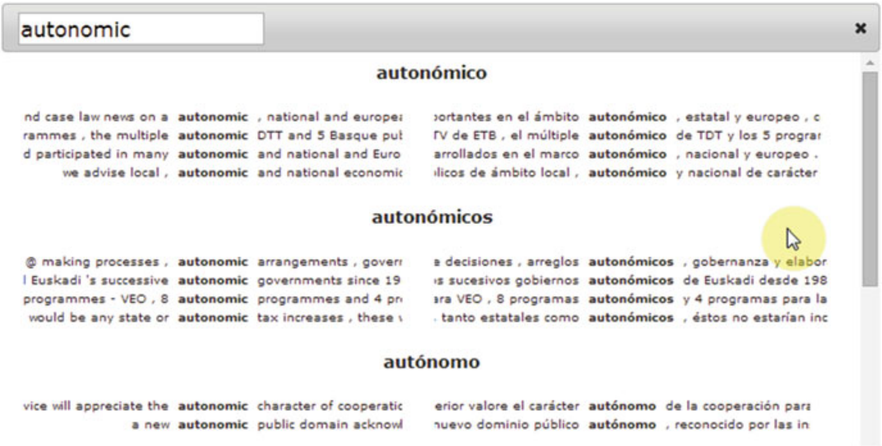

Fig. 7.1 Example of a search result in the prototype biconcordancer tool integrated in the CASMACAT translator's workbench

described above by O'Brien, have been built and used for over two decades (Langlois 1996). The present chapter deals in particular with an increasingly popular type of parallel bilingual resource: bilingual concordancers, or *biconcordancers*. This type of informational tool allows the user to search for a word, or any character string, within a previously-aligned bilingual parallel corpus. Hence, the search result consists of a list of segments in a language A containing the searched character string, and their corresponding segments in a language B, as illustrated in Fig. 7.1.

By way of a literature review and a case study, a new approach in empirical translation process research (TPR) is proposed in this chapter, that is, the investigation of translator's interaction with (digital) information and informational tools, or TII. More specifically, the chapter reports on translators' interaction with the first prototype of a biconcordancer (BiConc) integrated in the CASMACAT workbench. The BiConc tool was introduced in the third CASMACAT field trial (CFT14), a post-editing experiment conducted with seven English-to-Spanish professional translators in a Madrid-based translation company.

Several questions motivate TII research: how well do human translators work with the information and informational tools they currently have at their disposal? How accurate, rich and relevant is the information they find? How user-friendly are informational tools for translators? How can the information and the tools be improved to maximize translators' performance and well-being, and the quality of their work? As far as the CASMACAT workbench is concerned, how can the performance of the built-in BiConc tool be assessed and improved? What are the advantages and drawbacks of integrating an informational tool to a translation environment, as compared to having an array of external web-based resources? These are some of the questions that motivated the present investigation, which remains exploratory given the scope and limitations of a pilot study and of the Translation Data Analytics (TDA)[3] project, and are partly dealt with in this chapter.

Overall, the chapter argues that human-centered research is essential not only in the understanding of the cognitive processes involved in translation activity, which is TPR's ultimate goal (Balling and Carl 2014; Jakobsen and Jensen 2008; Jakobsen 2003, 2011; O'Brien 2009), but also in the development and the improvement of tools intended to better address translators' professional needs (Carl et al. 2011). Thus, this case study and subsequent investigations in the same vein can be used to inform the efficient integration of the BiConc tool and other informational resources to the CASMACAT workbench and other future-generation translation environments.

7.2 Theoretical Framework: From Translator-Computer Interaction to Translator-Information Interaction

It is difficult to think about translation today without thinking about computer tools and technologies. In recent years, there has been an increased awareness of the significance of technologies and the role they play in translation research, teaching and practice. More than ever before, translation researchers, trainers and professionals are aware of the importance of improving existing tools and creating new tools to cope with the evolution of technology and the ever-changing professional needs of translators. There is a tangible need to design and develop ergonomic and flexible interfaces that take the human factor into consideration and that are adapted to the translator's workflow and needs (Carl et al. 2011; LeBlanc 2013; O'Brien 2012; Taravella and Villeneuve 2013), since any application that is too rigid impedes the work that it is meant to support (Karamanis et al. 2011, p. 49). Given the current state of affairs, research that takes the human factor into account is bound to play a more prominent role in translation tool design and implementation in the years to come.

