Title: Stress, cognitive, emotional and ergonomic demands in interpreting and translation: a review of physiological studies

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Stress, Cognitive, Emotional and Ergonomic Demands in Interpreting and Translation: a Review of Physiological Studies

Abstract

The autonomic nervous system is responsible for modulating peripheral functions in the human body and consists of sympathetic and parasympathetic branches. Its activation affects, among other things, heart rate, respiratory rate, salivation, perspiration, pupillary dilation, and blink rate. For some years now, physiological measurements have found their way into interpreting and translation studies to investigate, in particular, cognitive, emotional and ergonomic demands and stress in translating, interpreting and post-editing. We conducted a meta-review of publications from 1990 until 2020 in order to investigate the relevance of (a) the four constructs of emotional, cognitive and ergonomic demands and physiological stress and of (b) physiological data for translation and interpreting research. With our selection of search terms, we identified 369 publications investigating one of the four constructs, of which 28 use physiological data. Analysis of the 28 studies shows a tendency towards triangulating physiological with other types of data, which reflects the complexity of the investigated tasks and constructs. Moreover, there seems to be an effort to increase sample size, which is an important step towards more robust results in quantitative research in the field.

Keywords

Meta-review, physiology, emotion, ergonomics, stress, cognitive demands, translation, interpreting

1 Introduction

The survival of the individual and species depends on the ability of the organism to adapt to its external environment (Chrousos & Gold, 1992). Favorable conditions facilitate processes that enhance growth, development, and reproduction, whereas threatening conditions trigger physiological changes in the body that help the individual to survive the stressful environment, while searching for more favorable circumstances (Chrousos & Gold, 1992). Any internal or external stimulus that is potent enough to be perceived as a threat to the stability of homeostasis places the organism in a responsive state and activates an adaptive response (Chrousos, 1998). Since the first studies in the middle of the last century, a new branch at the interface between physiology and psychology has developed: psychophysiology. Psychophysiology is concerned with the experience of the environment and its physiological manifestations (Cacioppo, Tassinary, & Berntson, 2007) and uses these interactions to gain a better understanding of human behavior.

In translation and interpreting (T&I) studies, the interactions between mind and body have increasingly moved into focus and scholars have started stressing the importance of studying these processes as embodied phenomena (Muñoz Martín, 2017; Risku, 2010; Zeier, 1997). Relating psychophysiological research to translation and interpreting processes can make an important contribution as, by definition, the body and its interaction with cognitive processes play a central role from the perspective of embodied cognition. In all forms of interdisciplinary research, a high degree of integration and reciprocity are considered important quality features (Boix-Mansilla, Feller, & Gardner, 2006). In the following, we therefore set out to take a closer look at psychophysiological research as well as the use of physiological data in T&I studies, the various underlying psychological constructs that have been investigated and the measurement methods that have been used. Measures include cardiovascular biomarkers (heart rate, blood pressure), electrodermal activity (skin conductance), voice frequency, stress hormone level, muscle tension (EMG), pupil dilation and blink rate. Electrophysiological methods such as EEG or fMRI and ocular measures such as fixation duration or fixation count have not been included in this review as their use relates to concepts and

rationales that are different from those underlying physiological methods. An appropriate introduction to and appraisal of those studies would therefore go beyond the scope of this review.

1.1 Adaptive responses and the measurement of physiological correlates

The underlying assumption of psychophysiological research is that "psychological and behavioral processes unfold as organismic-environmental transactions" (Cacioppo et al., 2007, p. 14) and have physiological manifestations. These manifestations affect the pupil, cardiovascular activity, respiration, perspiration and salivation and are mediated by the sympathetic division of the autonomous nervous system (ANS). This division is specialized for the mobilization of energy and predominantly produces energy expenditure, catabolic functions and adjustments for intense activity (Peters et al., 1998; Rickels, 1972). Particularly in emergency situations and in conditions that require activity, the sympathetic division provides physiological adjustments that optimize behavior in response to threat. Imagine yourself walking alone at night and hearing an unfamiliar noise behind you. Within seconds, your physiology springs into action, your heart races, your blood pressure rises, your pupils dilate, improving vision and you begin to sweat. The above example illustrates how the ANS provides a coordinated program of adaptive responses that happen immediately and can consist in the prototypical examples of going into fight mode, priming an individual to do battle, or flight mode, so that one can escape from an adversarial situation (McCarty, 2007). An additional response has been described as the "freeze-mode" which is a self-paralyzing response in situations in which one cannot defend oneself. Under such circumstances, "freezing" permits an organism not to feel the enormity of what is happening or to deceive a potential predator (Alban & Pocknell, 2017).

In the psychophysiological literature, a large diversity of physiological data such as cardiovascular (heart rate, blood pressure) and electrodermal activity, pupillometry and blink rate, voice pitch and voice intensity, muscle tension, respiration rate as well as stress hormones has been used to assess different psychological constructs (e.g., Charles & Nixon, 2019; Klebba, 1985; Mauss & Robinson, 2009). An important advantage of measuring physiological manifestations in the human body is that they are assumed to be involuntary and therefore less subjective than self-report (Cacioppo, et al., 2007). In addition, they provide a measurement of bodily reactions in real time, and physiological

markers can provide information about sub-conscious psychological processes that would otherwise be inaccessible. Nevertheless, psychophysiological approaches also present some methodological challenges that have led to a number of practices in order to deal with these challenges. One challenge is the variability of the response. Physiological reactions can differ greatly between participants according to their gender, age (Lovallo, Farag, & Vincent, 2010) or state, such as fatigue (Lock, Bonetti, & Campbell, 2018). Diurnal patterns (Fisk et al., 2018; Lovallo et al., 2010, Lowenstein, Feinberg, & Loewenfeld, 1963) or environmental characteristics like illumination (Brown & Page, 1939; Fisk et al., 2018) can further condition the physiological response. Hence, there can be substantial variability in the measurements that may obscure the actual effect the experimenter is interested in. Consequently, studies that use physiological methods require a substantial number of participants and/or within participant testing to obtain significant results. Another approach to deal with this variability is to normalize the data. For this reason, researchers typically collect data not only during the experiment, but also during a pre- or post-experimental neutral condition that serves as a baseline. This baseline can then be used to normalize the experimental data (for pupillometry see Mathôt, Fabius, Van Heusden, & Van der Stigchel, 2018, for heart rate and electrodermal activity see Rojo López & Korpal, 2020, as well as Andreassi, 2007, pp.259--268).

The most important challenge, however, is the lack of specificity of physiological responses. Activity in the autonomic nervous system can reflect a variety of complex processes including task demands, emotional response and motor behavior. In addition, psychological and physiological events can be associated through different types of relations, ranging from one-to-one to many-to-many relations: An element in the psychological set can be associated with only one element in the physiological set of responses or with an entire subset of elements in the physiological domain. Pupillometric studies exemplify this challenge: pupils dilate in response to emotionally arousing stimuli (Bradley, Miccoli, Escrig, & Lang, 2008; Partala & Surakka, 2003; Wang et al., 2018) or pain (Chapman, Oka, Bradshaw, Jacobson, & Donaldson, 1999) but also in response to cognitive demands (Hess, 1972; Kahneman, 1973; Peavler, 1974). At the same time, emotional intensity correlates with heart rate but also increases skin conductance (Wang et al., 2018). As a result, establishing a cause-and-effect relationship between a particular psychological construct and physiological responses

presents a challenge. In the following sections, we will take a closer look at four main constructs that can trigger adaptive responses: emotional demands, different types of stress, cognitive demands and ergonomic demands.

