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# “The Eyes, Chico. They Never Lie.”: A Review of Eye Tracking Technology As a Tool in Interpreting Studies

## Sözlü Çeviri Çalışmalarında Bir Araç Olarak Göz Takip Teknolojisinin İncelenmesi



Nazlıgül Bozok [1]

[1] İstanbul University, Faculty of Letters, Department of Translation Studies , İstanbul, Türkiye

**Abstract** The “black box” metaphor in Interpreting Studies (IS) encapsulates interpreters’ complex and hidden cognitive processes while navigating linguistic and cultural boundaries. With the rise in process-oriented research within the field and the advances in technology, it is now possible for researchers within the field to explore the activity occurring in the interpreter’s mind. Technology, in this case, for eye tracking, holds great promise for providing insight, as there is a link between eye movements and cognitive effort. The aim of the present paper is to examine the previous studies in IS that use eye tracking, stressing both its limitations and its significance for comprehending cognitive effort. With this aim in mind, the studies investigated have been divided into 3 periods: (a) the early encounters, which refers to the period between 1981 and 1995, (b) the revival, which refers to the period between 2009 and 2020, and (c) the present, which covers the works published in the last four years. Building on these published works, future research could advance the field by increasing the sample size, conducting comparisons across different groups, embracing different measures and statistical tools, and involving a greater range of language pairs.

**Öz** Sözlü Çeviri Çalışmalarında “kara kutu” metaforu, tercümanların dilsel ve kültürel sınırlarda gezinirken geçtikleri karmaşık, gizli bilişsel süreçleri kapsar. Günümüzde, alandaki süreç odaklı araştırmaların artması ve teknolojik ilerlemeler tercümanın zihnine bir pencere açma olanağını beraberinde getirmiştir. Göz takibi, göz hareketleri ve bilişsel çaba arasındaki ilişki göz önünde bulundurulduğunda, çevirmenin bilişsel çabası hakkında bir içgörü kazanma imkânı tanımaktadır. Bu makalenin amacı alanda yürütülmüş çalışmaları, göz takibinin hem sınırlılıklarını hem de bilişsel çabayı anlamak için önemini vurgulayarak, kapsamlı bir şekilde incelemektir. Bu amaçla, çalışmalar üç dönemde ele alınmıştır: (a) 1981-1995 yılları arasındaki ilk dönem, (b) 2009-2020 yılları arasındaki canlanma dönemi, (c) 2020 sonrası dönem. İncelenen çalışmaların ışığında, gelecekteki araştırmaların örneklem büyüklüğünü artırarak, farklı gruplar arasında karşılaştırmalar yaparak, farklı ölçümleri ve istatistiksel araçları benimseyerek ve daha çeşitli dil çiftleriyle deneyler yaparak alana katkı sağlama potansiyeline sahip olduğunu söylemek mümkündür.

**Keywords** cognitive effort · cognitive load · eye tracking · Interpreting Studies · process-oriented research

**Anahtar Kelimeler** bilişsel çaba · bilişsel yük · göz takibi · Sözlü Çeviri Çalışmaları · süreç odaklı araştırmalar

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Corresponding author | Sorumlu Yazar: Nazlıgül Bozok nazligulbozok@gmail.com

## Introduction

In Translation and Interpreting Studies (TIS), the “black box” metaphor has long represented the complex processes that both translators and interpreters undergo while decoding a message in the source language and encoding it in the target language. In his renowned work “A Rationale for Descriptive Translation Studies”, Toury (1985, p. 25) states:

> “Translation processes, those series of operations whereby actual translations are derived from actual source texts, though no doubt also empirical facts, and as such part of the object-level of translation studies, are nevertheless only indirectly available for study, as a kind of ‘black box’, an open system whose internal structure can only be guessed at, or tentatively reconstructed.”

The term itself implicates that the structures and processes are hidden and must be inferred from other sources (Nairne, 1997 as cited in Hildebrandt & Oliver 2000, p. 195). Looking from the perspective of TIS today, it is arguable that the process research has reached a level that can uncover, if not all, some of those hidden parts, offering a glimpse of translators and interpreters’ cognitive processes. The traces of these processes can be observed through various means, such as production accuracy, self-reflections, the speed of accompanying movements, pupil dilation, and multiple patterns of brain activity (García, 2019, p.11). Seeber (2013, pp. 19- 20) categorizes four methods for measuring the cognitive load: (a) analytical methods (e.g. the Effort Models), (b) subjective methods (e.g. think aloud protocols), (c) achievement/performance methods (e.g. error analysis methods), (d) psychophysiological methods (e.g. EEG, PET).