Simply put, HCI research focuses on designing computer applications that are *useful*, *usable* and *universal* (Shneiderman 2008). A typical HCI research project seeks to design or redesign a particular computing technology in order

[3]This pilot study was carried out within the framework of the TDA project held in July-August 2014 at the Centre for research and innovation in translation and translation technology (CRITT), located at the Copenhagen Business School, in Denmark. The aim of the TDA project was to explore and analyse translator-computer interaction data available in the CRITT TPR-DB in an effort to assess and elaborate methods to produce data-driven user profiles, to investigate differences in communication styles, and to identify patterns of user behavior for more and less successful man–machine communication. The TDA project was supported by the European Union's 7th Framework Program (FP7/2007-2013) under grant agreement 287576 (CASMACAT).

to (1) improve upon or enhance a given experience or (2) create a quiet different experience than before (Harper et al. 2008, p. 58):

> In both situations, initial research is conducted by learning more about people's current experiences [...]. Ethnographic studies, logging of user interaction and surveys are commonly deployed. Based on the findings gathered, we begin to think about why, what, and how to design something better. To aid the process, usability and user experience goals are identified and conceptual models developed. Prototypes are built, evaluated, and iterated, demonstrating whether the user goals have been met or whether the new user experience is judged to be enjoyable, pleasurable or valuable by the target group.

Thus, usability studies combining tool use and translation processes are therefore more than necessary in translation research, as O'Brien (2012, pp. 116–117) argues:

> [TCI] would likely benefit from an increased focus on ethnographic-style, cognitive ergonomic studies of both translation tools and the translation process itself [...]. More experimental studies of translator-tool interaction could be carried out using formal usability research methods such as screen recording, eye tracking, and observation, the results of which could then be used by translation technology developers to improve the specifications of tools for the benefit of translators and, ultimately, the end users of those translations.

As stated in the introductory section, the work described in this chapter aims at proposing a new approach in empirical TPR, that is, the investigation of the way translators interact with (digital) information and informational tools. Thus, TII would complement O'Brien's notion of TCI. Furthermore, the idea that TII is a larger discipline that encompasses TCI is put forward. Indeed, some HCI and HII researchers argue that HII constitutes a larger discipline, since it looks beyond computers. It focuses on the interaction between humans and the information in the environment, in all its complexity, regardless of the tools used to facilitate such interaction (Fidel 2012; Gershon 1995; Marchionini 2008); the computer just happens to be one of the mediums that facilitate or mediate the interaction with the information we need and produce. Humans have always been in constant interaction with information, be it via machines or not. Our world is based on information (Kurzweil 2013, pp. 2–3).

The study of the interaction between humans and information is not new. However, with the advent of ICTs and, in particular, of the Internet, the field of HII has become particularly popular within the research communities in computer science and an array of other disciplines (Fidel 2012, pp. 17–21). The massive influx of mobile, Internet-connected devices has led humans to new ways of accessing enormous quantities of information and services at any time and from practically anywhere, making it necessary to investigate HII from every angle and every field, and to strengthen HII as a multidiscipline.

Two research areas related to HII are particularly well grounded today, and offer a great potential in empirical TPR: information retrieval (IR) and information behavior (IB). The former investigates the models and mechanisms of (computer) systems that allow or facilitate the retrieval of information. The latter examines information research strategies, information evaluation criteria, and the modalities and contexts of information use. In other words, while IR focuses on developing and improving informational tools, IB investigates the ways of browsing the different sources of information, and of evaluating if the information found is adequate for solving a given problem in order to use it according to the constraints set by the context (Fidel 2012, pp. 35–37).[4] Thus, IB informs IR research: In the search of informational tools that are more efficient, it is necessary to meticulously investigate translators' interaction with the different informational resources that are currently made available to them. It is also essential to include real users working in real-life situations when assessing the usability and the performance of new tools and tool prototypes, which in return helps designers and developers in making key decisions about particular aspects and features of a user interface.

In sum, TII offers a great potential in empirical TPR and translation studies in general since, in the search for translation tools that are efficient, ergonomic and well-adapted to translator's needs, it is necessary to thoroughly study translators' interaction with information and with the different informational resources they use to carry out their tasks. Let us now illustrate TII research by presenting, after a brief overview of the CFT14 experiment, the methodology and the results of this case study looking into professional translators' interaction with the CASMACAT built-in BiConc tool prototype and other external informational tools, and with the information retrieved in those resources.