1.2 Emotional demands

From the beginning of psychophysiology as a discipline, physiological change has been closely linked to emotionally demanding situations. Emotions are one of the central evolutionary products that likely evolved to produce adaptive responses to the environment. They have been defined as episodes of "interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism" (Scherer, 2005, p. 697). From our own experience, we know that bodily reactions are an important part of emotional response and one of the components involved in emotion processes is the physiological component of emotion. The experience of anger, for example, goes together with an increase in heart rate and an increase of blood flow to the hands and arms (Levenson, Ekman, & Friesen, 1990) to support action tendencies associated with this emotion.

Emotions can be studied from various perspectives that differ in how they conceptualize emotional states. According to the dimensional perspective, emotional responses are organized by only a limited number of underlying dimensions such as valence, i.e., contrasting states of pleasure with states of displeasure, and arousal, i.e., contrasting states of low arousal with states of high arousal (Russell & Barrett, 1999). Arousal "refers to a short-term increase in some process that can be viewed as involving excitatory processes -- usually an increase in behavior or physiological activity" (Fowles, 2009, p. 50). Arousal, or intensity, is hypothesized to intensify the vigor of people's current responses whatever they might be. The essence of the general arousal concept is that it results in an overall increased response and is a critical factor in organizing patterns of physiological response in emotional reactions. From their meta-analysis of emotion measures, Mauss and Robinson (2009) draw the conclusion that measures of the autonomous nervous system primarily respond to broader dimensions

of emotion, such as arousal. They therefore recommend focusing on these aspects of emotional states with ANS measures.

1.3 Different types of stress

Activation of the automatic nervous system as a function of emotional response is commonly measured using indices based on electrodermal or cardiovascular responses (Gatti, Calzolari, Maggioni, & Obrist, 2018; Shi et al., 2017). However, in the majority of situations, these responses do not occur in isolation but together with other physiological changes and as part of a set of responses mediated by the ANS. This idea corresponds to the conceptualization of adaptive responses as a general type of stress in which stress is referred to as a nonspecific response of the body made to any kind of encountered demand (Selye, 1976). According to this view, all living beings are constantly under stress and anything, pleasant or unpleasant, that speeds up the intensity of life causes a temporary increase in stress (Kaltsas & Chrousos, 2007). During stress, cardiac output and respiration are enhanced and blood flow is redirected to provide the highest perfusion to the brain and musculoskeletal system. Although stress is frequently addressed in translation and interpreting studies and the concept seems clearly defined, it is delimited only rarely. When studying stress, it is important to distinguish between physiological and psychological stress elicitors. Physiological stress is elicited, for example, by physically noxious agents (injuries, drug abuse), exercising or unfavorable environmental conditions such as changes in temperature (Lazarus, 1999). Conversely, when the cause of the stress reaction is psychological, the mind rather than the body initiates or sustains it and the reaction is cognitively mediated. While the bodily changes that are produced by physiological and psychological stress are the same, these two types of stress should be viewed as two versions of the same process, separate and distinct adaptive responses of the organism. Distinguishing between physiological and psychological stress is difficult. Therefore, when psychological stress is studied, the subject's physical conditions must be kept as stable as possible (Lazarus, 1999).

Psychological stress and emotion are closely interlinked, as many negative emotions, for example anger or anxiety, arise from stressful situations and stress may also be involved in efforts to maintain positive emotional states. Accordingly, the psychological literature also refers to stress as an

emotional response to “either acute or chronic strains” (Uchino, Ruiz, & Holt-Lunstad, 2009, p. 383), emphasizing its relation to the individual’s perceived coping potential and the importance of stress in explaining physical health outcomes. In this sense, stress has also been studied in the context of ergonomic demands and working conditions (i.e., occupational stress). Lazarus suggests that we should “view stress, emotion, and coping as existing in a part-whole relationship” (1999, p.37) and that these concepts should only be separated for convenience of analysis. Further, he points out that the concepts stress, emotion and coping form a conceptual unit, with emotion being the superordinate concept. The notion of stress has also been adopted by researchers in T&I as can be seen from the following four examples: “Physiological stress responses during media and conference interpreting” (Kurz, 2002); “Interpreting as a stressful activity: physiological measures of stress in simultaneous interpreting” (Korpal, 2016), “Stress in written and sight translation in training settings” (Baghi & Khoshsaligheh, 2019) or “Translator’s experience of occupational stress and job satisfaction” (Courtney & Phelan, 2019).

1.4 Cognitive demands

The idea that cognitive demands can trigger an adaptive response goes back to the beginnings of psychology and research on sensation and attention (Angell & Thompson, 1899) but the relationship was only firmly established once Kahneman and colleagues demonstrated that pupil dilation, heart rate and skin conductance correlate with increasing difficulty in a digit transformation task (Kahneman, Tursky, Shapiro, & Crider, 1969). A couple of years later, Kahneman developed a capacity model of attention (Kahneman, 1973). According to this model, the arousal, i.e., the intensity of the physiological response, determines the amount of available cognitive resources that are invested to solve a task which he also called “mental effort” (Kahneman, 1973, pp. 13--27).

Among the wealth of models that attempt to explain the nature of cognitive demands (Barrouillet, Bernardin, & Camos, 2004; Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007; Lavie, Hirst, de Fockert, & Viding, 2004; Wickens, 2008), the Cognitive Load Theory by Sweller and Chandler (Chandler & Sweller, 1991; Sweller, 2011) is a popular one. Cognitive Load Theory originated in educational research, and its premise is that cognitive resources are limited.

Consequently, the processing of inadequately designed instruction material or didactic techniques can require cognitive resources that are then no longer available for learning. Research on Cognitive Load Theory has long been restricted to self-ratings of the perceived effort by a one-item scale (de Jong, 2010) and by performance measures (Paas,Tuovinen, Tabbers, & Van Gerven, 2003, p. 64). More recently, physiological indicators have also been used, such as heart rate (Paas & Van Merriënboer, 1994), pupil dilation (Mitra, McNeal, & Bondell, 2017), and -- less commonly -- stress hormone levels such as cortisol (Wilson & Eggemeier, 1991). The notions of cognitive load or mental effort originated in psychological research, but the construct has since then been adopted or at least referred to by many scholars in T&I studies, as exemplified by the Effort Models (Gile, 2009), the Cognitive Load Models (Seeber, 2011), Alves' relevance-theoretic approach (2007) or the cognitive model of translation sketched by Shreve and Lacruz (2017). They all outline "efforts" necessary for or "loads" associated with translation or interpretation.

1.5 Ergonomic demands

Ergonomics is a more recent discipline that seeks to enhance human performance and maintain human well-being by adopting a holistic approach (Wilson, 2014). A more precise definition holds that "ergonomics is the theoretical and fundamental understanding of human behavior and performance in purposeful interacting [in] sociotechnical systems, and the application of that understanding to design of interactions in the context of real settings" (Wilson, 2000, p. 560). Key concepts that situate the research within the field are fatigue, drowsiness, (mental) workload, occupational stress or physical load. They exemplify the discipline of ergonomics as meandering between psychology, physiology and sociology. It is therefore not surprising that research in ergonomics borrows psychophysiological methods in order to assess ergonomic demands that can emerge at the workplace. In contrast to many psychological studies, ergonomic studies attempt to simulate real-life settings, which makes them particularly interesting for T&I studies.

Typically, ergonomic studies have investigated work environments and environment factors such as air traffic control (Zeier, 1994), car driving (Baldauf, Burgard, & Wittmann, 2009), impact of machine noise in forest work (Ljungberg & Neely, 2007), or the impact of sedentary work on

subjective experience, performance and physiological correlates (Wahlström, 2005). Important research has also been done using pupillary movements (Lowenstein, Feinberg, & Loewenfeld, 1963) or blink patterns to detect drowsiness and fatigue (Martins & Carvalho, 2015). According to a meta-review (Charles & Nixon, 2019), heart rate and ocular measures of pupil dilation and blinks are among the most widely used physiological techniques: each of these measures has been reported in more than half of the corpus (58 publications). Among these three, blink rate seems to be the most successful method to detect changes in mental workload. In the following, we will take a closer look at the relevance of the above-mentioned constructs for research on translation and interpreting and the use of physiological data in T&I studies.

