3 Cognitive processes

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Overview

The shift in interest from the product as the primary object of study in T&I (i.e., a focus on target texts and their relation to source texts) to the producer (i.e., a focus on cognitive processes) can be dated to the early 1980s. Holmes (1972/2004: 185) anticipated this shift by including process-oriented research in his much-cited map, placing it within the descriptive branch of Translation Studies and suggesting that this area might come to be known as "translation psychology or psycho-translation studies." Since then, process research has become almost synonymous with cognitive approaches to T&I. Toury's distinction between translation acts (1995, 2012; see also Chesterman 2013), or cognitive processes, and events, or *socially situated* processes, however, underscores the fact that cognitive processes are always embedded in a context. Perhaps more apparent in interpreting, which has long been identified as a socially situated activity (e.g., Berk-Seligson 1990; Wadensjö 1998; Angelelli 2004), the interaction between processes and contexts has developed into a vibrant area of research in T&I.

Theoretical foundations

Attempts by certain psychologists in the 1950s to explain language acquisition and use in behaviorist terms ushered in a cognitive turn in linguistics with far-reaching consequences for various disciplines, including T&I. The notions of competence and performance, introduced to differentiate knowledge of one's native language from use of it (Chomsky 1965), were broadened to account for knowledge structures underlying all types of communication (e.g., Hymes 1972; Canale and Swain 1981), including translation. Competence models of varying degrees of complexity have been proposed in T&I to account for the differences between translators and bilinguals (e.g., Cao 1996; Kalina 2000; PACTE 2000, 2003; Colina 2003), and expertise studies have provided insights into how translators and interpreters become "experts" in their field (e.g., Smith and Ericsson 1991; Ericsson 1996, 2006; Ivanova 1999; Moser-Mercer et al. 2000; Shreve 2006).

Models of the mental lexicon, although initially monolingual, soon encompassed bilingual processing, and attempts were made to explain lexical decision-making (e.g., Levelt 1983; de Bot 1992; de Groot 1997; de Groot and Kroll 1997; Paradis 1997, 2004) along the lines suggested by Broadbent's analogy of cognitive processing as a sequence of information-processing operations (1958). These were developed further into psycholinguistic models of comprehension and production, with T&I represented as flows of bilingual information- processing and decision nodes (e.g., Gile 1995; Krings 1986; Bell 1991). Theorizing about human memory helped explain difficulties in processing linguistic information in terms of working memory constraints (e.g., Baddeley and Hitch 1974). In addition, the distinction between declarative memory, comprising semantic and episodic memory, and procedural memory, involving motor skills, has been very useful in explaining the complexities and routine aspects of T&I activities.

Theory building about the cognitive processes involved in translation and interpreting has drawn on research into bilingualism (e.g., Malakoff and Hakuta 1991; Bialystok 1992; Grosjean 1997), as well as language comprehension and production. The cognitive process of understanding spoken or written texts can be understood as the building of a mental model of the propositional content (e.g., van Dijk and Kintsch 1983). Relevance theory (Sperber and Wilson 1986, 1995; Gutt 1991) has been used to explain translation as interpretative language use, guided by human inferential processes. More recently, notions from cognitive linguistics have helped us to understand translation and interpreting as mediating processes between conceptual worlds (e.g., Rojo and Ibarretxe-Antuñano 2013) and have fed into the development of cognitive translatology, which, alongside its commitment to empirical enquiry, embraces embodied, situated, and/or distributed cognition (e.g., Muñoz Martín 2010a, 2010b, 2013; Risku 2010).

Evolution of the topic in TIS

Interest in cognitive processes arose early in the area of conference interpreting, probably because of the high memory demands it imposes. One of the first attempts to describe the black box, the *théorie du sens*, later known as the *Interpretive Approach* (Seleskovitch 1968; Seleskovitch and Lederer 1984), divided the interpreting process into three interrelated phases: understanding, deverbalization, and re-expression. The first phase was assumed to involve not merely linguistic decoding but also cognitive inputs of encyclopedic and contextual knowledge, generating a "sense" on which the second phase, deverbalization, was based. The third phase, re-expression, was considered to be a process similar to monolingual language production, deriving directly from a non-verbal level of cognition. The view of an interpreter as an information-processing system prompted research into memory capacity and cognitive sub-skills, such as anticipation and inferencing, and into cognitive processing models (e.g., Moser-Mercer 1997/2002, 2000). Cognitively oriented research