7.2.1 The CFT14 Experiment: An Overview

This pilot TII study was performed based on data collected during the third CASMACAT field trial (CFT14), carried out in June 2014 by researchers from the CRITT (Alabau et al. 2014).[5] The CFT14 consisted in delivering the CASMACAT workbench to professional English-to-Spanish translators and having them post-edit two 4500-word medical specialized texts (package leaflets for schizophrenic patients) under two different conditions: (1) traditional post-editing with no assistance during the process (P), and (2) post-editing through interactive translation prediction featuring online learning (PIO). The 2 texts consisted of 131 and 141 segments respectively. They were pre-translated using a statistical machine translation (SMT) engine and then loaded into the CASMACAT environment for participants to post-edit them. An eye-tracker was used to record participants' gaze behavior. Lastly, a questionnaire followed the experiments.

[4] According to Fidel (2012, p. 85) context is important because, even before carrying out any search, it is context that shapes the informational needs, since the motivation to search for information is not only cognitive, but also contextual.

[5] The team of researchers listed below are to be acknowledged for their work on the CASMACAT workbench and, in particular, for running the CFT14 experiment and providing us with the data presented in this section: Vicent Alabau, Michael Carl, Francisco Casacuberta, Mercedes García Martínez, Jesús González-Rubio, Bartolomé Mesa-Lao, Philipp Koehn, Daniel Ortiz-Martínez, and Moritz Schaeffer.

The principal goals of this field trial were: (1) to assess the benefits in terms of productivity derived from introducing online-learning techniques; (2) to investigate how post-editors use informational tools during the post-editing process, in particular the built-in BiConc tool; (3) to assess how professional reviewers use the newly-introduced CASMACAT electronic pen functionalities while reviewing post-editors' output; and (4) to collect feedback from reviewers using the electronic pen as an additional input method for revision (*ibid.*).

All post-editors were freelance translators recruited by *Celer Soluciones* SL, a Madrid, Spain-based translation company. Participants were 35 years old on average. They were all regular users of language technologies in their day-to-day work. All participants but one had experience post-editing machine-translated texts as a language service.[6] More detailed data on the participants' age, expertise, education, etc., is available in the CRITT TPR database[7] (metadata folder; see also Hvelplund and Carl (2012) for a description).

Participants were all given the time to familiarize themselves with the CASMACAT workbench; some of them were using it for the first time. Likewise, in order to ensure an equal distribution of texts and conditions across participants, variables were counterbalanced from participant to participant.

To measure whether participants become faster when post-editing with interactive translation prediction and online learning techniques (goal 1 of this field trial), task completion times and keystroke activity were measured and analyzed. Time was measured using *FDur*, *KDur* and *PDur* values (see Chap. 2, Sect. 2.4.6, for a definition of these values). In order to measure the productivity benefits derived from introducing online-learning techniques during the post-editing process, the amount of technical effort (i.e. the number of insertions and deletions needed to correct the raw SMT output) was calculated for the two conditions. Keystroke activity was measured by using *Mdel* values (i.e., number of manually generated deletions) and *Mins* values (i.e., number of manually generated insertions). It is important to make the distinction between manual and automatic insertions and deletions since the interactive translation prediction functionality triggers a number of automatic insertions and deletions that do not require any technical effort (i.e. typing activity) from the post-editor (*ibid*,). Table 7.1 compiles the keyboard activity and production time measures across participants.

Now, usability studies such as the CFT14 should take into account the translation/post-editing process as a whole in order to control for any possible confounding variables that may have an impact on the data. Results of the CFT14 (see Alabau et al. (2014)) (also reported in this volume; see Chap. 4) show in particular that post-editors did not seem to be faster under the PIO condition. However, a more in-depth qualitative analysis of the process data collected shows

[6]Only participant 4 (P4) reported that she did not have any experience in post-editing. As it will be seen in the Methodology section below, this does not have an impact on the results of the pilot experiment reported in this chapter.