2 Physiological data in interpreting and translation studies

2.1 Research questions and scope of the review

Our review addresses two main questions:

1) How relevant are conceptual constructs relating to emotional, cognitive or ergonomic demands and stress to researchers in the field of T&I studies? To answer this question, we count the frequency with which they are cited in T&I studies.
2) How do researchers in T&I studies use physiological data? To answer this question, we discuss the research questions and the underlying constructs in physiological T&I studies.

Our initial aim was to obtain a comprehensive overview of the relevant literature. This had several implications on the scope of our review. First, we decided to incorporate a large range of published academic contributions, including journal articles, chapters in collected volumes, handbook chapters, monographs, encyclopedic entries and conference proceedings because all of these might contribute to highlighting the relevance of the topic in T&I studies. Second, some journals like *Meta*, *Babel*, *Forum* and others accept contributions in languages other than English. For this reason, we also included publications written in German, French or Spanish. Third, we chose to consider publications from 1990 until 2020 in order to cover early as well as present empirical research or methodological reflections.

2.2 Methodology

In order to capture a maximum number of publications, we opted for a three-step approach. First, we conducted a search in databases that are tailored to T&I studies, namely the *Translation Studies Bibliography* (Gambier & van Doorslaer, 2020) and *BITRA* (Franco Aixelá, 2001). Second, we searched journals in adjacent disciplines such as linguistics, psychology, cognitive sciences or philosophy using *web of science* (Clarivate, 2020) as a more general database. Finally, we manually checked non-indexed T&I journals for relevant publications. The starting point for this manual search was the list of T&I journals published by the *European Society for Translation Studies* which allowed us to identify the remaining journals that focus on T&I studies but are not (yet) indexed in a database. Within each step, we conducted two searches. The first search included search terms related to physiological data[1]; the second one used search terms associated with the three constructs of emotional, cognitive and ergonomic demands[2] and the more general term 'stress'. For the search beyond T&I studies, we additionally used a third set of search terms[3] related to translation and interpreting in order to eliminate irrelevant results. All search term sets used wild cards and Boolean operators and were used in all relevant database fields, i.e., in the title, the keywords and the abstract. As a consequence, publications that did not use one of the keywords in one of the fields were not captured by our search. Publications that appeared in more than one database were only counted once. An overview of the journals that were included in the review, the type of search and the number of results for each set of keywords is included in the appendix.

2.2.1 Inclusion criteria and categorization. All results were checked for their salience in order to ensure that they fell within the scope of our review. Results of homonymy (for example, "pupil" in the sense of *student* instead of a part of the eye, "skin" in the sense of *leather* instead of a human organ) were discarded. Publications needed to fulfil three criteria to be included:

- The publication deals with community or conference interpreting or sign language interpreting, sight translation, translation or post-editing.

- The publication focuses on the effect on the (student) translator or interpreter or the translation or interpretation process (and not on effects on the user or reader, for instance)
- Translation or interpreting involve two different languages (as opposed to respeaking, for instance).

Subsequently, we categorized all selected publications according to three characteristics: type of research, task under study and underlying construct(s) motivating the study. Regarding type of research, we made an initial distinction between empirical contributions that were based on data collected by the authors and those that were not based on data. Within the empirical studies, we distinguished between experimental studies, surveys, corpus studies and a final group of miscellaneous research designs that encompassed case studies, field studies, ethnographic studies and observational studies describing the effects of certain interventions or trainings. Contributions that were not data-based included theoretical, methodological and philosophical reflections. We identified eight basic categories for the tasks: 1) conference interpreting (simultaneous, consecutive); 2) community interpreting (health care interpreting, legal and conflict interpreting); 3) sign language interpreting; 4) translation, including localization and audio-visual translation; 5) sight translation; 6) post-editing; 7) audio description; and 8) general. This last group encompassed publications with a more general approach that did not focus on any particular task. As the third characteristic, we identified the underlying construct(s) that had motivated the study. Table 1 displays the description and keywords associated with each construct. It must be emphasized, however, that categories may overlap and of course depend on the authors' argumentation and the experimental set-up.

Construct	Description
Emotional demands and psychological stress	Studies referring to emotions, psychological stress, emotional intelligence or stability, anxiety, ambiguity avoidance, affect or empathy.
Cognitive demands	Studies referring to task difficulty, mental effort, processing effort or cognitive load, attentional demands or "problem triggers".
Ergonomic demands	Studies on occupational stress, well-being or workplace ergonomics.

Physiological stress	Studies pursuing a more general approach in that they address the physiological stress response without referring to cognitive, ergonomic or emotional demands.

Table 1: description of the keywords associated with each construct

2.2.2 Identification of physiological studies. This first categorization of our sample allowed us to address the first research question concerning the relevance of the keywords associated with the four constructs of cognitive, emotional and ergonomic demands and stress in T&I studies. In order to answer the second research question regarding the use of physiological data it was necessary to identify those studies that used physiological data. Physiological data was defined as data related to physiological states that are mediated by the sympathetic nervous system in response to our environment. This is different from behavioral data, such as task performance or gaze behavior, or self-reports. Even though observation of behavior and self-reports are widely used to measure cognitive, emotional or ergonomic demands or stress, they are based on other cognitive concepts and assumptions, such as the eye-mind-hypothesis (Just & Carpenter, 1980), rather than physiological measures. For this reason, behavioral studies were only included quantitatively in the sample to assess the relevance of our constructs in T&I studies and not discussed in detail. A similar approach has been adopted for electrophysiological studies using EEG, fMRI, PET or similar methods that allow the localization of activation in the brain in response to specific stimuli. These methods require a detailed understanding of the apparatus and functioning of the brain in order to interpret these studies, which may be addressed in a separate review. For this reason, electrophysiological studies that addressed one of the four constructs were included quantitatively but not reviewed in detail. The subset of physiological studies included thus only studies that used at least one of the following measures associated with the sympathetic nervous system: cardiovascular measures (heart rate, heart rate variability, systolic and diastolic blood pressure), electrodermal activity, pupillometry, blink rate, electromyogram, voice pitch and intensity, stress hormone level (cortisol, epinephrine), and respiration rate.

2.3 Sample description

In the end, our sample included a total of 369 relevant publications. The overwhelming majority (69 %) were articles published in journals, followed by book chapters or contributions to anthologies (22 %) and conference proceedings (5 %). Encyclopedic entries and monographs represented only 2 % and 2 % of all publications, respectively. Approximately two-thirds (n=241) of all publications were empirical studies. In this group, the most important type of research was experimental (68 %), followed by surveys (14 %), miscellaneous (10 %) and corpus studies (8 %).

2.4 Results

Publications on translation and conference interpreting accounted for the majority of publications (76%). Other tasks were covered to a much lesser extent. More than half of all contributions dealt with cognitive load. Approximately one quarter of all publications cover emotional and ergonomic demands. Table 2 displays the number of contributions for each task and each construct.

