The Impact of Translation-Memory (TM) Technology on Cognitive Processes: Student-Translators' Retrospective Comments in an Online Questionnaire

Tina Paulsen Christensen & Anne Schjoldager

Aarhus University
Business and Social Sciences
Department of Business Communication
Translation and Interpreting

Abstract. The use of Translation-Memory (TM) technology and other translation software is bound to influence translators' cognitive processes. Unfortunately we still lack empirically founded knowledge of this. Our paper therefore presents and discusses the theoretical background, setup and preliminary findings of a small-scale pilot study of student-translators' retrospective comments in an online questionnaire survey regarding what they had experienced during an introductory hands-on course in TM-assisted translation. We also discuss some basic concepts and methods within translation process research, and apply a simplified model of the translation process that comprises three main phases taken from a general writing model: planning, drafting and postdrafting. As far as our student-translators are concerned, TM technology seems to affect processes in all of these phases.

Keywords: Translation-Memory (TM) technology, translation process research, cognitive processes, retrospective comments, questionnaire survey

1   Introduction

Because of the digital revolution, professional translation is no longer a purely human activity, but nowadays tends to be carried out by means of translation-memory (TM) technology. TM technology is basically a database in which source-text (ST) segments and target-text (TT) segments are paired in order for a translator to access and re-use them in a current translation. Many features of TM technology are bound to influence the translators' cognitive processes in some way or other (Garcia 2007; Biau Gil/Pym 2006; Mossop 2006). Unfortunately, we still lack empirically documented knowledge of how translators, their workflows and cognitive processes are affected by TM technology (Christensen/Schjoldager 2010). By reporting on a small-scale study of student-translators' retrospective comments, we hope to contribute with some knowledge about the impact of TM technology on

119

translators' cognitive processes. Our study is inspired by and draws on Dragsted's (2004 and 2006) research on segmentation in human and TM-assisted translation and O'Brien's (2006 and 2008) studies of cognitive loads in connection with various TM match types.

As we are interested in studying translators' cognitive processes when they interact with TM technology in order to help them become more aware and critical of its impact on their work, it is worth emphasising that our aim is translation-theoretical and not technological. In other words, our aim is to understand how translators think while using TM technology, not to suggest improvements to the software itself. We would also like to emphasise that the student-translators of our study are probably more conscious of any changes dictated by TM technology than are professional and experienced TM translators, who must be expected to have integrated any changes caused by TM technology into the general translation process.

In this paper, we shall briefly discuss the field of translation process research (section 2), methods used within this field (section 3) and the concept of TM-assisted translation (section 4). We shall then proceed to discuss the background and preliminary results of our own study (sections 5-9) and shall round off with some concluding remarks (section 10).

2   Translation process research

As noted by Holmes (1972/2000) in his seminal paper on the name and nature of translation studies, translation research was traditionally product oriented, i.e. focussed on linguistic and textual descriptions of translated texts. As far as we are aware, Holmes was the first to identify a process-oriented branch of translation studies that was concerned "with the process or act of translation itself" (Holmes 1972/2000: 177). Pointing out that "the 'little black box' of the translator's mind" has been the object of much speculation, Holmes (1972/2000: 177) advocates a descriptive (i.e. empirical) approach to translation process research. As pointed out by Palumbo (2009: 92), it was Krings' (1986) pioneering work on translators' use of time and reference books by means of verbal reporting (introspection) that marked the beginning of empirically founded translation process research. Krings' study and many that followed focussed on cognition, i.e. Holmes' "little black box", drawing on and adopting methods from cognitive psychology, especially verbalising methods.

As suggested by Schubert (2009), translation process research tends to focus either on external or internal processes (see also Göpferich 2008: 1). These approaches differ essentially as far as the object of study is concerned, but they complement rather than rival each other as far as knowledge is concerned. The external process may be defined as "everything in the translation process which can be observed by another person", which he also refers to as the translation workflow (Schubert 2009: 19). Similarly, Breedveld (2002: 9) describes translation not only as a mental process, but also as "a social process in which different actors interact and influence the text-in-production". Examples of such external, observable process data are translators' use of tools or their consultation with colleagues and clients. In

continuance of this, using a TM may be described as part of an external process, and perhaps the TM itself may then be seen as an extended cognitive resource or as distributed cognition (Hutchins 2000).