into conference interpreting also focused on the strategies interpreters seem to employ to cope with memory and processing limitations, such as generalizing, chunking, and omission (e.g., Kohn and Kalina 1996). Parallel attempts to describe the translation process drew on models of artificial intelligence, with decision-making flows indicating which strategies were used when problems were encountered (Krings 1986; Lörscher 1991). Seen from this perspective, translation could be considered a decision-making activity involving declarative and procedural knowledge, which could be broken down into the following stages: identifying problems, clarifying problems, accessing relevant information, solving problems, choosing solutions, and evaluating solutions (Wilss 1996).

Since translation and interpreting are multitask activities involving two languages, researchers have tried to break down the process in order to examine each step in detail. Psycholinguistic models represented the receptive stages of the translation process as top-down decoding or source-text (ST) analysis through visual word recognition, loops of syntactic parsing, and lexical retrieval through semantic and pragmatic processing, and target text (TT) production as bottom-up encoding or synthesis through similar levels and loops (e.g., Bell 1991; Gile 1995). In order to understand better the differences between the two activities, parallels have been drawn with reading and listening research (e.g., Danks and Griffin 1997). For example, the first steps of the process have been assumed to involve a linguistic analysis of the ST/spoken input in order to build up a mental model of the content, with domain knowledge and metacognitive considerations of text function and audience playing an important role in comprehending the ST.

To gain information about how translators and interpreters approach their tasks and how they deal with problems, post-task interviews and retrospective commentaries have been used. These techniques, however, are limited by the constraints of selective and working memory and, like all self-report methods, may result in recitations of ideal procedures rather than actual self-reflection. An alternative window onto the black box of the translator's mind is offered by concurrent verbalization (also known as think-aloud). This technique was first used over a century ago (cf. Camps 2003; Göpferich 2008) and experienced a revival with the cognitive turn. The oral mode of data elicitation makes it unsuitable for investigating simultaneous interpreting, but it was quickly taken up as a method of choice by many researchers interested in the cognitive processes involved in translation (e.g., Krings 1986; Jääskeläinen 1999; Englund Dimitrova 2005). Ericsson and Simon's review of psychological studies (1984/1993) suggests that concurrent verbalization can yield valid data about sequences of thoughts and problem-solving processes if participants are asked to verbalize the contents of their working memory during a task, making it a significant advance over examinations of text products or observations of the process. Thinking aloud while translating, however, is not without its limitations as a research technique insofar as it may affect components of the process under investigation, such as lexical decision-making (cf. Jääskeläinen

2000) or revision (cf. Krings 2001), and is generally believed to slow down the process (cf. Jakobsen 2003; Ehrensberger-Dow and Künzli 2010). Used on its own, it cannot be linked directly to a problem the translator is dealing with at any particular time unless the verbalization includes enough of the ST or TT to make the location in the process clear. Of more concern is that thinking aloud seems to interfere with the process itself (known as "reactivity"; cf. Leow and Morgan-Short 2004), especially with professional translators (Jakobsen 2002: 203). One reason for this could be that more aspects of a professional's processes are internalized and automatized, and so bringing them to the surface by verbalizing them requires cognitive resources that would otherwise be employed in problem solving.

As computers became more common in the translation workplace, logging keystrokes and mouse movements and/or recording all activities on the computer screen made it possible to monitor the translation process more accurately than by simply observing translators or interviewing them afterward. In combination with concurrent verbalization, keylogging programs and screen recording software provide more precise reconstructions of problem-solving processes as they make possible the examination of pauses, deletions, insertions, and other revisions around predicted problems or "rich" points (cf. PACTE 2005). Moreover, the interference effects produced by concurrent verbalization and the memory decay limitations of many retrospective techniques can be circumvented by using the replay feature of logging and screen recording software to obtain self-report information (cf. Hansen 2006). Recording in the background as the translator translates, computer logging is non-invasive; the recordings can then be immediately played back to the translator, who comments on the translation as it unfolds. The metacognitive data elicited by these stimulated-recall retrospective commentaries can provide insights into the translators' underlying cognitive processes.