	Stress	Cognitive demands	Emotional demands	Ergonomic demands	TOTAL per task
Conference interpreting	11	73	24	18	126
Community interpreting	0	3	11	18	32
Sign language interpreting	0	2	1	11	14
Sight translation	0	9	1	0	10
Translation	1	86	34	34	155
Post-editing	0	30	0	0	30
General	0	1	1	0	2
TOTAL per construct	12	204	72	81	369

Table 2: Number of publications on specific tasks and concepts

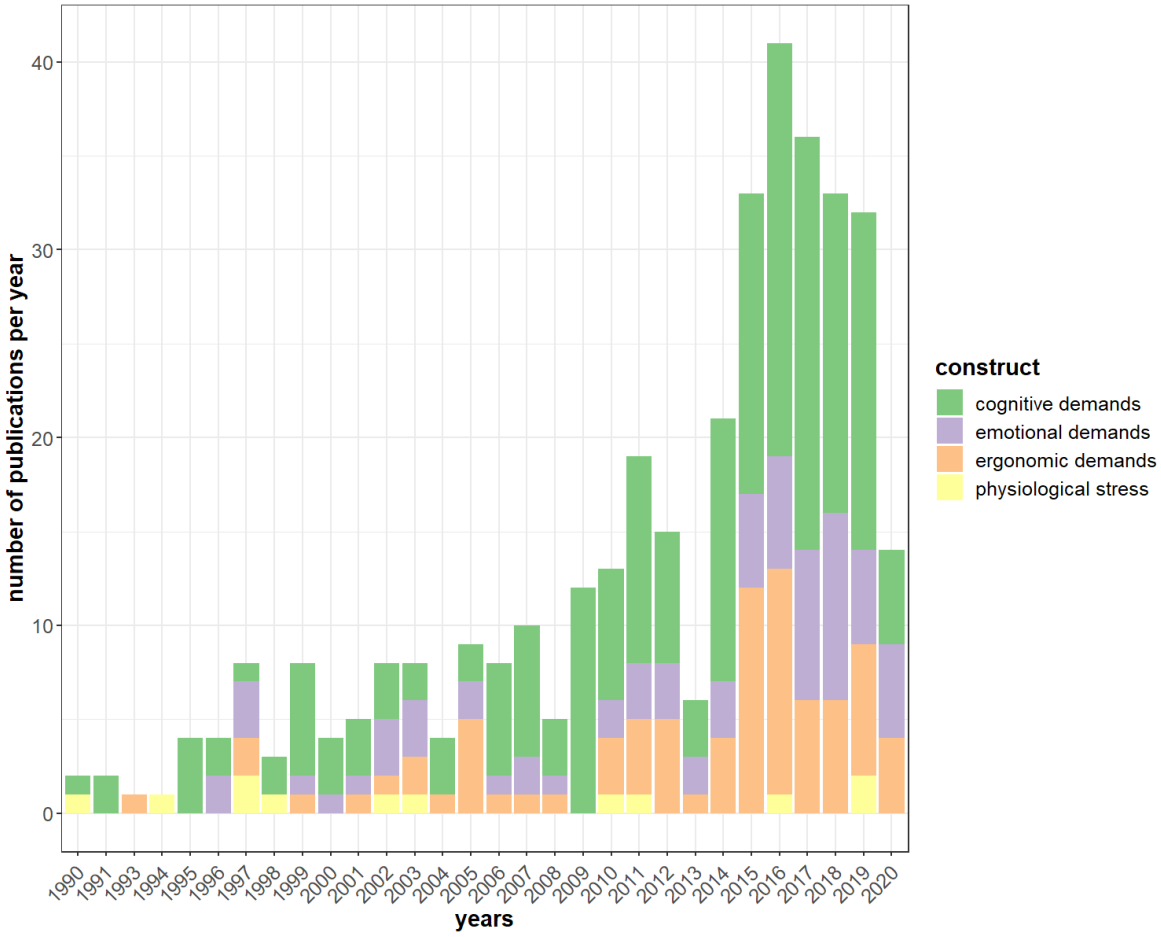

Figure 1: Number of publications per year from 1990 to 2020 (search concluded 31 December 2020). The colors represent the number of publications related to different constructs.

A closer look at these figures reveals that constructs are not evenly distributed across tasks. Some constructs seem to play a more important role in some tasks than in others -- at least from a research perspective. The studies on conference interpreting, for example, seem to focus on cognitive demands, while publications in community interpreting or sign language interpreting appear to be essentially motivated by ergonomic demands/occupational stress. Similarly, research on post-editing so far seems to concentrate solely on cognitive demands, while studies on translation seems to have a broader perspective, extending to emotional and ergonomic aspects. This observation does not necessarily mean that certain constructs are not important or interesting in some of the tasks. Instead, it may simply reflect the reality that tasks like translation and conference interpreting (the first publications in the sample are from 1996 and 1990, respectively) have been studied for a longer time

and from more diverse perspectives than tasks that have emerged more recently, such as post-editing (2006), or only recently attracted research interest, like community interpreting (2000).

The number of publications related to cognitive, emotional or ergonomic load has been increasing since 1990; the strongest increase can be observed in publications on cognitive demands (see Figure 1). The fraction of studies using physiological data, however, is very small. From a total of 369 publications, only 43 covered the set of keywords related to physiological data. Among these, 28 entries were empirical studies that actually reported physiological data, seven of which reported multiple physiological measures (for instance blood pressure and heart rate). A closer look at figure 1 shows that the number of these studies has increased rapidly from around 2010 onward. Physiological studies mostly focus on translation (n=12) and conference interpreting (n=12). Post-editing (n=2), sight translation (n=1) and sign language interpreting (n=1) have been investigated to a far lesser extent with physiological methods. The most popular methods were pupillometry (n=17) and heart rate (n=7). Other methods that were reported include measuring cortisol and electrodermal

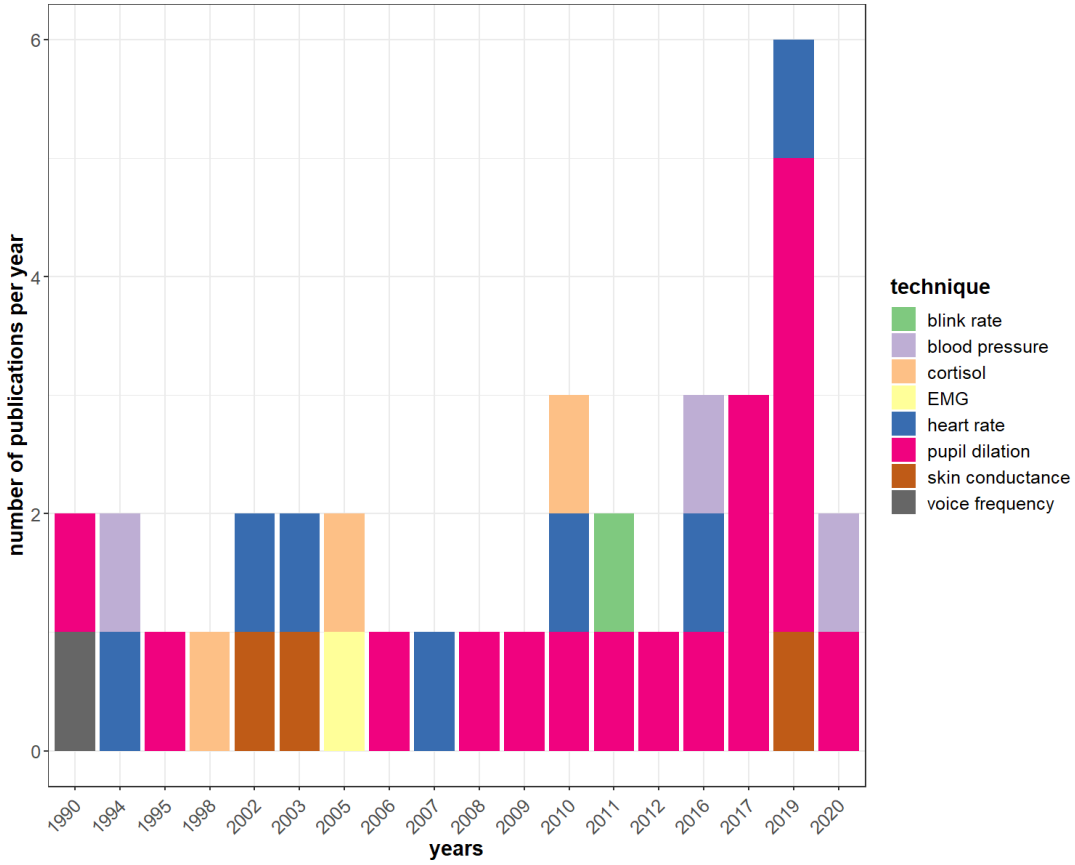

Figure 2. Number of studies that reported the use of a certain physiological technique from 1990 to 2020. Please note that some studies report more than one method.

activity, voice frequency and electromyogram (EMG). The next two sections take a closer look at this subset of physiological studies, first in interpreting studies, including sign language interpreting, and then in translation studies, including post-editing and sight translation.