Internal translation processes concern mental activities, which cannot be studied directly and therefore tend to be studied by methods that are borrowed from cognitive psychology, especially verbalising methods (see section 3, below). Internal processes – such as thoughts, feelings, beliefs etc. – may be further subdivided into conscious and non-conscious (subconscious) activities. Following Göpferich (2008: 1), we shall refer to conscious internal activities as cognitive processes. According to Hutchins (2000: 1), cognitive processes are involved in memory, decision making, inferencing, reasoning and learning, for instance.

3　Methods in translation process research

Today a variety of methods are employed in translation process research. Depending on which criteria are used, the methods can be classified in different ways. Distinguishing between offline and online methods, we take our starting point in Krings' (2005: 348) model of basic methods applied in translation process research, focusing on features that are relevant for our own investigation (section 5, below). For a more detailed discussion of the pros and cons of various methods within translation process research, see Dam-Jensen/Heine (2009) and Christensen (forthcoming).

Offline data are collected after the translation process. *Online data* are produced during the translation process. As regards online methods, Krings distinguishes between data collected by way of observation of the translation process and data collected by way of verbal-report data during the process. Regarding offline methods, he distinguishes between product analysis and verbal-report data.

Verbal-report data comprise a subject's verbalised thoughts. Since we are not conscious of automated processes, it must be assumed that only conscious, i.e. cognitive, processes can be made accessible by means of verbal-report methods (Göpferich 2008; Álvarez 2007). For our purposes, we shall regard the verbalising activity as an act of metacognition, i.e. thinking about thinking.

Online verbal-report data are obtained when translators are asked to verbalise their thoughts during the task. These verbalisations, which are regarded as introspection, are recorded orally and subsequently transcribed in think-aloud or talk-aloud protocols (both abbreviated as TAPs), for instance. Introspective verbalisations are assumed to allow us rather direct access to subjects' minds, though verbalisations are not, of course, identical to the actual processes themselves. Online verbal-report methods are generally criticised for interfering with the on-going translation process because translators are distracted from the task at hand. It has also been said that, because of the additional cognitive load of online verbalising, subjects tend to give priority to procedural thinking over other cognitive processes (House 2000: 152).

Offline verbal-report data are obtained when translators are asked to verbalise their thoughts after the translation task. These verbalisations, which are regarded as retrospection, comprise specific or general comments about a given task. Comments

are elicited in interviews or in questionnaires, for instance. Interviews and questionnaires may ask both closed and open questions. Closed questions provide mainly quantitative data, whereas open questions provide qualitative data. In translation studies, questions may relate to TTs and STs, or they may relate to workflows and (cognitive) processes. Questionnaires may be answered orally with the researcher present, or, typically, they are answered in writing and given or posted to the researcher afterwards. Offline verbal-report data, particularly retrospective comments, are sometimes criticised for rendering information that may not be consistent with what actually goes on in the subjects' minds, mainly because of the unavoidable delay between the actual processes and the verbalisations. The risk of distortion is generally thought to increase with time. Thus, for instance, Ericsson (2006: 230) notes that subjects are only able to recall relatively accurately what went on in their minds immediately after completing the task in question.

4   TM-assisted translation

TM technology is a form of computer-assisted translation (CAT). CAT covers human-aided machine translation (HAMT) and machine-aided human translation (MAHT). In HAMT, translation is essentially carried out by the software itself, but human translators are required to resolve specific problems and to correct the TT afterwards, which is mostly referred to as postediting. In MAHT, translation is carried out by a human translator, but computer assistance, TM technology for instance, is an integral part of the translation process. As mentioned in section 1, TM technology is basically a database of segmented and paired STs and TTs that a translator can access and re-use in a current translation. Thus, the TM continuously provides the translator with translation proposals (matches) that derive from his/her own or other peoples' translations. In effect, the translator may spend more time revising previous translations in segments offered by the TM than s/he does translating 'from scratch' (Garcia 2010). This and other features – the enforced segmentation of the ST (Schäler 2001; Dragsted 2004, 2006) and its uncritical and form-based method of ST/TT alignment, for instance – are bound to influence the translators' cognitive processes in some way or other (Garcia 2007; Biau Gil/Pym 2006; Mossop 2006).