Eye tracking falls into the last category and has been utilized in IS literature since 1981 (see McDonald & Carpenter, 1981). Compared with other psycho-physiological methods, such as electroencephalography (EEG) or positron emission tomography (PET), eye tracking is more affordable and raises fewer questions regarding ecological validity during process monitoring (Seeber, 2013). Eye-tracking technologies have gained popularity in cognitive translation and interpreting studies (CTIS) as a promising method for uncovering the black box of the interpreter’s mind, driven by the belief that oculomotor behaviors can reveal underlying cognitive activities (Rayner, 2009). In the light of the growing tendency to integrate eye tracking into interpreting studies (IS), the present study aims to review works in the field that utilize eye tracking in the field, highlighting both its drawbacks and its implications for understanding cognitive effort. At this point, it should be noted that this paper ignores, for reasons of the scope and the language barrier, studies within the broader field of translation studies (see Pavlović & Jensen, 2009; Hvelpund, 2014; Temizöz, 2014; Chang & Chen, 2023; Jia et al., 2023) and works published in languages other than English (see Wang et al. 2018; Lian & Kang, 2019; Seubert, 2019).

## A Brief History of Eye Tracking

Before delving into the research conducted within the field of IS, it is useful to look at how eye measurements were initially integrated into academic research so that the reader can compare the timelines of eye tracking and its integration into IS research, which is the focus of the following section. Therefore, this part aims solely to provide an outline of some fundamental works in the history of eye tracking.

The origins of eye tracking date back to 1823 when Charles Bell linked eye movements to brain activity, establishing a physiological connection between the eyes and the nervous system, thus revealing their role in neurological and cognitive processes as a potential gateway to understanding the mind (Carter & Luke, 2020). Rayner (1998, p. 372) states that Javal’s initial observations marked the beginning of the first era of eye tracking studies, which lasted until about 1920. In 1878, Javal proposed various methods to study eye movements during reading, including observing afterimages, attaching a feather to the eye, and using light deflections from a mirror, ultimately confirming horizontal rather than vertical eye movement. He is known to be the first person to record eye movements during the process of reading, and he coined the term “saccades” for rapid eye movements; however, Wade and Tatler (2009, pp. 1-4) argue that there is a lack of evidence to credit Javal’s works as the first efforts to measure the ways the eyes move during reading, and they criticize Huey (1908) and Woodworth (1938) for “deflecting students of vision from attributing the first measurements of eye movements to those who conducted the experiments– Hering and Lamare”.

To hear the ocular muscles, Hering (1879, pp. 145-146) placed two rubber tubes – which resembled a miniature stethoscope – on the eyelids and proposed that although the eyes appear to glide steadily along the line, the clapping sounds disclose the eyeball’s erratic movement. Stating that his study was designed to complement Javal’s studies on the physiology of reading, Lamare (1892, p. 355) highlighted that the eye can focus on only a small area of the visual field at a time; to read an entire line, the eye must traverse it successively, and, executing a certain number of movements, divide it into an equal number of sections, plus one. To track these movements, Lamare (1892, p. 357) proposed several methods, which include feeling the movements by placing a finger over the closed eye when reading with the open one, and “hearing” the movements via an apparatus – a drum with an ebonite membrane in the center and to which a small tube in contact with the conjunctiva or eyelid and is connected to both ears by rubber tubes – yielding distinctive sounds that an assistant can note.

Based on the knowledge gathered from all eye tracking studies conducted to that point, in the late 1890s, Huey created an eye tracking device that could measure eye movements while reading (Reed & Meyer, 2007) and found that words are frequently jumped over and that often, parts of words, rather than whole words, are the focus (Walczyk et al., 2014, p. 604). He placed a plaster cup with a hole over the reader’s cornea, linking it to a rotating drum with an aluminum stylus. This setup allowed the continuous recording of eye movements during reading, with cocaine sometimes used as a numbing agent (Walczyk et al., 2014, p. 604). Javal, Hering, Lamare, Huey and many of their contemporaries (e.g. Landolt, 1891; Tscherning, 1898; Delabarre, 1898) not only advanced the field of reading research by meticulously examining eye movements but also laid the foundational principles for the development of modern eye tracking technologies.