2.5 Physiological studies in interpreting studies

The subset of physiological studies includes 13 in interpreting studies. The median number of participants is nine, with only three studies exceeding 15 participants (Klonowicz, 1994; Korpal & Jasielska, 2019; Roziner & Shlesinger, 2010). In all cases, participants were professional interpreters or interpreting students. In four studies, researchers used physiological data to investigate cognitive demands (Hyönä, Tommola, & Alaja, 1995; Korpal, 2016; Seeber & Kerzel, 2012; Tommola & Hyönä, 1990), and to a lesser extent emotional demand (Korpal & Jasielska, 2019) and ergonomic demand (Delisle, Larivière, Imbeau, & Durand, 2005). These four studies[4] all took place in a controlled laboratory setting and tested specific stressors, such as simultaneous interpreting compared to shadowing or listening (Hyönä, et al.,1995; Tommola & Hyönä, 1990), verb position (Seeber & Kerzel, 2012), speech pace (Korpal, 2016), speech emotionality (Korpal & Jasielska, 2019) and physical exposure during sign language interpreting (Delisle et al., 2005). However, in most cases (n=6) and especially in earlier studies, researchers investigated stress during interpreting as a more general phenomenon including cognitive and ergonomic aspects (Darò, 1990; Klonowicz, 1994; Kurz, 2002, 2003; Moser-Mercer, Künzli & Korac, 1998; Roziner & Shlesinger, 2010). The data for these six studies on stress was collected during a conference setting, focusing on stress levels before and after (prolonged) turns (Klonowicz, 1994; Moser-Mercer et al., 1998), during remote and on-site interpreting (Roziner & Shlesinger, 2010), during media and conference interpreting (Kurz, 2002) or differences in stress levels in professional interpreters compared to interpreting students during interpreting (Kurz, 2003). A special case is Darò (1990), who explored one professional interpreter's voice frequency in different languages in a pilot study.

In the aforementioned studies, there seems to be some degree of relationship between the setting (laboratory or conference) and the methods that were applied. Methods that need bulky devices like eye-trackers (Hyönä et al., 1995; Seeber & Kerzel, 2012; Tommola & Hyönä, 1990), EDA meters

(Korpal & Jasielska, 2019) or electromyographs (Delisle et al., 2005) and/or require a carefully controlled environment and comparable stimuli were more often used in laboratory settings. For example, two out of three pupillometric studies (Hyönä et al., 1995; Seeber & Kerzel, 2012; Tommola & Hyönä, 1990) took place in a controlled laboratory setting that allows the maintenance, for instance, of the same level of illumination during the whole experiment, which is crucial for pupillometric studies. In most cases, laboratory studies reported increased cognitive load for the stressor under investigation[5].

Methods that seem more feasible for conference settings are heart rate (Klonowicz, 1994; Korpal, 2016; Kurz, 2002, 2003; Roziner & Shlesinger, 2010), also in combination with blood pressure (Klonowicz, 1994; Korpal, 2016; Roziner & Shlesinger, 2010), and cortisol levels (Moser-Mercer et al., 1998; Moser-Mercer, 2005; Roziner & Shlesinger, 2010). Heart rate is the most common physiological method (n=5) so far used in interpreting studies as an indicator for stress. A reason to use heart rate as a physiological measure in workplace settings is obviously the convenience of the equipment, as it does not require any set-up or calibration procedures (as compared to eye trackers, for example). Measurements are typically taken at specific points during data collection, for instance at the beginning and the end of a conference day, and therefore do not interfere with the task itself. An exception are the studies conducted by Kurz (2002, 2003), who used a more sophisticated biofeedback system that allowed continuous measurement of the heart rate. With the advent of smartwatches, continuous measurement of heart rate is possible without impeding an experiment. However, no study using smartwatches has yet been reported in interpreting studies. In two of three studies, blood pressure was insensitive to the stressor (Korpal 2016; Roziner & Shlesinger 2010), whereas the predicted differences in heart rate were confirmed in all studies except Roziner and Shlesinger (2010).

To date, studies on skin conductance (n=2) (Korpal & Jasielska, 2019; Kurz, 2002) and voice frequency (n=1) (Darò, 1990) have been scarce in interpreting studies. Skin conductance has been found to be affected by emotional load and in particular speech emotionality (Korpal & Jasielska, 2019), as well as by elevated stress levels in media interpreting compared to conference interpreting (Kurz, 2002). Higher stress levels during foreign language production compared to native language production may affect voice frequency (Darò, 1990). The latter two studies, however, had only one

participant each and should therefore be considered case studies. The only study to apply skin conductance on a more reliable number of participants (n=20) was reported by Korpal and Jasielska (2019). It is therefore difficult to comment on the reliability or efficacy of these methods.

2.6 Physiological studies in translation studies

The subset of physiological studies in translation studies consists of 15. The earliest study dates from 2006 (O'Brien, 2006) and the most recent from 2020 (Lehr and Hvelplund, 2020). The number of participants ranges from four (O'Brien, 2006) to 52 (Lachaud, 2011), with a median of 21 participants. With the exception of Lachaud (2011) who used bilinguals, translation research studies exclusively used professional translators or translation students as participants. However, the samples sometimes seem quite heterogeneous, especially regarding the level of translation competence. In some studies, the samples consist of students of translation and of adjacent disciplines like interpreting or Modern Languages (Chang, 2011; Koglin & Cunha, 2019; Pfurtscheller, Grabner, Brunner, & Neuper, 2007; Su & Li, 2019) or of undergraduate and graduate translation students (O'Brien, 2008). With the aim of grouping participants more consistently according to their (reported) competence level, Fonseca (2019) conducted a hierarchical clustering analysis.

Almost all studies used physiological data to investigate cognitive demands (n=14). They did so with regard to post-editing (Fonseca, 2019; Koglin & Cunha, 2019), directionality (Chang, 2011; Pavlović & Jensen, 2009; Su & Li, 2019), translation memory matches (O'Brien, 2006, 2008), text difficulty (Liu, Zheng, & Zhou, 2019), word translation difficulty (Lachaud, 2011; Pfurtscheller et al., 2007), professionality (Hvelplund, 2016), the processing of subtasks in dubbing translation (Hvelplund, 2017a), source text versus target text processing (Hvelplund, 2017b), and digital resource consultation (Hvelplund, 2017c). The two exceptions are Baghi and Khoshsaligheh (2019) who conducted a study on stress during written and sight translation, and Lehr and Hvelplund (2020) who investigated emotional response to different source texts and how that response affected the allocation of cognitive resources. Apart from Pfurtscheller et al. (2007) and Baghi and Khoshsaligheh (2019), the studies sketched above are all eye-tracking studies that took place in a laboratory setting and report pupillometric data in combination with gaze behavior data like fixation duration, transition count and

saccade duration, although Chang (2011) also reported blink rate. In most cases, pupil dilation was larger during the high demand condition if two conditions were compared. Translation into a second language seems to trigger consistently larger pupil dilation (Chang, 2011; Pavlović & Jensen, 2009; Su & Li, 2019) as does the use of digital resources (Hvelplund, 2017c) or false friends in word translation (Lachaud, 2011). The results are more mixed with translation matches (O'Brien, 2006, 2008), post-editing of machine translations (Fonseca, 2019; Koglin & Cunha, 2019) or source and target text processing (Hvelplund, 2017b) where pupil dilation does not seem to differentiate between conditions. Since experimental procedure (interstimulus time), environment (illumination) as well as data collection and normalization procedures are not always sufficiently documented, it is difficult to assess whether the pupillary movements were biased due to light adaptation or carry-over effects. Nevertheless, pupil dilation seems a promising method for studies on translation and post-editing that take place in a controlled laboratory environment.