5   The study

As already mentioned, the aim of our study is to discover the impact of TM technology on translators' cognitive processes, i.e. internal processes that are potentially conscious and that may be subject to metacognition and verbalisation. We assume that student-translators who have just experienced TM-assisted translation for the first (or nearly the first) time may be regarded as more suitable informants of mental changes dictated by the technology than professional and experienced TM translators, who may no longer be conscious of any changes that the technology may have caused to their mental processes. With a view to fulfilling our aim, we chose to conduct a small-scale pilot study of our own students who had

participated in an introductory hands-on course in TM-assisted translation, which was part of an obligatory course in translation methodology and theory at our department in 2009.

The course comprised an introduction to TM technology in general and Translator's Workbench (Trados 2007) in particular followed by a practical task of TM translation. For the purpose of the practical task, one of the authors (Christensen) had constructed a Danish/English TM of three STs and three TTs by aligning authentic parallel texts taken from a company website. All these texts were instructions for the use of mobile phones. Two pages from one of the English texts were doctored and used as a ST in the course, so as to allow students to retrieve different kinds of matches from the TM. Out of a total of 51 segments in the ST, students could only retrieve seven perfect matches[1] in the TM, though translation proposals at the word and phrase level could easily be retrieved from the concordance facility. Students were given no explicit translation brief, as they were merely told to translate the ST for the benefit of Danish users of the mobile phone in question. The practical task lasted for approximately 70 minutes.

Course participants were 23 MA students of English, French, German or Spanish. Out of these, 22 students (a response rate of 95.7 %) filled in an online questionnaire, which was made available to them immediately after the course and for the following week. Questionnaire answers were given in closed boxes (mainly for background information) and in open boxes, where students were asked to write their thoughts about and reactions to what they had experienced during the course. The questionnaire comprised a total of 26 questions, which, for the sake of our analyses, may be divided into five thematic parts:

A. Personal information about respondents (questions 1-7)
B. Previous experience with TM assisted translation (questions 8-13)
C. Level of IT skills (question 14)
D. Comments to the course (questions 15-19)
E. Comments to the translation process (questions 20-26)

6   What students told us about themselves

In this section, we shall summarise what students told us about themselves and what they thought about the course, i.e. their answers to questions 1-19. Most students were between 24 and 27 years old. The average age was 26.4. Most (18) students studied two foreign languages at their BA level, whereas some (4) studied a foreign language and another topic, mainly communication studies. Few (6) had experience as professional translators, which was mainly as freelancers. Some (10) were aware of the existence of TM technology prior to the course, but few had tried to use it.

---

[1] In fact, the seven perfect matches that could be retrieved from the TM of the course were only marked as 97 percent matches by the system. The reason for this is that, in Translator's Workbench (Trados 2007), perfect matches retrieved from aligned and imported texts are given a 3 percent penalty, to distinguish them from perfect matches aligned from texts that were translated in the system itself, which are marked as 100 percent matches.

Three said that they had tried working with TM technology before, but none of these had done so professionally.

According to their answers to our question 14 regarding their IT skills, students did not seem overconfident. When asked to which extent the following statement was true for them personally: "I know a lot about computers and most current programs and, generally speaking, I'm able to solve technical problems as they occur", most said that this was true "to some degree" (9) or "to a small degree" (8).

As mentioned above, in questions 15-19, we asked students to comment on the hands-on course itself. Many reported some technical problems with their computers and/or the program (Trados), but most seem to have sorted out these problems themselves, and they were generally well satisfied with their participation in the course.