The second era in eye tracking research began in the 1920s with film-based recording techniques, explored non-invasive methods providing objective records of eye movements, capturing both directional changes (Płużyczka, 2018, pp. 105-106). The focus of research at this time was on the relationship between eye movements and simple visual stimulus properties, rather than cognitive factors, which gained importance after the 1970s (Jacob and Karn, 2003, p. 575). For instance, Walker (1933) used a photographic technique to obtain simultaneous binocular records of 50 subjects’ vertical and horizontal eye-movements and discovered significant differences in eye movements regarding duration of fixation, size of fixation, and rate of reading. Likewise, Stone (1941) measured the eye movements (e.g. rate of reading, number of fixations, average duration of fixations) of 64 subjects while reading texts from various fields by using the Ophthalm-O-Graph, but made no commentary on the cognitive factors underlying the significant difference in individual or group measures. Hartridge and Thomson (1948) designed a new apparatus that, using a counterbalanced frame with a mouth plate, microscope, and light sources, allows precise measurement of eye movements independent of head movements, while enabling subjects to observe fixation points uninterrupted. In the 1960s, however, studies establishing a link between pupil dilation and cognitive activity started to emerge. While previous research has indicated that pupil dilatation is related to interest and emotionality (see Hess & Polt, 1960), Hess and Polt’s (1964, p. 1191) experiment with 5 participants illustrated that there is a correlation between pupil dilatation and problem difficulty and highlighted that pupil response not only demonstrates mental activity per se, but also the strong correlation between mental activity and problem difficulty. Another highlight of the study is that substantial pupil constriction is observed only after the subject articulates their response to a problem, regardless of the amount of time that passes before the response is elicited. In the light of this premise, Kahneman and Beatty (1966) conducted their own experiment with five participants and revealed that, during a short-term memory task, pupil diameter reflects the amount of material under active processing, with dilation occurring during presentation, constriction occurring during reporting, and rate changes linked to task difficulty. The 1960s also witnessed a rise in developing eye trackers resembling today’s equipment, with systems designed by various scholars (e.g. Shackel, 1960).

The mid-1970s mark the beginning of the third era (Rayner, 2009, p. 1), with scholars attempting to develop theoretical models addressing the correlation of fixations with particular cognitive processes. Acknowledging groundbreaking works bridging eye movements and higher mental processes (see Monty & Senders, 1976), the current paper mainly focuses on the Just and Carpenter Hypothesis (1976), which is “one of the most notable and earliest contributions to eye tracking research in the third era still influences a large amount of eye tracking research in TS to this day” (Federici & Walker, 2018). Central to Just and Carpenter’s theory is the "eye-mind assumption," which posits a direct correlation between the duration of eye fixations on words and the cognitive processing of those words. The immediacy assumption further posits that readers are likely to attempt to process every single word of a text or other stimulus as it is encountered, even at the risk of making an incorrect judgement.

The fourth and final era, which began in late the 1990s (Rayner, 2009, p. 2), witnessed the proliferation and technological development of eye tracking technology. Currently, the two leading eye-tracker manufacturers are Tobii (https://www.tobii.com/) and SR Research (https://www.sr-research.com/), and researchers are working on access software to convert webcams into low-resolution eye trackers (Semmelmann & Weigelt, 2018). Eye tracking is now utilized in a wider range of disciplines, which include, but are not limited to, economics (see Lahey & Oxley, 2016), architecture (see De la Fuente Suárez, 2020), marketing (see Bebko, Sciulli & Bhagat, 2014), advertising (see Higgins, Leinenger & Rayner, 2014) and, of course, translation and interpreting, the focus of the present paper.

## Eye Tracking in IS: The First Encounters, The Revival, and The Present

This section covers eye tracking as a tool in IS research in three periods. The first focuses on the early efforts in utilizing eye-trackers interpreting studies between 1981 and 1995. The second addresses studies conducted between 2009 and 2020, defined as “the revival” period of eye tracker in IS research. The last one investigates the most recent literature, and focuses on current trends over the last four years.