The remaining two studies used heart rate and -- in the latter case -- blood pressure as a physiological indicator for cognitive demands (Pfurtscheller et al., 2007) and stress (Baghi & Khoshsaligheh, 2019). Pfurtscheller et al. (2007) report changes in heart rate depending on the difficulty of word translations. While Pfurtscheller et al. (2007) conducted their study in a laboratory setting with controlled stimuli and a simple task, Baghi and Khoshsaligheh (2019) used genuine translation tasks, such as translating a passage of an academic text in written or oral mode. The latter recorded heart rate and blood pressure before, in the middle and after the task. In these more ecological conditions, the authors found significant changes in heart rate during written and sight translation although no differences in blood pressure were found. These results, together with early studies on interpreting, suggest that heart rate may be a suitable technique for research in applied settings.

3 Potentials and limitations of physiological data in T&I studies

We identified 369 publications related to concepts like cognitive, emotional or ergonomic load, and the increase in number from 1990 onward suggests that these constructs are gaining importance. The number of physiological studies (n=28) remains low, yet we can observe an increase

from 2010 onward in particular for pupillometric studies, which is also the most widely used method. One reason may be the advent of more extensively implementable eye-tracking technology like cornea reflection in 2010 (Gao, Yin, Cheng, & Feng, 2012). This also seems to have conditioned a shift towards more controlled laboratory study designs compared to early studies on interpreting where data was essentially collected during real-life settings. One reason -- even though it is speculative -- may be that T&I researchers are more and more "whole-time researchers" instead of "practisearchers" (Gile, 2018, p. 24) and hence receive more instruction in experimental design and methods.

The most popular methods among T&I researchers seem to be pupillometry -- often as a by-product of a larger eye-tracking study -- as well as heart rate, which is relatively easy to implement since the advent of heart rate monitors. In most cases, researchers who applied heart rate or pupillometry to test their predictions were able to confirm them. This does not exclude flaws in the experimental design or the methodology, but it encourages the view that these two methods can be applied in T&I research even though interpreting, translating or post-editing are more complex tasks than those typically found in psychophysiological studies. However, not all physiological methods seem to be equally suited to investigating T&I activities: skin conductance, for instance, has until recently required the fixing of electrodes to the fingertips of the participant. While this is possible in oral tasks such as simultaneous interpreting or sight translation, it is much less advisable for written tasks such as translation or consecutive interpreting. Another aspect to consider is practicability: measuring cortisol levels, for instance, requires shipping the samples to specialized laboratories for analysis.

Apart from these more practical considerations, we would like to point out some methodological challenges that researchers may face when using physiological data and propose some good practices that we observed in our corpus. One of the first difficulties we observed is a lack of comparability and standards in physiological T&I studies. In the field of psychology, it is usually recommended to normalize the data with help of a baseline condition in order to reduce idiosyncratic differences within and between participants (see Mathôt et al., 2018, Andreassi, 2007 or Rojo Lopéz & Korpal, 2020). Even though some researchers apparently apply a baseline condition (e.g., Klonowicz, 1994; Korpal, 2016; Korpal & Jasielska, 2019), the normalization procedure is not always well

documented, with exception of Seeber and Kerzel (2012) and Pfurtscheller et al. (2007). As a consequence, it is difficult to compare different studies and their effects on physiological measures. Explaining the normalization procedures in more detail would certainly help to better appreciate the results reported by the authors.

The potential for noise in physiological data also means that physiological studies require an appropriate number of participants. All studies considered, the median number of participants was 11, with one-third having more than 15 participants. This is certainly a challenge inherent in T&I studies, as professional translators and interpreters are a limited (and expensive) resource, and may be the reason some researchers included students (n=9) rather than professionals (n=10)[6]. The low number of participants may also explain why some authors (Kurz, 2002, 2003; Moser-Mercer et al., 1998) do not report any statistics. Small-scale studies, however, make it difficult to evaluate whether the observed effects can be replicated and generalized to the profession.

Other points of concern with regard to data quality are the text material and the experimental procedures. In most studies, researchers carefully designed and manipulated stimuli and experimental procedure to isolate the factor under investigation and reduce confounding effects. The degree of manipulation is not the same across all studies, but apart from the first early studies on interpreting, the setting cannot be characterized as authentic. This trade-off between data quality and ecological validity is an important topic in physiological studies: ecologically valid experiments risk obscuring the data whereas controlled experiments providing high quality data may lead to conclusions that are only of limited applicability in the real world. One approach that allows acceptable data quality to be maintain while shifting towards higher ecological validity is to triangulate physiological variables. The idea here is to 'stabilize' the emerging picture: if all results point in the same direction, the researchers can draw their conclusion more confidently than if they rely on only one physiological variable (e.g., Korpal, 2016; Korpal & Jasielska, 2019). Another suggestion, though not observed in the literature reviewed in this study, would be to combine laboratory observation with self-reports in real-life settings. Again, results showing the same trend could suggest that the effects observed in the laboratory may also hold in practice.

Finally, the reviewed literature shows that physiological data may be highly sensitive but not necessarily very specific. The same variable can be used to investigate different constructs and reacts to cognitive, emotional as well as ergonomic demands. Pupillometry was used in most cases to investigate cognitive demands (see Seeber & Kerzel, 2012; Koglin & Cunha, 2019, Chang, 2011), but Lehr and Hvelplund (2020) used it to study emotional aspects of translation, and Roziner and Shlesinger (2010) examined pupil dilation to study stress in different interpreting situation. A very promising practice that emerged from the reviewed literature is to adopt self-reports as a valuable complement to the physiological data. Self-reports offer insights into participants' experience and therefore allow physiological data to be validated. With exception of Roziner and Shlesinger's (2010) very thorough study, self-reports generally only covered the construct underlying the study. Studies on emotional demands, for instance, used questionnaires on emotional experience like the Positive and Negative Affect Schedule (PANAS) (Korpal & Jasielska, 2019) or the State-Trait Anxiety Inventory (STAI) (Moser-Mercer, 2005; Moser-Mercer et al., 1998). Studies on cognitive demands employed questionnaires on effort (O'Brien, 2008) or standardized questionnaires like the NASA Task Load Index (NASA-TLX) (Liu et al., 2019). However, the different types of demands, emotional, cognitive or ergonomic, may overlap. Self-reports indicating high cognitive demand, for instance, do not necessarily exclude a feeling of frustration, anger or anxiety. A study on this overlap has, to the best of our knowledge, not yet been done, but we might consider the following example: A complicated speech at a high delivery rate (cognitive demands) may raise feelings of frustration, anger or inability to cope with the task (emotional demands) and may at the same time cause muscle tension (ergonomic demands). A promising research approach would therefore be to include questionnaires on other types of demands in order to obtain a fuller picture.