7   Why they thought TM-assisted translation was different

We shall now focus on answers to two questions, namely questions 20 and 21. Question 20 asked students directly if they had felt that translating with a TM was different from translating without a TM. All 22 students answered 'yes' to this question. Since they had all answered in the affirmative, question 21 then asked them why they had felt that TM-assisted translation was different.

Assuming that this would get us closer to understanding perceived changes in their cognitive processes, students' answers were divided into four categories: positive comments, negative comments, neutral/other comments and don't know. Eight students gave answers that comprised both positive and negative comments. Two students gave answers that comprised both positive and neutral/other comments. Four students wrote answers that were categorised solely as positive, whereas seven students offered only negative comments. Nobody said that they did not know.

Admittedly, students' answers to the question may refer not only to internal (cognitive) processes but also to external processes (workflow). As far as the 14 positive comments are concerned, we think that they may refer to both kinds of processes, when they all imply that TM-assisted translation made their work faster, more manageable, more efficient and/or more consistent. One (No. 18) even said that TM technology made translating more interesting.

As we see it, the negative comments to the impact of TM technology are more reflective of cognitive processes than the positive comments are. Thus, a total of 13 students offered negative comments that indicated some cognitive changes, mainly that TM technology made them think less for themselves and made them trust and use their own judgement less. In other words, many regretted a general loss of control. Thus, for instance, student No. 22 wrote that s/he tended to accept uncritically what was offered by the TM and only to use his/her own knowledge when no translation proposals (matches) were offered:

> "You tend to constantly trust the options of the program, so I didn't have to think a lot for myself actually. You feel that you're getting something helpful, and you make use of it, of course. For

124

instance, I used the concordance facility a lot, in order to find out which proposals the program could offer (and not what I myself could offer). So, only if there were no proposals from the TM, did I translate myself, and this was a lot less pleasant than copying a proposal and pasting it into the target-text segment."

Two comments that were categorised as neutral/other (No. 17 & No. 20) expressed a similar cognitive change, but in these comments the tendency to accept uncritically the translation proposals from the TM was seen as a risk that could and should be considered. Consider what student No. 17 wrote, for instance (here in our close translation and with a few clarifying explicitations in square brackets):

"Generally speaking I was afraid of letting the TM take over my job of assessing the [target] text. In other words, I was very much conscious of the fact that I shouldn't let my brain relax too much and just accept the translation proposals without thinking. For me, the problem was that when your eyes have first registered a translation proposal, it's harder to think of other solutions. Actually, I wish I could have looked at the English [source] text and made a draft [translating without a TM] before working with the TM, but this wouldn't be efficient, of course."

Similarly, student No. 20 commented that a changed routine caused by TM technology forced him/her to spend more time on the postdrafting stage (here in our close translation):

"Of course, you got a good deal of possible solutions, just like that. Think though also that you risk staring yourself blind on what's on the computer screen. I would therefore never hand in anything like this, without revising it on paper first!"

8   What they thought about enforced sentence-based segmentation

In question 24 we asked students to comment specifically on sentence-based segmentation in TM technology, assuming that answers would also relate to their cognitive processes. First, students were asked to indicate what they thought about sentence-based segmentation by clicking on one of three options: (1) It's an advantage, (2) It's a disadvantage, or (3) I don't know. Eleven students said that it was an advantage; one student said that it was a disadvantage, whereas ten students said that they did not know. Then, students were asked to give reasons for these answers.

We have categorised comments as either positive comments, negative comments, neutral/other comments or no comments/haven't thought about it. Two students offered comments that were both positive, negative and neutral/other; nine students wrote comments that were both positive and negative; one student offered comments that were both negative and neutral/other; seven students wrote comments that were entirely positive; and one student commented in a way that was categorised as

neutral, whereas nobody gave comments that were only negative. Two students said that they could give no reasons for their answer (no comments/haven't thought about it).