### The First Encounters (1981-1995)

The earliest known academic work utilizing eye tracking in IS is known to be McDonald and Carpenter’s “*Simultaneous Translation: Idiom Interpretation and Parsing Heuristics*” in 1981. Their "simultaneous translation" is now referred to as "sight translation" (SiT). McDonald and Carpenter (1981) recorded the eye fixations and performance of the subjects, 4 German and English bilingual subjects – two expert translators and two amateurs. The subjects were given 44 texts containing some idiomatic phrases such as “hit the nail on the head” or “break the ice” in English to be sight-translated into German. To confirm comprehension, subjects were asked three questions after each paragraph, avoiding idiomatic phrases to prevent undue focus. High accuracy (over 95% correct answers) indicated that the subjects understood the material they interpreted. The study revealed that the different patterns of eye fixations occurred according to whether the subjects interpreted ambiguous phrases idiomatically or literally (McDonald & Carpenter, 1981, p. 238). Another highlight of the study was that the eye fixations also reflected error recovery strategies, which enabled the translator to go back and identify the error in the problematic part of the sentence when a discrepancy was detected (McDonald & Carpenter, 1981, p. 241).

In 1986, the first prominent study focusing on pupil dilation in IS was conducted by Tommola and Niemi, who measured the cognitive load in simultaneous interpreting (SI) in a syntactically different language pair (i.e. English and Finnish). In the study with one participant reading five different texts, Tommola and Niemi (1986) found that maximum pupil dilation occurred during episodes that required language restructuring.

Claiming that pupillometry holds promise for online investigations of the comprehension and production of spoken language, in 1990, Tommola and Hyöna focused on simultaneous interpreters' mental load. The study involved 9 native Finnish-speaking junior and senior T&I students and employed 3 English source texts with approximately 500-600 words. The task order was as follows: listening, shadowing, and interpreting and – for the practice effect – the authors noted "if there were a practice effect, the task performed last, SI would benefit most, which would again increase the conservativeness of the design." (Tommola & Hyöna, 1990, p. 3). It was concluded that there was a statistically significant difference among the three tasks, with the interpreting stage causing the highest average pupil dilation, which was consistent with their task difficulty hypothesis.

Hyönä, Tommola, and Alaja (1995) implemented two experimental designs to assess pupil response during SI to measure the processing load. In the first experiment, 9 Finnish speaking junior and senior T&I students were given 3 source texts in English and asked to complete 3 tasks (i.e. listening, shadowing and simultaneous interpreting). The results indicated that SI produced a higher pupil dilation, followed by shadowing and listening, respectively. However, the authors highlighted that it could not be conclusively stated whether pupil responses show momentary processing load changes, as these might instead indicate prolonged general arousal caused by task difficulty, and the lower levels of dilation for listening may reflect the lack of any output requirements (Hyönä et al., 1995, p. 603). Therefore, these issues were addressed in the second experiment in which 18 different subjects completed the same tasks at a lexical level. The results were consistent with the first experiment as pupil dilation was significantly greater in "lexical translation". Hyönä et al. (1995, p. 611) suggested that their experiments "gives researchers license to employ pupillometry in the study of more theoretically motivated questions.". At this point, it is important to remember that this research has its roots in cognitive psychology rather than T&I theory, or the challenges or problems concomitant with any act of translation (Federici & Walker, 2018).

## The Revival (2009-2020)

Given the history of eye tracking research, Senders (2000) associated eye tracking with a Phoenix repeatedly rising from its ashes with the development of new technological systems to overcome emerging problems. Regarding interpreting research, it is possible to say that eye tracking revived in the late 2000s and early 2010s. This is not to say that no research was conducted between these two defined periods, but rather, it highlights the emergence of a stronger trend towards integrating eye tracking in IS research. During this period, utilizing an eye tracker was more common in research focusing on SiT and SI, and far fewer examples of consecutive interpreting (see Vranjes et al., 2018) or sign interpreting (see Wehrmeyer, 2014) exist compared to the abovementioned. This period also witnessed major works focusing on methodological issues in eye tracking research within TIS (see Hvelpund 2014; Korpal 2015).