4 Some methodological notes

This review has a couple of limitations that we would like to point out. First of all, the number of results depends on the search terms that were entered into the search engines. Despite our attempt for a very inclusive approach, we cannot exclude that some publications are missing for the simple reason that they did not contain any of the keywords we used. Similarly, we did not include 'grey

literature' like unpublished dissertations. Even though some of them provide very interesting and innovative insights and are publicly available, they are often not indexed in search engines or otherwise systematically and therefore difficult to collate. Against this backdrop the numbers indicated here may only represent the tip of the iceberg.

Another important aspect we would like to emphasize concerns the categorization of the literature into our three constructs of emotional, cognitive and ergonomic demands. It is important to understand that this categorization is to some degree artificial in several respects: constructs are containers for different concepts, models and theories. Cognitive demands encompass for instance 'effort' in Gile's Effort Models (2009), 'cognitive load' in Seeber's Cognitive load model (2011), 'processing effort' in Alves' Relevance theoretical approach (2007) as well as studies that did not explicitly mention the underlying theory but simply assumed that one task should be more difficult than the other (see also methodology section). Nevertheless, we hope that this categorization provides a useful overview for the reader.

5 Conclusion

This study presents results from a meta-review on publications investigating interpreting and translation tasks from the viewpoint of cognitive, emotional or ergonomic demands or more generalized physiological stress phenomena. We identified 369 relevant publications. Our results show that the notions of cognitive, emotional or ergonomic demand have gained interest from 1990 on. In a second step, we focused on studies using physiological data to examine interpreters' or translators' cognitive load. Across tasks, we identified a total of 28 studies, often combining different types of physiological indicators or combining physiological data with self-reports or behavioral data. Although our sample is small, we can draw the encouraging conclusion that studies seem to have become increasingly complex, which reflects the complexity of the investigated tasks and constructs. The number of participants has slowly grown, and studies are providing more and more reliable data. Experimental designs in laboratory settings seem to have become more rigorous and more effective in controlling for unwanted secondary effects that may confound the data. Methodological issues are being addressed more thoroughly.

In the 28 studies, the most popular physiological methods were heart rate and pupillometry. Other methods such as blood pressure, skin conductance, blink rate, hormone levels, muscle tension or voice frequency were much less frequent. In most cases, the analyses of the collected data confirmed the respective authors' predictions. Remarkably, this holds even for some cases where the data was collected during a real-life assignment and not in a laboratory. However, in our sample, we did not find a one-to-one-relationship between a certain construct and a certain physiological correlate. In other words, researchers did not always use the same physiological measure to investigate a single construct but rather used different physiological correlates for the same construct or the same indicator for multiple constructs. It should be borne in mind that physiological reactions are rather unspecific and may reflect different kinds of demands -- emotional, cognitive or ergonomic ones, or several ones at the same time. Among the good practices to resolve this ambiguity, we identified in particular triangulation of physiological data with other types of physiological data and/or with self-report and behavioral data as well as the careful design of stimuli and the experimental procedure.

Despite their methodological complexity, physiological data can provide valuable insights for the study of translation and interpreting processes and inspire innovativeness in research designs. They can complement other types of data to provide additional and more objective indicators and tap into processes that otherwise would remain unknown territory. Theories that were framed and methodologies that were developed in psychophysiological research are therefore of high interest for translation and interpreting scholars. However, psychophysiologically oriented research is often limited to highly controlled laboratory conditions and to student samples, whereas translation and interpreting scholars often aim for a high ecological validity due to the complexity of the processes they are studying and their applied orientation. Their ecologically valid approaches can also make a relevant contribution to psychophysiological research because studies that focus on translation and interpreting processes frequently include professionals. These studies can enhance the heterogeneity of samples and contribute to extend previous findings to professionals. In addition, they can provide input to improve the ecological validity of the processes under study by employing tasks that are certainly more complex but also closer to reality. All of the above can promote a high degree of

integration and reciprocity in the interdisciplinary exchange between T&I studies and psychophysiological research, as complex as it is fascinating, which holds promising opportunities.

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[1] The first set of search terms included: physio*, pupil*, blink*, cardiovascular, heart rate, heart beat, blood pressure skin, electrodermal, voice pitch, f0, fundamental frequency, EMG, muscle, hormone, cortisol, *adrenaline, *epinephrine, respiration, breathing.

[2] The second set of search terms included: cognitive load, cognitive effort, mental load, mental effort, processing load, processing effort, work-load, workload, emotion, empathy, stress, ergonomic*, well-being, task difficulty, text difficulty, text complexity.

[3] The third set of search terms included: translat* AND NOT translational, interpret*, post-edit*, MT (for machine translation).

[4] Tommola and Hyönä (1990) and Hyönä et al. (1995) seem to report data from the same experiment but from different angles.

[5] Roziner and Shlesinger (2010), who reported pupillometric data during remote and on-site interpreting, found a (statistically non-significant) trend contrary to their prediction but acknowledged that their data might have been distorted by changes in illumination.

[6] The remaining 5 studies contrasted students and professionals.

Appendix

Number of results for each journal and each keywordset.

journal	keywordset	search	number of results
Across Languages and Cultures	constructs	database	8
Across Languages and Cultures	physiology	database	1
American Journal of orthopsychiatry, The	constructs	database	1
Applied Psycholinguistics	constructs	database	1
Asia Pacific Translation and Intercultural Studies	constructs	database	1
ATA Chronicles, The	constructs	database	1
Babel	constructs	database	9
Bilingualism: Language and Cognition	constructs	manual	1
Brain Research	physiology	database	1
Brain Research Bulletin	physiology	database	1
Cadernos de Tradução	constructs	database	1
Chinese Translators Journal	constructs	database	1
Copenhagen Studies in Language	constructs	database	1
Current Trends in Translation Teaching and Learning	constructs	database	1
English Language Teaching	constructs	database	1
Ergonomics	constructs	database	1
European Journal of Applied Physiology	physiology	database	1
Forum	constructs	database	3
Forum	physiology	database	1

Free/open-source machine translation	constructs	database	1
Frontiers in Digital Humanities	constructs	database	1
Hermeneus	constructs	database	1
Hermes	physiology	database	1
Hikma	constructs	database	1
Hikma	physiology	database	1
International Journal of Bilingualism	constructs	database	1
International Journal of Bilingualism	physiology	database	1
International Journal of Industrial ergonomics	constructs	database	1
International Journal of Interpreter Education	constructs	database	1
International Journal of Modern Language Teaching and Learning	constructs	database	1
Interpreter and Translator Trainer, The	constructs	manual	7
Interpreters' Newsletter, The	constructs	manual	11
Interpreters' Newsletter, The	physiology	database	2
Interpreting	constructs	database	14
Interpreting	physiology	database	4
Intralinea	constructs	manual	4
Journal of Deaf Studies and Deaf Education, The	constructs	database	2
Journal of Interpretation (JOI)	constructs	manual	7
Journal of Interpreting	constructs	manual	1
Journal of Occupational Rehabilitation	physiology	database	1

Journal of Specialised translation, The (JoSTrans)	constructs	database	10
Journal of Specialised translation, The (JoSTrans)	physiology	database	2
Journal of Translation Studies	constructs	database	1
La traduction dans le monde arabe	constructs	database	1
Language Matters	constructs	database	1
Lebende Sprachen	constructs	database	4
Les Cahiers de l'ILCEA	constructs	database	7
Les Cahiers de l'ILCEA	physiology	database	1
Letras de Hoje	constructs	database	1
Linguistica Antverpiensia	physiology	database	2
Linguistica Antverpiensia	constructs	database	4
Machine Translation	constructs	database	3
Mental Health Review Journal	constructs	database	1
Meta	constructs	manual	22
Meta	physiology	manual	2
Monographs in Translation and Interpreting (MonTi)	constructs	manual	4
Monographs in Translation and Interpreting (MonTi)	physiology	manual	1
New Voices in Translation Studies	constructs	database	2
Patient Education and Counseling	constructs	database	1
Perspectives	constructs	database	9
Perspectives	physiology	database	1
Poznan Studies in Contemporary Linguistics	constructs	database	1