By combining computer logging techniques with verbal elicitation, researchers have identified and examined in detail various phases of the translation process. Alternatively termed preliminary (Krings 1986), orientation (Jakobsen 2002), planning (Englund Dimitrova 2005), or pre-drafting (Mossop 2007), the first phase involves reading the ST or segments of it, analyzing it, and doing any research necessary to aid comprehension. Although students are often taught to read carefully and analyze an ST before attempting to translate it, professionals seem to vary the length of the orientation phase and the number of cognitive activities performed during it, depending on the domain, the genre, the tools used, and their personal working style (cf. Alves and Liparini Campos 2009; Carl et al. 2011; Ehrensberger-Dow and Massey 2013). The orientation phase of some professionals consists of little more than glancing over the text; the reading, analysis, and research activities are incorporated into the next phase.

Once the first character of the TT is typed, the second phase of the process begins. The production of the TT draft has been called the main (Krings 1986), drafting (Jakobsen 2002; Mossop 2007), or text generation (Englund Dimitrova

2005) phase of the translation process. Rather than simply writing what has been previously formulated in the mind of the translator, as suggested in some psycholinguistic models of the translation process, the activities during this phase indicate that it comprises a complex recursive process of reading, comprehension, analysis, research, text production, reformulation, revision, rereading, and checking the emerging TT.

Although it can be difficult to determine precisely when the second phase of the process ends and the third phase begins, one definition that has proven useful is the point at which the last punctuation mark of the last sentence is typed. The follow-up (Krings 1986), revision (Jakobsen 2002; Englund Dimitrova 2005), or post-drafting (Mossop 2007) phase of the translation process has also been termed "self-revision" to distinguish it from revision done by someone else (which has been termed "other" revision by Mossop 2007). In Englund Dimitrova's study (2005), self-revision in the third phase was shown to be important in moving away from literal solutions produced in the previous phase (confirmed in a study by Pavlović and Antunović 2013). Researchers have also explored the cognitive processes involved in revising other people's translations (e.g., Künzli 2007).

Many investigations of the cognitive processes involved in translation compare students to professionals, based on the assumption that students have not yet developed translation competence whereas professionals have. Translation competence has been defined in various ways, from Pym's minimalist definition (2003: 489)—the ability to select one viable TT from a series, quickly and with justified confidence—to Shreve's inclusion of it as "a specialized form of communicative competence" (1997: 120). In Kiraly's model of the translator's mental space (1995: 99–109), the boxes, decision nodes, and unidirectional arrows of the earlier psycholinguistic models are replaced by a more interactional view of internal and external resources in combination with relatively uncontrolled and controlled processes. Interaction, represented by bidirectional arrows, has also been included in the PACTE group's holistic model of translation competence (2003: 60), which comprises various sub-competences or components: the bilingual sub-competence, the extra-linguistic sub-competence, the translation-knowledge sub-competence, the instrumental sub-competence, the strategic sub-competence, and psycho-physiological components. The model has formed the basis for much recent research into the cognitive processes involved in translation and was adapted by Göpferich (2008, 2009, 2013) for her own longitudinal study investigating the development of translation competence.

Parallel developments in Interpreting Studies culminated in Kalina (2000), which described the competences required for professional interpreters in similar terms. In addition to excellent linguistic skills and specialized domain knowledge, procedural knowledge about interpreting and strategic processing are necessary. The real-time nature of most interpreting tasks requires TT production/output to occur almost simultaneously with comprehension of ST input. The unique demands that this places on cognitive processing have been

captured in so-called effort models (cf. Gile 1995, 2009; Seeber 2011, 2013), based on the assumption that there is a limit to an individual's cognitive resources at any particular point in time. With the increasing demands and time pressure involved with professional translation, such models are being re-examined by translation process researchers as well. The concept of "mental load" proposed by Muñoz Martín (2012) is an example of how translation and interpreting process research might be reconverging.