[7]Available at: https://sites.google.com/site/centretranslationinnovation/tpr-db

Table 7.1 Overall typing activity measures and production times

Participant	Cond	Ins/ST char	Del/ST char	Fdur	Kdur	Pdur
P1	P	0.88	0.79	469	290	138
P1	PIO	0.73	0.38	467	245	117
P2	P	0.85	0.70	418	265	129
P2	PIO	0.66	0.25	572	234	105
P3	P	0.45	0.41	420	227	71
P3	PIO	0.47	0.32	579	257	95
P4	P	0.54	0.46	657	217	112
P4	PIO	0.67	0.21	517	261	142
P5	P	0.63	0.53	331	262	132
P5	PIO	0.45	0.31	325	253	120
P6	P	0.51	0.45	704	230	84
P6	PIO	0.40	0.14	433	230	88
P7	P	0.68	0.63	530	197	63
P7	PIO	0.41	0.32	444	217	75
Average	PIO	0.54	0.27	476	242	106
Average	P	0.65	0.57	504	241	104
Average	P + PIO	0.60	0.42	490.43	241.79	105.07

that an explanation for this can be found in the participants' information behaviour. Actually, working with online-learning techniques was observed to have a positive impact in terms of efficiency gains, but only when the time used by post-editors to search information is not taken into account (*ibid.*). Thus, it is evident that overall task completion times might not be a good indicator of performance when the post-editor needs to conduct informational searches to verify the quality of and improve the SMT system output. Now, even though participants did not become faster in terms of task times, their keyboard activity, as reflected in *Mins* and in particular in *Mdel* values, shows that post-editors had to type less when post-editing with interactivity and online learning techniques (condition PIO) as opposed to doing traditional post-editing (condition P). This means that online-learning techniques may help post-editors to save some effort during their work: Participants working under the P condition deleted 0.65 keystrokes and inserted 0.57 keystrokes on average per source text (ST) character. However, in the PIO condition, they inserted 0.54 keystrokes and deleted 0.27 keystrokes per ST character on average. Thus, a comparison of keyboard activity in both conditions shows that there was a decrease in the number of insertions and deletions in the PIO condition. Since both texts were comparable in size and translation difficulty, this decrease in technical effort (i.e., typing activity) must be attributed to the expected benefits of online-learning techniques during the post-editing process. See also Chap. 3 for similar findings.

This being said, based on this data alone, one cannot explain the fact that there were no significant benefits in terms of efficiency gains when overall task times are considered. Preliminary observations of screen recordings of all post-editing sessions pointed to the fact that participants often double-checked, in various informational resspurces, solutions proposed by the SMT system, even when those solutions had been populated throughout segments by the machine-learning technique implemented for the PIO condition.

The present chapter deals primarily with the second main goal of the CFT14 experiment: the investigation of post-editors' interaction with informational tools and, in particular, with CASMACAT's built-in BiConc tool. The following sections describe the methodology and the results of this pilot investigation.

7.2.2 Methodology

For the purposes of this pilot TII study, only the segments in which CFT14 participants used the CASMACAT BiConc tool were examined. By using the BiConc, post-editors were able to retrieve information such as term equivalents and collocations (see Fig. 7.1 in the introduction Sect. 7.1), which would guide them in making an informed decision while solving a particular translation problem. The BiConc's search results are sorted by their relative frequencies (i.e., the most probable translations are shown first) based on the training data available in CASMACAT.

Using the CFT14 log files (i.e., the "event.xml" files), a script using the Cygwin[8] terminal was run to extract data about the post-editing segments where the BiConc tool was used at least once. A total of 55 instances of BiConc use were found. For each one, the script provided us with the following data: *Event ID* (i.e., information on the participant's identity, the text number and the post-editing condition; e.g., "P01_P2" (meaning "Participant 1, post-editing condition P, text 2"); *segment ID* (e.g., "10804"); and *token(s) searched* (e.g., "autonomic"). With the segment ID in hand, it was then possible to extract, from the CFT14 log files, the source segment (i.e., the original segment in English), the raw SMT output, and the participant's final target (i.e., the final segment in Spanish after the entire project was saved). An MS Excel spreadsheet was created to store and analyse these data. For each one of the 55 instances found, the data was stored in columns as follows: Event ID, segment ID, token(s) searched, source segment, raw SMT output, and final target segment.