A total of 18 students offered positive comments to sentence-based segmentation in TM technology. All seem to indicate that they found it a logical and useful way of dividing up the translation task, which, in itself, does not indicate any cognitive changes. However, the fact that many students are aware of the negative sides of this enforced segmentation does indicate a certain change in their cognitive processes. Again, many students mention that TM technology involves a risk of making you oblivious to contextual and functional aspects of the translation. Thus, for instance, student No. 12 mentions that, though your task becomes more manageable, you may be forced to work in a way that changes your usual process:

> "Positive: It's more manageable. Negative: As already mentioned, you tend to focus on each individual segment and risk forgetting about the coherence of the text. It may also be a problem that you cannot see the context of the translation proposal offered by the TM. This can result in wrong translations".

Another student (No. 9) implies that sentence-based segmentation disturbs your natural (cognitive) translation process when you are working with units below the sentence level, which you sometimes do:

> "It's an advantage because you wouldn't be able to work with larger chunks at the same time anyway. It's a disadvantage because you easily lose track of the text as a text. It can also be a disadvantage if you work on segments that are smaller than a sentence, but I found that the concordance facility helps you make up for this".

A comment by another student (No. 6) to qualify her first answer of "I don't know", which was categorised as neutral/other, makes a similar point (here translated closely by us, with explicitations in square brackets):

> "From what I've experienced, I cannot really see that it is an advantage or a disadvantage. You can still view the rest of the text [on the screen], so it's still possible to relate the segment to its context, if you need to [while working] with individual sentences".

9 Preliminary results: What they told us about the impact of TM technology on cognitive processes

We shall now try to conclude on the cognitive changes caused by TM technology that were suggested by our students, using a simplified model of the translation process as an analytical tool. Viewing translation as a recursive and reiterative writing activity (see also Mossop 2000; Breedveld 2002; Jakobsen 2003), we shall assume that translation processes may be categorised as belonging to one of three main phases: planning, drafting and postdrafting. Inspired by Englund Dimitrova

(2010), we shall subdivide the drafting phase into comprehension, transfer and production.

1) The *planning phase* includes activities such as researching the topic and the respective communities of the ST and the TT, interpreting relevant norms and the communicative purpose of the TT (skopos), reading and analysing the ST, choosing a macrostrategy and, in the case of TM-assisted translation, selecting and assessing an available TM. For our purposes, a macrostrategy concerns the translator's choice of an overall plan or a set of principles for carrying out a specific translation task, which tends to be either ST- or TT-oriented (e.g. Schjoldager 2008). Our results seem to imply that students tend to forget about the planning phase. In particular, many students' answers indicate that macrostrategic decisions were no longer part of their translation process. We are aware that this may not be true for professional translators in an authentic situation. (Actually, we are hoping that it is not.)

2) The *drafting phase* concerns the translator's work with the ST itself and, as mentioned above, it may be understood as comprising three subphases:

2.1) The *comprehension phase* comprises the decoding (understanding) of ST segments (words, phrases, etc.), drawing on what the translator has learned during the planning phase and drawing on the translator's own knowledge of relevance for the task. In principle, TM-assisted translation should not differ from human translation in this respect, but many students seem to indicate that comprehension was less thorough than it usually is.

2.2) The *transfer phase* concerns the shift from one language to another, thinking in two languages at the same time, as it were, and making microstrategic decisions. Microstrategies may be defined as a set of procedures that guide the translator's decisions in connection with specific points of a translation task, including both problem-oriented decisions and other decisions. Because of its continuous and automatic offering of translation proposals (matches), we would expect TM technology to affect the translator's cognitive processes in the transfer phase, which was also indicated by many students, who seem to have copied TM proposals rather making their own microstrategic decisions.

2.3) The *production phase* comprises what the translator carries out in relation to the TT itself, including some textual decisions. This phase is generally thought to comprise some on-going revision of the TT. Following Mossop's (2007: 167) distinction between self-revision and other-revision, this on-going revision may be characterised as self-revision. As the TM translator is not only revising text that s/he is writing him/herself, we would expect TM technology to affect the production phase. This impact may be even stronger if the translator is translating by means of a TM comprising aligned and imported texts from other translators, as our students were (section 5, above). Interestingly, our results indicate that many students seem to have spent more time assessing and revising what was offered by the TM, i.e. other-revision, than on revising what they had written themselves 'from scratch'.