Scholars, at the time, were particularly interested in comparing SiT with other tasks, such as reading or translating. Comparing two groups, four translators and four interpreters, Dragsted and Hansen (2009) divided the group consisting of translators into two groups and asked the first group to sight translate half of a political speech in English into Danish followed by a second phase of translating the other half, and vice versa for the second. The interpreters, on the other hand, were only tasked with conducting the sight translation part of the experiment. Together with keystroke logging, an eye tracker was utilized to gather gaze data (i.e. hotspot analyses, source text fixation count and average fixation duration). The hotspot analysis revealed that interpreters exhibited controlled, linear gaze behavior focused on the source text segment being translated, while translators displayed scattered fixations across both source and target text windows, reflecting a less segment-focused approach. It was observed that all translators except one had far more ST fixations than the interpreters. The comparison of the ST fixation count and fixation duration values indicated that the interpreters exhibited fewer but longer gaze fixations, while the translators demonstrated a higher number of ST fixations with shorter average durations. The study concludes “the interpreters appear to process segments more consecutively and to work in a more focused manner than the translators, who have more regressions and backtracking, searching other areas of the screen to look for clues for the current segment.” (Dragsted & Hansen, 2009, p. 601). Another study comparing bilingual reading, SiT, and translation was conducted by Shreve et al. (2010) with 11 subjects who were given texts with two versions: one with a syntactically complex paragraph and one with a simplified version; participants performed both tasks but only one such task on any given text. The study utilized both eye and keystroke data. The findings revealed that SiT is more susceptible to interruption than it is to translation, and confirmed the predicted syntactic effect. The findings also highlight that, as the source text is still present in SiT, it is extremely sensitive to visual disturbance. It is also noteworthy that the authors provide a list of lessons learned for future research. Huang (2011) is credited as being the first to explore the process of comprehension in IS by focusing on horizontal and vertical translation processes (see Moratto, 2020, p. 26). Recruiting 18 interpreting students and using a Chinese ST, Huang focused on three different tasks: reading silently, reading aloud, and SiT. In a more recent study, Chimel and Lijewska (2019) investigated how professional and trainee interpreters process syntax in SiT. With 24 professionals and 15 trainees involved in translating subject-relative clauses and more challenging object-relative clauses, their results illustrated that trainees took longer to match professionals' accuracy and viewed the text less frequently to avoid interference, particularly with object-relative sentences. The study also found that syntactic difficulty affected translation and viewing times, with longer translation times, but reduced source text viewing for object-relative clauses. Other significant research conducted within the given period focuses on, but is not limited to, topics such as investigating ear-voice span (see Zheng & Zhou, 2018), and problem triggers (Su & Li, 2019) in SiT.

In eye tracking in SI in the 2010s, major works were published by Seeber and Kerzel (2011), Seeber (2012), Korpal and Stachowiak-Szymczak (2018) and Stachowiak-Szymczak and Korpal (2019). With the aim of measuring online cognitive load in SI, Seeber and Kerzel (2011) focused on the task evoked pupillary responses (TERPs) of 10 professional interpreters. A head-mounted binocular eye tracker was used in the experiment, which involved two contexts (i.e. sentence context and discourse context), each of which encompassed 32 target sentences with equal symmetrical and asymmetrical constructions. The study concluded that there were increases in cognitive load during SI at the end of syntactically asymmetrical sentences, as predicted by Gile (2008); also, discourse context enables the interpreters to reduce cognitive load, particularly while interpreting verb-final constructions (Seeber & Kerzel, 201, p. 238). The following year, in his eye tracking experiment, Seeber focused on the multimodal integration of numbers, and found that, only for larger numbers, interpreters focused on the visual target that contained redundant information—that is, the same information transmitted on the auditory channel (Seeber 2012 as cited in Seeber 2017, p. 466). In another article addressing the measures and methods to evaluate the cognitive load in SI, Seeber (2013) explains the potential of, and also, the limitations of pupillometry in research, and highlights the importance of methodological rigor for ensuring its reliability as a tool. Towards the end of the 2010s, Korpal and Stachowiak-Szymczak (2018) used a remote eye tracker to measure cognitive effort in numerical data processing in SI. Their experiment included 22 interpreting trainees and 26 professional interpreters who were tasked with interpreting two speeches from English into Polish accompanied with a PowerPoint presentation on the screen. The results showed that the subjects had longer fixations for numbers than for other elements. Another contribution of Stachowiak-Szymczak and Korpal (2019) is their experiment comparing the cognitive effort allocated for numbers during SI of 22 trainee interpreters and 26 professional interpreters in terms of total gaze time, fixation count, fixation duration and accuracy scores. Arguing that their results are "an indirect corroboration of the model proposed by Seeber" (Stachowiak-Szymczak & Korpal, 2019, p. 248), they concluded that professionals focus more on slides and numbers with briefer fixations than trainees, who exhibit longer fixations and higher overall gaze time during SI with a PowerPoint slide. Another valuable contribution to eye tracking studies in IS is Kumcu's (2011) experiment conducted within the framework of his master's thesis. Kumcu (2011) investigated the reading patterns, cognitive load (by average fixation duration) and performance of two groups, one group who received the text to be interpreted in advance; the second group who did not have such preparation). His findings included differences in reading patterns (reading for SI as for the first group, reading during SI in the second one), significant difference (although not statistically) in cognitive load favoring the second group, better contextualizing of information by using SI strategies in the first group.