Key studies

One of the most widely cited and influential studies on cognitive processes dates back to the infancy of translation process research, when Krings conducted a think-aloud study of student problem solving (1986). Using color-coding of text to reflect different processes in conjunction with protocols of articulated thoughts, Krings' research was the first of its kind to link the process with the product in defining and empirically describing problems and subsequent problem-solving behavior. His research ushered in a decade of empirical studies on cognitive processes in translation using think-aloud protocols (TAPs, cf. Jääskeläinen 2002). In the mid-1990s, keystroke logging was introduced to the research arena as a tool for capturing process data. Along with multiple options for documenting cognitive processes came a series of studies dedicated to exploring potential impacts of the research tools and techniques themselves. Jakobsen (2003) discovered that having translators think aloud concurrently with task completion results in a reduction in translation speed and requires translators to process texts in smaller segments. In other words, translators were exhibiting tendencies that they would not otherwise exhibit while translating texts. This study was by no means intended as a call to move away from TAPs but rather to draw attention to the fact that different cognitive aspects of translation call for different analytic mechanisms.

Alves' 2003 volume, *Triangulating Translation*, introduced what is now widely regarded as a best practice in translation process research, namely exploring phenomena and eliciting data through multiple, combined methods, including (but not limited to) TAPs, keystroke logging, concurrent or retrospective summaries, eye-tracking, and screen recording. It is in this current era of triangulation that we have seen a series of breakthrough discoveries in such domains as attention, time and resource allocation, segmenting, variation among students, novices, professionals, and experts, and human-computer interaction.

In recent years, research on the allocation of cognitive resources has often overlapped with comparative research on the behaviors and tendencies of various populations, including students, novices, professionals, and experts. For example, in a study on allocation of effort across the three fundamental phases of translation—orientation, drafting, and revision—Jakobsen (2002) found that experts tend to demonstrate balanced cognitive rhythms, whereas the transition rhythms of novices are much more erratic. As a possible

explanation, several studies have found empirical evidence that experts exhibit higher levels of metacognition, implying greater efficacy when critically reflecting on and monitoring their own performance (Alves and Gonçalves 2003; Hansen 2003: 26; Jääskeläinen 2010). In a follow-up study, Alves and Gonçalves (2007) arrived at another possible explanation for this, namely the tendency for professionals to have greater confidence in their decision-making processes and for novices to be more insecure in this regard, a pattern also observed by Künzli (2004).

Studies using eye-tracking technology have shed greater light on aspects of allocation exhibited by various types of translators through visual attention data, or information about where translators look on the screen, in which sequences, and for how long. Combined with the pause and temporal data provided by keystroke loggers, visual attention data adds a level of granularity that provides researchers with a more nuanced understanding of what might actually be going on in the translator's mind during task completion. Interestingly, the advent of eye-tracking challenged previous assumptions made about translation processes using keystroke logging alone. For example, using keystroke logging to capture pausing tendencies, Dragsted (2004) initially proposed the idea that cognitive segmenting is relatively linear, demarcated by start and end pauses. At the time, this was a very important discovery in that cognitive segments were shown not to correspond with the default sentential segments with which translators work when using translation memories. In a follow-up exploration of segmenting patterns using eye-tracking (Dragsted and Hansen 2008), however, the boundaries of cognitive segments were shown to be more fuzzy, with gaze evidence suggesting that processing is both inter-segmental and intra-segmental – in other words, far from linear. Comprehension and production were shown to transpire not so much in a fashion distinct from each other, but rather in a coordinated fashion, almost to the point of occurring simultaneously. In light of their findings, Dragsted and Hansen (2008: 27) introduced the concept of eye-key span (EKS), or the temporal duration between the first fixation on an ST component and the production of its equivalent in the TT, as a more accurate metric for empirical research on cognitive segmenting.

Eye-tracking has also provided more detailed information on cognitive process variations between novices and professionals at various stages or loci of translation, including planning, comprehension, transfer, production (drafting), and revision. For example, multiple studies have documented visual attention patterns, suggesting the tendency for students to allocate more attention to the ST and for professionals to allocate more attention to the TT (Jakobsen 2005; Sharmin et al. 2008; Jensen 2011). If time spent on task is a reflection of the cognitive effort allocated to problem solving, this variation may in part explain why students tend to struggle primarily with comprehension, whereas professionals deliberately focus more on the TT for purposes of evaluation and revision. Interestingly, Sharmin et al. (2008), which also examined the impact of time pressure on ST–TT attention allocation patterns, found

that the number of fixations on the ST decreases under time pressure while the number of fixations on the TT remains the same. Perhaps the tendency of professionals to dedicate more attention to the TT is also a result of conditioning and experience in working under time pressure.