3) The *postdrafting phase* comprises a (supposedly) final revision of the TT, which can be carried out by somebody else than the translator, in which case it may be referred to as other-revision (Mossop 2007). As the production phase of TM-assisted translation may be expected to be rather different from that of human translation, so is probably the postdrafting phase: With its enforced segmentation of the ST and its offering of previously translated segments (matches) from other

assignments, you might expect TM translators to carry out a more thorough final revision of the TT. Though the introductory course did not give students an opportunity to carry out any postdrafting as such, many indicated that they expected the technology to change this phase too, saying that they expected the TT to need some textual revision afterwards.

10   Concluding remarks

Seeing that we still lack empirically documented knowledge of how TM technology and other translation software influence translators' cognitive processes, we have presented and discussed the theoretical background, setup and findings of a small-scale pilot study of student-translators' retrospective comments in an online questionnaire survey regarding what they had experienced during an introductory hands-on course in TM-assisted translation.

   All 22 students clearly felt that translating with a TM was different from translating without a TM, i.e. human translation. Assuming that translation processes may be categorised as belonging to one of the above-mentioned phases, we suggest that, as far as our student-translators are concerned, the greatest impact of TM technology seems to occur during the drafting phase. Thus, for instance, all students report that TM technology tends to take over the translation process when they uncritically accept whatever is offered by the TM, and many report that, especially because of the sentence-based segmentation, the technology forces them to work in a way that is different from what they are used to when carrying out human translation. More specifically, as far as the three subphases are concerned, it is suggested that the comprehension phase becomes less thorough, that the transfer phase is largely neglected, as microstrategic decisions are generally copied from previous translations, and that the production phase comprises more (other-)revision than actual production. Furthermore, according to many students' answers, the planning phase appears to be almost forgotten, and many also indicate that, because of all these changes in the planning and drafting phases, the postdrafting phase will have to change too, in the sense that textual aspects of the TT must receive more attention.

   In view of recent advances within machine translation (MT) combined with an increasingly competitive market, perhaps much professional translation is soon to be carried out as HAMT (Fiederer/O'Brien 2009). While such automation of the translation process will not eliminate human translators altogether, the impact on their cognitive processes is bound to increase considerably. Therefore, to help translators prepare for an increasingly digitalised future, we shall need more empirically founded studies of how they interact with TM and other translation technology.

References

Álvarez, A.M.G.: Students' translation process in specialised translation: Translation Commentary. Journal of Specialised Translation, issue 07, 139-163 (2007)

Biau Gil, José R., Pym, A.: Technology and Translation: a pedagogical overview. In: Pym, A., Perekrestenko, A., Starink, B. (Org.), Translation technology and its teaching. Tarragona, Spain, 5-19,
http://isg.urv.es/library/papers/BiauPym_Technology.pdf [Accessed on March 30, 2011] (2006)

Breedveld, H.: Writing and revising processes in professional translation. Across Languages and Cultures 3 [1], pp. 91-100 (2002)

Christensen, T.P.: How to investigate mental processes in translation memory-assisted translation? (forthcoming)

Christensen, T.P., Schjoldager A.: Translation-Memory (TM) Research: What Do We Know and How Do We Know It? Hermes – Journal of Language and Communication Studies 44, 89-101 (2010)

Dam-Jensen, H., Heine, C.: Process Research Methods and Their Application in the Didactics of Text Production and Translation. Trans-kom 2 [1], 1-25 (2009)

Dragsted, B.: Segmentation in Translation and Translation Memory Systems – An Empirical Investigation of Cognitive Segmentation and Effects of Integrating a TM System into the Translation Process. Samfundslitteratur, Copenhagen (2004)

Dragsted, B.: Computer-aided translation as a distributed cognitive task. Pragmatics & Cognition 14 [2], pp. 443-464 (2006)

Englund Dimotrova, B.: Translation Process. In Gambier, Y., Doorslaer, L. (eds.), Handbook of Translation Studies, vol. 1, pp. 406-411. John Benjamins, Amsterdam/Philadelphia (2010)