The core of this pilot investigation was the examination of screen-capture videos.[9] Thanks to these videos, it was possible to observe and analyze the way translators interacted with the BiConc tool (and other external informational resources) in order to solve a given problem while post-editing those segments. Additional columns were then added to the Excel spreadsheet to store data such as information relevance (see *Experimental results and analysis* below); the

[8]The Cygwin package is available at: www.cygwin.com

[9]The videos are available in .fbr format in the following address: http://bridge.cbs.dk/field_trial3/VIDEO/. While playing the files, it is necessary to forward the video to the specific segment being analyzed. The segment ID can be seen on the left hand side of the CASMACAT user interface.

external informational resources used, if any; and notes (i.e., other observations and hypotheses, some of which are reported in Table 7.2 in the following section).

7.3 Experimental Results and Analysis

A first glance at the dataset allowed us to notice that only three out of the seven participants in the CFT14 study made use of the BiConc; event IDs only showed activity for participants P1, P3 and P7 in both post-editing conditions (i.e., P and PIO).[10] P7 carried out the most searches in the BiConc (24 in total); P3 carried out 20, and P1 carried out 11 searches. Figure 7.2 illustrates the use count of the BiConc per participant and per condition.

It is worth noting that participants who did not use the BiConc were also the ones who reported using fewer external resources overall. Also, among the reasons for not using the BiConc, participants P2, P4, P5 and P6 reported in the questionnaire that they forgot that they had this possibility and only used those informational tools with which they were already familiar (see Chap. 5).

It can also be observed that participants who did use the BiConc made it in both P and PIO conditions, but with a considerable difference between them. P1 and P7 used the BiConc fewer times in PIO. Generally, this could be attributed to the fact that successful searches[11] followed by edits in the text resulted in improved SMT outputs, since solutions approved by the user are populated throughout segments thanks to the online-learning technique implemented. However, P3 shows the opposite search pattern, with many more searches in the PIO condition. To find an

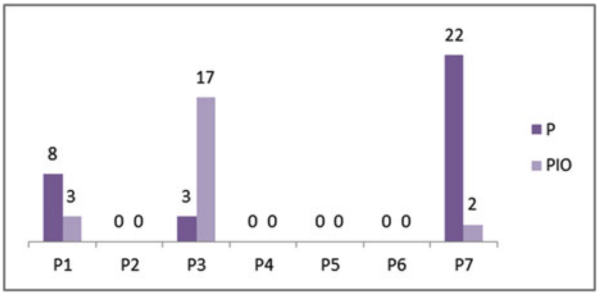

Fig. 7.2 Use count of BiConc tool per participant and per condition

[10]By examining the videos, it was possible to notice that the BiConc tool was not accessible to P4 in neither condition (i.e. that the BiConc tool button did not appear on the CASMACAT interface). The reason for this issue is unknown. Thus, only half of participants who had access to the tool actually made use of it.

[11]The notion of information relevance will be discussed below.

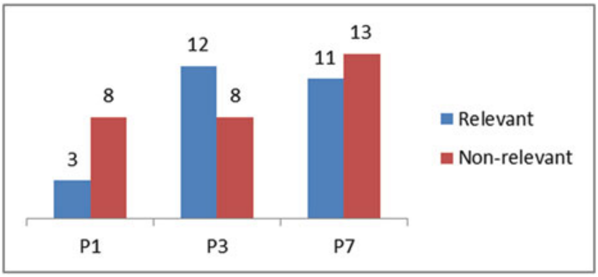

Fig. 7.3 Information relevance measurements per participant

explanation for this difference, it is necessary not only to look into the experimental design (see Sect. 7.2.1) but also to closely examine the screen recordings for P3's post-editing process. P3 post-edited text 1 in PIO making use of the BiConc but with few cases of successful information retrieval (see Fig. 7.3), which seems to have affected her confidence in the BiConc when post-editing the second text (under the P condition), where she still made a fair number of searches during the post-editing task, but preferred external resources over the CASMACAT built-in BiConc tool.

In addition to the number of times post-editors actually used the BiConc, it was also important to investigate the number of times such searches led to successful cases of information retrieval. This can be associated with the concept of *relevance*, extensively discussed in the HII literature.[12] As pointed out by Fidel (2012, p. 26), the evaluation process is almost always necessary when retrieving information (from digital information systems). Indeed, once information is acquired, a person examines and evaluates that information to discern what is relevant (and what is not) to the particular problem they are trying to solve.