Poznan Studies in Contemporary Linguistics	physiology	database	2
Psychophysiology	physiology	database	1
Quarterly journal of experimental psychology	physiology	database	1
Revista Canaria de Estudios Ingleses	constructs	database	1
Revue Française de Linguistique Appliquée	constructs	database	1
Sendebar	constructs	database	2
SKASE	constructs	manual	3
Sozial-und Präventivmedizin	constructs	database	1
Studia Universitatis Babes-Bolyai Philologia	constructs	database	1
T21N	constructs	database	2
Target	constructs	database	10
Target	physiology	database	2
TextconText	constructs	database	1
Translation & Interpreting. The International Journal of Translation and Interpreting Research (T&I)	constructs	database	20
Translation and Cognition	constructs	database	1
Translation and Interpreting Review	constructs	manual	1
Translation and Interpreting Studies	constructs	database	7
Translation in context	constructs	database	1
Translation Journal	constructs	database	2
Translation Spaces	constructs	database	8
Translation, Cognition & Behaviour (TCB)	constructs	database	3

Traduction, Términologie, Rédaction (TTR)	constructs	manual	1
VALS-ASLA	physiology	database	1
VIAL. Vigo International Journal of Applied Linguistics	constructs	database	1

5.1.1 Number of results for each keywordset in collective volumes, handbooks and encyclopedia

title	**keywordset**	**search**	**number of results**
Audiovisual Translation -- Research and Use	physiology	database	1
Bridging the Gap: Empirical Research in Simultaneous Interpretation	physiology	database	1
Cognitive Explorations of Translation	constructs	database	3
Cognitive Processes in Translation and Interpreting	constructs	database	1
Efforts and Models in Interpreting and Translation Research. A Tribute to Daniel Gile	constructs	database	2
Empirical Modelling of Translation and Interpreting	constructs	database	2
Empirical Translation Studies. Process and Product	constructs	database	1
Eye Tracking and Multidisciplinary Studies on Translation	constructs	manual	5
Fast-forwarding with Audiovisual Translation	constructs	BITRA	1

Foreign Language Comprehension and Production	physiology	database	1
From the Lab to the Classroom and Back Again. Perspectives on Translation and Interpreting Training	constructs	database	1
Handbook of Research on Teaching Methods in Language Translation and Interpretation	constructs	database	1
Handbook of Translation and Cognition, The	constructs	database	5
Identité, altérité, équivalence: la traduction comme relation	constructs	database	1
In our hands: educating healthcare interpreters	constructs	BITRA	1
Innovation and Expansion in Translation Process Research	constructs	database	3
Innovation and Expansion in Translation Process Research	physiology	database	1
Interdisciplinarity in translation and interpreting process research	constructs	database	1
Interdisciplinarity in translation and interpreting process research	physiology	database	1
Interpreting across genres: Multiple research perspectives	constructs	database	1
Interpreting and Technology	constructs	database	1
Interpreting in the 21st century: challenges and opportunities	constructs	database	1

Looking at Eyes: Eye-tracking studies of reading and translation processing	physiology	database	1
Making Way in Corpus-based Interpreting Studies	constructs	database	3
Methods and strategies of process research	constructs	database	3
Moving Boundaries in Translation Studies	constructs	database	1
Multilingual mediated communication and cognition	physiology	manual	2
New Directions in Empirical Translation Process Research	constructs	database	4
Post-editing of Machine Translation: Processes and Applications	constructs	database	1
Probing the Process in Translation: Methods and Results	constructs	database	1
Psycholinguistic and Cognitive Inquiries into Translation and Interpreting	constructs	BITRA	1
Reembedding Translation Process Research	constructs	database	2
Reembedding Translation Process Research	physiology	database	1
Researching Cognitive Processes of Translation	constructs	database	1
Routledge Companion to Translation Studies, The	constructs	database	1
Routledge Handbook of Interpreting, The	constructs	database	1

Routledge Handbook of Translation and Technology, The	constructs	database	1
The Development of Translation Competence: Theories and Methodologies from Psycholinguistics and Cognitive Science	constructs	database	1
The Evolving Curriculum in Interpreter and Translator Education. Stakeholder Perspectives and Voices	constructs	database	1
Topics in Interpreting Research	constructs	database	1
Tracks and Treks in Translation Studies	constructs	database	1
Traducción e interpretación en los servicios públicos: nuevas necesidades para nuevas realidades	constructs	database	1
Translating Sensitive Texts: Linguistic Aspects	constructs	database	1
Translation and Cognition	constructs	database	1
Translation and Meaning	constructs	database	1
Translation as a Cognitive Activity	constructs	database	1
Translation as Intercultural Communication	constructs	database	1
Translation in Transition: Between Cognition, Computing and Technology	constructs	database	2
Translation in Transition: Between Cognition, Computing and Technology	physiology	database	1
Translation Practice in the Field: Current Research on Socio-Cognitive Processes	constructs	database	1
Translation Research Projects 2	physiology	database	1

Translation zwischen Theorie und Praxis	constructs	database	1
Translationsdidaktik: Grundfragen der Übersetzungswissenschaft	constructs	database	1
Translationsqualität	constructs	database	1
Translator as Mediator of Cultures, The	constructs	database	1
Translator, The	constructs	database	1
Trends in E-Tools and Resources for Translators and Interpreters	constructs	database	1
Unity in Diversity	constructs	database	1
Routledge Encyclopedia of Interpreting Studies	constructs	database	6

5.1.2 Number of monographs included, and the keywordset associated with the monograph

title	author	year	keywordset	search
Translation and Emotion. A Psychological Perspective	Hubscher-Davidson	2017	construct	database
Basic concepts and models for interpreter and translator training	Gile	2009	construct	database
Becoming a translator: an accelerated course	Robinson	1997	construct	database
Simultaneous Interpretation. A Cognitive-Pragmatic Analysis	Setton	1999	construct	database
Dealing with other people's tragedies: the psychological and emotional impact of community interpreting	Baistow, Taylor	2000	construct	database
Visuelle Informationen beim Simultandolmetschen: eine Eye-tracking Studie	Seubert	2019	construct	database

5.1.3 Number of results for conference proceedings for each keywordset

congress	keywordset	search	number of results
2nd EM+/CNGL	frameworks	database	1
2nd International Conference on Current Trends in Studies of Translation and Interpreting	frameworks	database	1
5th National Chinese Conference on Interpreting	frameworks	database	1
7th Jornades de Traduccío	frameworks	database	1
7th workshop on statistical machine translation	frameworks	database	1
8th NLPCS Human-Machine Interaction in Translation	frameworks	database	1
AMTA	frameworks	database	3
Anais do V Encontro Nacional de Tradutores / Proceedings of the V Brazilian Translators' Forum	frameworks	database	1
CIUTI-Forum 2010 - Global Governance and Intercultural Dialogue: Translation and Interpreting in a new Geopolitical Setting	frameworks	database	1
Cognitive Explorations of Translation	physiological measures	database	1
EAMT	frameworks	database	1
FIT Congress	frameworks	database	2
Human Factors and Ergonomics Society	frameworks	database	1
ICEAL	frameworks	database	1

The critical link 5. Quality in interpreting – a shared responsibility	frameworks	database	1
Translation and meaning 6	frameworks	database	1
Workshop on Humans and Computer-assisted translation	frameworks	database	1