Ericsson, K. A.: Protocol analysis and expert thought: Concurrent verbalizations of thinking during experts' performance on representative tasks. In: Ericsson, K.A., Charness, N., Feltovich, P.J., Hoffman, R.R. (eds.), The Cambridge Handbook of Expertise and Expert Performance, pp. 223-241. Cambridge University Press, Cambridge (2006)

Fiederer, R., O'Brien, S.: Quality and Machine Translation: A realistic objective? The Journal of Specialised Translation 11, 52-74 (2009)

Gambier, Y.: Translation strategies and tactics. In: Gambier, Y, Doorslaer, L. (eds.), Handbook of Translation Studies, vol. 1, pp. 412-418. John Benjamins, Amsterdam/Philadelphia (2010)

Garcia, I.: Power-shifts in web-based translation memory. Machine Translation 21, 55-68 (2007)

Garcia, I.: Is machine translation ready yet? Target 22 [1], 7-21 (2010)

Göpferich, S.: Translationsprozessforschung. Stand – Methoden – Perspektiven. Narr, Tübingen (2008)

Holmes, J. S.: The name and nature of translations studies. In: Venuti, L. (ed.), The Translation Studies Reader, pp. 172-185. London/New York (1972/2000)

House, J.: Consciousness and the strategic use of aids in translation. Tirkkonen-Condit, S.; Jääskeläinen, R. (eds), Tapping and mapping the processes of translation

and interpreting: outlooks on empirical research, pp. 149-162. John Benjamins, Amsterdam/Philadelphia (2000)

Hutchins, E.: Distributed Cognition, http://files.meetup.com/410989/DistributedCognition.pdf [Accessed 30 March, 2011] (2000)

Jakobsen, A. L.: Effects of Think Aloud on Translation Speed, Revision and Segmentation. In: Alves, F. (ed.), Triangulating Translation. Perspectives of process oriented research, pp 69-95. John Benjamins, Amsterdam/Philadelphia (2003)

Krings, H.P.: Was in den Köpfen von Übersetzern vorgeht. Eine empirische Untersuchung zur Struktur des Übersetzungsprozesses an fortgeschrittenen Französischlernern. Narr, Tübingen (1986)

Krings, H.P.: Wege ins Labyrinth – Fragestellungen und Methoden der Übersetzungsprocess-forschung im Überblick. Meta 50 [2], 342-358 (2005)

Mossop, B.: The Workplace Procedures of Professional Translators. In: Chesterman, A., San Salvador, N.G., Gambier, Y.. Translation in Context. Selected Papers from the EST Congress, Granada 1998. [Benjamins Translation Library 39] pp. 38-48. John Benjamins, Amsterdam/Philadelphia (2000)

Mossop, B.: Has Computerization Changed Translation? Meta 51 [4], 787-793 (2006)

Mossop, B.: Revising and Editing for Translators. St Jerome, Manchester, U.K./Kinderhook, USA (2007)

Nord, C.: Text Analysis in Translation Theory. Methodology and Didactic Application of a Model for Translation-Oriented Textual Analysis. Second edition. Rodopi GA, Amsterdam/Atlanta (2005)

O'Brien, S.: Eye-tracking and translation memory matches. Perspectives: Studies in Translatology 14 [3], pp. 185-205 (2006)

O'Brien, S.: Processing fuzzy matches in translation memory tools: an eye-tracking analysis. In: Göpferich, S., Jakobsen, A.L., Mees, I.M. (eds.), Looking at Eyes. Eye-tracking studies of Reading and Translation Processing, pp. 79-102. Samfundslitteratur, Copenhagen (2008)

Palumbo, G.: Key terms in translation. Continuum, London/New York (2009)

Schäler, R.: Beyond Translation Memories. In: Proceedings of the Workshop on Example-Based Machine Translation. http://www.eamt.org/events/summitVIII/papers/schaeler.pdf [Accessed 16 December, 2009] (2001)

Schjoldager, A.: Understanding Translation. Academica, Aarhus/Copenhagen (2008)

Schubert, K.: Positioning translation in technical communication studies. Journal of Specialised Translation, issue 11, 17-30 (2009)

130