Determining information relevance has been considered a monumental, complex endeavour, primarily because the judgement of relevance can be both subjective and dynamic (*ibid*., pp. 27–32). As this challenge is being acknowledged, it is argued that, as far as this chapter is concerned, the assessment of information relevance is based merely on whether or not the information found in the BiConc tool by the post-editor was the information used[13] to solve the problem at hand (in other words, if the information found was the information kept in the final target text, when the entire project was being approved and saved).

[12]While relevance has been mainly associated with the performance evaluation of information systems, it has also been associated with the human processes that take place when people determine how relevant a piece of information is, and the elements that shape these processes (Fidel 2012, p. 27).

[13]As it can be observed in the screen videos, post-editors may "use" the information found in different ways: they can copy/paste it, or they could type it into the post-editing interface, for instance.

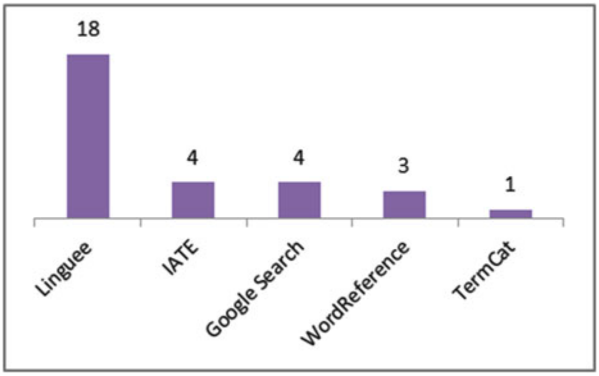

Fig. 7.4 Use count for external informational resources

A close examination of the search queries and results (and final target segments) reveals that the relevance rate varies among participants, with participants P1 and P7 having more relevant than non-relevant cases (see Fig. 7.3). On average, only 47 % of the BiConc searches (26 out of 55) provided participants with satisfying results (i.e., post-editors kept this information in the final target segment).

Furthermore, having a close look at the screen recordings, it can also be observed that participants who used the BiConc also used other Internet resources, such as term banks, dictionaries and corpora, to complement their information retrieval efforts. In addition to the CASMACAT BiConc, P1, P3 and P7 also searched information using Google (a search engine); Linguee (a biconcordancer); WordReference (a bilingual dictionary); and IATE and TermCat (terminology databases).

Remarkably enough, as shown in Fig. 7.4, for cases where the BiConc was used, the most frequently used external resource was another biconcordancer tool (i.e., Linguee), which was also observed to be extensively used by all CFT14 participants throughout the entire experiment.[14] These results reveal the extent to which today's professional translators favour this type of parallel bilingual resource over any other type of tool (e.g., dictionaries or term banks), complementing thus the results of some recent studies in the same vein (cf. Simard (2013); Daems et al., Chap. 6 in this volume). Hence, it can be concluded from this pilot investigation alone that online biconcordancers need to be constantly enhanced and improved, and integrated more tightly into translation environments.

It is worthwhile noting at this point that quantitative data (e.g., use counts and relevance measurements) may not be sufficient to investigate the TII process and

[14]This observation is based on screen recording examinations (i.e., by looking at the videos it was possible to observe that this particular resource was extensively used by all post-editors throughout the experiment). However, no exact figures on the total use of external resources in the CFT14 are available. Logging software such as Inputlog (Leijten and Van Waes 2013) will be included in future investigations.

Table 7.2 Some information behaviour noted during the BiConc tool use analysis using screen recordings

1. Having found a useful solution in the BiConc, the translator uses external resources to double-check information; results turn out to be the same
2. Although a good solution was proposed by the BiConc, the translator opts for a solution coming arguably from their cognitive background
3. Having searched for a term in both the BiConc and an external resource, with no results, the translator opts to leave notion implicit
4. The BiConc was used only after a query in an online bilingual dictionary yielded no results
5. When typing a good solution provided by the BiConc, the interactive post-editing system automatically inserted another good solution. The translator opts to keep the latter
6. A good solution was found in the BiConc, but translator made an adaptation, based on the information found
7. The translator copied/pasted a solution from BiConc. The font format from the BiConc (type, size and color) was kept in the text field; then, the translator opened a text editor to convert text into plain text, and copied/pasted it again into the CASMACAT environment
8. The translator searched both in the BiConc and in external resources, but solution provided by the BiConc was preferred
9. The BiConc took several seconds to display results; the translator could not wait and searched in an external resource; when returning to the CASMACAT workbench, the results of the query in the BiConc was being shown and turned out to be the same as found in the external tool