Before bringing this subsection to a close, for the case of Türkiye, it is noteworthy that a recent search of master's and doctoral theses in the field of Translation and Interpreting Studies in CoHe Thesis Center (Council of Higher Education Thesis Center, Türkiye) using the keyword "eye tracking" reveals that Kumcu's (2011) master's thesis still stands as the only work integrating eye tracking in Interpreting Studies after over 10 years. This is surprising when compared to the number of theses focusing on eye-trackers in disciplines regarded close to Translation and Interpreting Studies, such as Linguistics (see Bulut, 2012; Özdemir, 2012; Akal, 2014; Turan, 2018; Aktepe, 2023), Cognitive Sciences (see. Bahadır, 2012; Gönül, 2013; Başer, 2018; Çakır, 2022; Çora, 2023), and ELT (see Çokal, 2012; Karataş, 2013; Cinkara, 2014; Erdem, 2015; Rızaoğlu, 2016) in Türkiye. These disciplines' greater tendency to utilize eye-trackers can be studied and, if there is indeed such a tendency, the reasons behind why Translation and Interpreting Studies lags behind, rejects, or – simply – ignores eye tracking can be investigated in further studies. Secondly, having a closer look at the number of studies conducted in the 2010s, it is possible to state that research in SiT took the lead at the time, followed by simultaneous interpreting, and then followed by a few examples in other interpreting modes/settings. These studies, together with the abovementioned works on the methodological aspects of integrating eye tracking into IS research, are crucial as they laid the groundwork for the contemporary studies addressed in the following section.

## The Present (2020 - ongoing)

In the 2020s, so far, eye tracking continues to maintain the momentum gained in IS research in the previous decade. This period not only witnessed a rise in number and variety of studies conducted in simultaneous interpreting but also broadened its scope by incorporating various interpreting modes and settings such as dialogue interpreting (see Tiselius & Sneed, 2020), remote interpreting (see Kuang & Zheng, 2022; Doherty et. al, 2022, Yuan & Wang, 2024), and distance interpreting (see Zhu & Aryadoust, 2022), emphasizing its wider and more diversified scope.

The studies conducted in SiT in 2020s brought into focus further variables, such as directionality, coping strategies, and working memory. Su and Li (2020), for instance, conducted an experiment on rehearsed sight translation with 14 T&I students in English-Chinese language pair and evaluated their performance in terms of fixation duration, reinspective fixation duration, scanpaths of eye movements, ear voice span, and task time. Their work not only compared two tasks (i.e. the pre-reading and sight translation), but also devoted attention to the effect of directionality. It was observed that the subjects exhibited different reading patterns in given tasks, and both were affected by directionality. In the same language pair, Ma and Li (2021) targeted two interpreting strategies (i.e. chunking and reordering) for asymmetrical structures, both at the sentence and text levels. Eye tracking data from 23 postgraduate T&I students revealed that reordering required greater cognitive load, while chunking was deemed as "cognitively relieving" (Ma & Li, 2021, p. 24). In a similar vein with Huang (2011), discussed previously, Ho (2021) designed an experiment with 3 stages: silent reading, reading aloud, and SiT, and investigated the fixation count and mean fixation duration, first fixation duration, gaze duration, go past time, re-reading time, and total viewing time for 17 professional interpreters and 16 interpreting students. Data illustrated that professionals had higher accuracy levels but revealed no between-group difference in the mean score on style, overall task time, length of the SiT output, and mean fixation duration of each stage of reading. Although Ho (2021, p. 50) focused on working memory, there was no significant gap between the two groups, and its influence was not reported in the results.