New directions

Research on cognitive processes in T&I will likely continue to be driven by two current trends, namely a dedication to methods involving triangulation and the embracing of interdisciplinarity (cf. O'Brien 2013). One current research trend that will continue to gain momentum in the coming years involves the empirical exploration of post-editing processes (O'Brien et al. 2014), with a particular focus on how human processing compares and interacts with machine processing. The past few years have witnessed increasing collaboration between machine translation researchers and translation process researchers, with the common goal of enhancing productivity by pinpointing how humans and machine applications can ultimately complement each other from a text (and information)-processing standpoint.

Building on findings regarding CAT (computer-aided translation) tool usability, a current wave of cognitive process research involves aspects of human-computer interaction (e.g., O'Brien 2012). Here we are seeing a fundamental paradigm shift involving a deliberate movement away from design driven by programmers to design driven by translators and interpreters, based on empirically documented cognitive patterns. Much of the current research in this area is taking one of two interrelated directions. One direction involves longitudinal projects, such as CASMACAT (Elming et al. 2014) at the Copenhagen Business School, which are focused on using triangulated process data (eye-tracking, keystroke logging, and screen recording, for example) to optimize user interface design and assistive technology. A second direction involves cognitive ergonomics (Massey and Ehrensberger-Dow 2011a; Ehrensberger-Dow and Massey 2014), which examines, in part, indicators of efficacious and inefficacious desktop management, awareness of automated translation resource features, and interface interaction.

In some regards, research on human-computer interaction and cognitive ergonomics is entering an ethnographic turn, expanding on some of the central tenets outlined by Risku (2010) in her discussion of situated cognition. Based on the fact that translation is inherently interactive and dynamic, situated cognition examines cognitive dimensions from a social-contextual perspective. Rather than attempting to pinpoint what is in the black box per se, studies based on situated cognition examine how translators' interaction with the actors and factors of their working environment shapes their thought and behavior. In the coming years, we will likely see scholars continue to take up Risku's call to engage in ethnographic research of cognitive processes on location, for example, in translation agencies or in the natural working environments of freelancers.

Situated cognition also holds potential for advancing research on aspects of expertise in translation and interpreting (Shreve 2006). While we still know relatively little about what distinguishes the expert translator from the professional (Jääskeläinen 2010), it would seem that a natural setting, such as an in-house agency in which highly successful language industry professionals engage in authentic tasks not constrained by variables associated with an experimentally controlled lab, could serve as fertile ground for discoveries. Such on-location research, grounded initially in participant observation, could yield concrete indicators of the behaviors and strategies that embody expertise (cf. Albl-Mikasa 2013). Establishing more concrete empirical and ethnographic profiles of highly efficacious translators and interpreters could, in turn, go a long way toward optimizing process-oriented T&I training. Given the steadily increasing interest in process-oriented training, thanks in large part to user-friendly technology, such as web-based keystroke loggers, screen recorders, and speech recognition software, we are likely to see the continuation of research dedicated to increasing process awareness through reflection on one's own and others' processes (Massey and Ehrensberger-Dow 2011b; Angelone 2013). The time seems ripe for more extensive research on how process efficacy can be formally assessed and quality assured.

In closing, it is important to emphasize that many of these new directions align with the central tenets of the cognitive translatology paradigm proposed by Muñoz Martín (2010a, 2010b, 2013). Cognitive translatology is first and foremost an interdisciplinary applied science (Muñoz Martín 2010b); it benefits from exploration of core concepts, such as the various manifestations of bilingual proficiency used in conveying ideas across language and cultures, through a variety of scientific methods. The analytic lenses and methods of process research can and should vary. However, if its ultimate aim is to establish generalizable knowledge of translation and interpreting, cognitive translatology must achieve a certain level of operational compatibility across research projects. Muñoz Martín proposes a three-tier model that can serve as an ideal framework in this regard (2014: 13). First, translation task models need to be delineated. Second, the component sub-tasks need to be defined. Finally, the cognitive processes of interest need to be described in detail. Transparency, interdisciplinarity, and triangulation, the hallmarks of cognitive translatology, underscore why this particular paradigm holds great potential as a unifying catalyst for advancing cognitive process research in T&I.

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