evaluate the quality of information and information systems. Thus, it becomes necessary to further examine, through different data-collection methods such as input logging, screen recording, eye-tracking, active observations with video recordings, and interviews, different forms of behavior; and to formulate more-detailed hypotheses about the TII processes and the usability of information tools. For example, other translator-information behaviour observed in the CFT14 screen recordings is compiled in Table 7.2[15].

The list in Table 7.2 is neither exhaustive nor objective. The ability to describe this behavior may depend, for instance, on the researcher's own perception and valuation of the post-editing process and quality, and on their particular research goals. Likewise, to add to this list of observations, other-data collection methods, as mentioned above, would need to be combined with screen-recordings in order to triangulate the data and provide more-detailed analyses of post-editors' information behaviour. For instance, can eye-movement recordings provide an insight into the cognitive processes that take place when a translator opts to leave a certain notion implicit (see observation 3 in Table 7.2) or when she chooses a solution that does not come from any of the sources consulted (observation 2)? Can external video recordings provide information on the participants facial or physical reactions when interacting with the system (i.e. on the physiological usability of the system; see

[15]This behaviour can be attributed to one, two or all three participants who made use of the BiConc tool.

Hornbæk (2006)) (see observations 5, 7 and 9, for instance) and browsing the different sources of information (observation 1), and on why a certain piece of information appears to be relevant or not (observation 8)? Can we learn, through interview questions, why does the post-editor prefer some tools and resources over others (observation 4 in Table 7.2, and Fig. 7.4), or why would they prefer making an adaptation, or why is a piece of information inappropriate to solve a given problem (observation 6)? Hornbæk (2006) describes how different sources of data and an analysis of the relations between the different aspects of usability (efficiency, effectiveness and user satisfaction), and between subjective and objective measures, could provide a wider picture of the usability and the quality-in-use of a system or a system's feature.

For the purposes of this TII study, data triangulation would have been ideal, but was not possible given the scope and limitations of a pilot experiment and of the TDA project, as stated in the introductory section. In future experiments, these combined observations and further analyses will inform researchers, for instance, about certain preferences of individuals or about the cognitive processes involved in translation and information-retrieval tasks, or about technical problems with the workbench's user interface (see observation 7 in Table 7.2) or with the system as a whole (see observation 9).

Lastly, it would be very appropriate, from a usability point of view, to design and carry out longitudinal studies where the learning effect over a period of time could be observed. Indeed, a longitudinal study with the CASMACAT workbench was carried out before the built-in BiConc tool was introduced (see Chap. 5 in this volume) and showed that over time post-editors become faster when using ITP. It would be interesting to conduct further studies of this kind to investigate how the interaction with the BiConc and other information tools can change over time, how long it takes for a user to get fully acquainted with a given tool or with a given feature of a tool, or if there is a possible trade-off between different features of a system (e.g., it would be interesting to observe if a tight integration of information tools into a translation environment and an acquaintance with the tools by the user after a certain period of time can increase the benefits of the ITP feature in terms of efficiency gains).

Having discussed the results of this pilot investigation and formulated a few areas for future work, let us now point towards new directions in TII research.

7.4 Discussion: Towards Web-Based Translation Environments

This pilot study and other CASMACAT-related experiments point towards a major area of research in TPR and translation technology: The need for a tighter integration of Internet-based informational tools and translation environments. Empirical TPR needs to pay greater attention to the study of translators' interaction with (digital/Internet-based) information and to the optimal integration of such information into translation tools and the translation workflow.

ICTs, and particularly the Internet, have dramatically evolved over the past decades, and have led to major changes affecting not only individuals and organizations but society in general. They have made information accessibility constant, transparent and increasingly comprehensive. Indeed, the challenge is no longer to access information, but to be able to filter relevant information (Aubert et al. 2010, pp. 8–9) according to the context of use (Fidel 2012, p. 85).