Among the studies conducted within the framework of simultaneous interpreting during this period, there is a notable increase in studies investigating prediction in SI by using an eye tracker. For example, Amos et al. (2022) examined the predictive eye movements (i.e. fixations) of a group of 25 professional interpreters and a group of 25 professional translators working in French-English language pair, and uncovered that, while both groups could predict the upcoming language, there were no significant differences between two. Özkan, Hodzik and Diriker (2023) also conducted an experiment on prediction and SI in which they tasked 22 T&I students and 20 professional interpreters working in Turkish-English language pair with completing a Turkish visual-world eye tracking prediction task examining whether the accusative versus the nominative case markers on the initial nouns of sentences functioned as cues to predict an upcoming argument. The results confirmed that SI experience and working memory capacity – which was measured as a part of the experiment – provided an upper hand for the professionals. One of the key reasons for the significance of this study is that it proved an SI-related advantage in a non-interpreting task (Özkan et al., 2023, p. 20). Lozano-Argüelles and Sagara (2021) similarly focused on prediction, but worked with a different group of subjects: 32 Spanish monolinguals, 26 advanced L2 (Spanish) learners with interpreting experience, and 23 advanced L2 (Spanish) learners without interpreting experience. The subjects were instructed to listen to a sentence while seeing two words, and indicate the one they heard, with the aim of investigating whether these groups used lexical stress and syllabic structure in the first syllable to predict the rest of the word. The eye tracking data revealed that the first group and the second group predicted word endings based on lexical stress cues, while the third group could only do the same with nouns with a CVC unstressed first syllable. In another study with the three same groups, Lozano-Argüelles et al. (2023) examined prediction in L1 and L2, and tasked the subjects with performing a visual-world paradigm eye-tracking task and a number-letter sequencing working memory task. The study utilized eye tracking to measure the prediction of verbal morphology (present, past) based on suprasegmental information (lexical stress: paroxytone, oxytone) and segmental information (syllabic structure: CV, CVC). It was concluded that working memory facilitated prediction for the first and second group under higher cognitive load, but, only when there were fewer lexical competitors for the third group.

It is also striking that, in the recent years, eye tracking started to establish itself in research conducted on simultaneous interpreting with text (SIMTXT). To begin with, Seeber et al. (2020) compared SIMTXT to reading while listening (RWL). They tracked 15 professional interpreters' eye data during these tasks. The results illustrated that the subjects' eyes moved ahead during the first task, while the second one demonstrated slower visual processing. Accentuating the drift away from the "looking ahead" maxim in the case of SIMTXT, the authors recommend incorporating strategies for SIMTXT in interpreter training. Another significant contribution to the SIMTXT literature was made by Zou et al. (2022), who explored attention allocation of 9 professional interpreters between auditory and visual input during SIMTXT, and investigated whether different allocation patterns affect the quality. The subjects were given a warm-up text and six English STs to be interpreted into Chinese. Categorizing the subjects as ear-dominant, eye-dominant or ear-eye balanced by looking at the eye-voice span, ear-voice span and ear-eye span, Zou et al. (2022) found that ear-eye balanced subjects had the lowest translation quality in terms of the total number of errors and accuracy, but ranked only second in fluency. Ear dominant subjects, on the other hand, produced the highest translation quality in terms of fluency, but ranked only second in terms of the total number of errors and accuracy. Another example is Baktygereyeva's (2024) unpublished doctoral dissertation investigating the cognitive load of interpreting students and interpreting professionals during SiT and SIMTXT in different pacing conditions.

While it is not possible to address every single published work in detail here, in the interest of providing a full picture, it is essential to mention that, in the last 4 years, there have been other valuable studies on simultaneous interpreting (see Korpal & Stachowiak-Szymczak, 2020), consecutive interpreting (see Chen, 2020) and sign language interpreting (see Bosch-Baliarda, Soler-Vilageliu & Orero, 2020). Therefore, it can be concluded the past four years have witnessed a notable expansion in research, with studies covering a broader range of interpreting modes, samples, and topics, indicating a highly promising trend.