The Internet is considered the informational resource par excellence, the "*El Dorado*" of knowledge (Duval 2012, p. 50). Now, the fact that it is becoming accessible practically anywhere and anytime leads humans to develop new behavior and new ways of interacting with information; of understanding, using and producing information. The Internet is arguably becoming translator's primary source for information retrieval (Borja 2008; Simard 2013). Few translators still take the time to open, even to carry along their (huge) paper dictionaries, paper term records and language books, to name only a few "traditional" informational resources. On the web, translators can find hundreds of monolingual and bilingual dictionaries, concordancers and biconcordancers, terminology databases, grammar and conjugation guides, encyclopaedia and other documentation; in sum, practically all the information that may be useful when producing a translation. Therefore, a tighter integration of these tools is necessary: further studies need to be conducted to make informational resources easily accessible, flexible, user friendly and adapted to translator's preferences and to the changing conditions of HCI. Likewise, further cognitive studies are needed to examine the impact of ICTs, particularly the Internet, on the translator's behaviour[16] and cognitive abilities, and on the translation process as a whole.

In sum, the Internet will play an increasingly important role in TII research, both for understanding translator-information behavior and for improving the quality of the information and informational tools used by translation professionals. As web-based translation environments such as the CASMACAT workbench become more and more popular and efficient, it becomes essential to conceive new, and possibly better, ways of making these environments work together well with the information translators need to carry out their tasks efficiently and effectively.

[16]Cognitive psychology studies have shown that some cognitive functions such as reading, learning and memorizing are affected by the (intensive) use of the Internet. In fact, people will turn to a search engine to search answers to even the simplest question. Just knowing that a piece of information is readily available anywhere and anytime leads humans not to memorize it (Duval 2012).

7.5 Conclusion

In this chapter, the notion of translator-information interaction (TII) was introduced as the field of study that investigates translators' interaction with information, complementing thus Sharon O'Brien's notion of translator-computer interaction (2012). To illustrate TII research, the chapter reported on a pilot study examining translators' interaction with a prototype biconcordancer (BiConc) tool integrated in the CASMACAT workbench during the third CASMACAT field trial (CFT14). A systematic analysis of such interaction was possible through screen recording observations, which allowed to look well beyond the data provided by the CFT14 log files alone. This investigation was nonetheless of exploratory nature given the scope and limitations of a pilot study and, even more importantly, the complexity inherent to TII research. The study of the interaction between humans and information is complex because it implies considering every element and every aspect of the informational work: the interaction process and the changes that result from that interaction at the level of the individuals searching for information and the tools or systems used to retrieve the information (Marchionini 2008, p. 171). It is also worth considering a possible interplay between the information provided by the various tools and the translator's cognitive background (i.e., their knowledge). The translator looks for a given piece of information they do not know or they are uncertain about. Now, when judging the quality of a suggestion by the system, trust (i.e., trust in oneself) may also play a significant role. In other words, as observed in the behaviour described in Table 7.2 in Sect. 7.3, the interaction between the post-editor's cognitive background and the information provided by the tools is potentially an interaction of trust.

With this chapter, several research questions for future TII research were raised: how well do human translators work with the information and informational tools they currently have at their disposal? How accurate, rich and relevant is the information they find? How user-friendly are informational tools for translators? How can the information and the tools be improved to maximize translators' performance and well-being, and the quality of their work? How can the performance of an existing tool be assessed and improved? What are the advantages and drawbacks of integrating an informational tool to a translation environment, as compared to having an array of external resources? These questions can only be partly dealt with in a pilot investigation like the one described here. Only a larger-scale study with a larger sample size and combining different sources of data can provide a wider, and potentially better, picture of the TII processes and the usability of information systems and tools.

From this exposition, it may be concluded that TII studies, however complex they are, will be essential in the development and the improvement of tools intended to better address the needs of translators at the digital age. In the words of, Carl et al. (2011),

> [d]evelopment of translation tools could benefit from incorporating knowledge of human translation behavior and translator styles [. . .]. As Knight et al. (2007)[17] point out, "the combination of [. . .] usability studies and cognitive modeling [may help to] make an informed decision about critical aspects of a user interface."

In the age of translation technology, mobile computing and ubiquitous information, research on TII will become increasingly important in empirical TPR. Behavioural studies that explore information interaction will play a crucial role in the design and development of new tools that are user-friendly and adapted to translators' informational needs and to the changing reality of the translation industry.

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