## Points to Consider before Integrating Eye Tracking into IS Research

Although this paper explores the benefits of eye tracking in IS by reviewing previous works in the field, it is important to remind the reader that integrating an eye tracker in research is not always "rainbows and butterflies", and that eye tracking – as with other psychophysiological methods – is not without its drawbacks. Rather than making any major methodological claims, this section simply aims to serve as a starting point for those considering taking this road.

To begin with, data quality is inevitably influenced by the eye tracker and the experimental setup, the participant, the operator who sets up the eye image and provides instructions to the participant, and the physical recording environment (Nyström et al., 2012, p. 272). It is important to address these issues, and IS researchers should proactively identify and mitigate potential challenges that may emerge during the process, implementing preventive measures wherever feasible.

Another point to take into consideration regarding the use of eye-trackers in IS research is that it is pivotal to decide on which quantitative research methods to employ when interpreting the results. Emphasizing that translation (and interpreting) scholars should update their analytical, experimental, and theoretical toolkit, Federici and Walker (2018, pp. 20-21) state that:

> "Quantitative analysis of data has, comparatively speaking, been used far less in TS than the more traditional qualitative methods of analysis. [...] when analyzing differences between datasets, there is still an over-reliance on comparisons of descriptive statistics – means, medians, standard deviations, etc. – and, for those venturing beyond more basic comparisons, on null-hypothesis significance testing (NHST) yielding p-values from t-tests and analyses of variance (ANOVAs). Again, like in the experimental domain itself, Translation Studies has, on the whole (there are of course exceptions), not kept abreast of developments in inferential statistics."

Moreover, García (2019, p. 23) argues that eye tracking presents several limitations that can impact the reliability and interpretability of its findings, and lists 4 main challenges. The first challenge is that individualized calibration can prove cumbersome and unreliable. The process of calibration serves the aim of estimating the characteristics of a participant's eye as the basis for a fully customized and accurate gaze point calculation. Tobii – a widely used commercial eye tracker – uses a short procedure, including a six-point calibration process, with two points in the center and four points in the corners of the screen; however, the need for a frequent re-calibration to maintain accuracy may be intrusive to users (Huang & Bulling, 2019). The second challenge is that the technique’s sensitivity means that it can be affected by several factors such as light changes, noise induced by head motion, and participants’ uncontrollable physiological factors. Environmental light changes may be easier to control in an experimental setting; however, subject-related factors are more difficult to manage and may lead to the exclusion of data. Considering the inherent challenges of enlisting both novice and professional interpreters for experimental studies in the field of IS, such a significant risk may be untenable. The third challenge highlights that although the indicators can offer insights into broader concepts such as cognitive effort, but they are not detailed enough to observe smaller-scale activities, such as lexical access or semantic activation. Eye tracking is believed to be useful to validate preexisting interpreting models, such as Gile's Effort Model, or to provide information on the underlying interpreting mechanisms (Hu et al., 2022, p. 2). However, to trace less visible activities, other psychophysiological methods may be better options (for semantic activation with ERP – see Kutas & Federmeier, 2011). The final challenge is serious concerns over the generalizability and consistency of the findings. This can at least be minimized with larger samples and the replication of studies in IS. In addition, the triangulation of multiple measures and methods could yield more convincing results (Hu et al., 2022, p. 14).

It is also important to note that there is controversy over the practice of measuring the cognitive load by pupil dilation. These views suggest that high-precision methods should be used to measure the cognitive load/effort through pupil dilation. The pupil responds to three different stimuli: brightness, emotions, and cognitive load (Seeber, 2015). These three stimuli cause the pupil to dilate by 1.5 mm in bright environments and 8-9 mm in dark environments (Andreassi, 2000). Pupil dilation can start 200 ms after the stimulus is received; in the case of cognitive load, however, it can last as much as 300-500 ms (Beatty, 1982). In addition to the aforementioned drawbacks, while focusing on pupil dilation in IS, the following points should also be taken into consideration: (a) age, because it weakens the correlation between cognitive load and pupil dilation (van Gerven et al.,2003), (b) changes in the brightness level of the stimulus, because it can alter pupil responses (Holmqvist et al., 2015), (c) prolonged exposure to the stimulus, because it may cause changes in pupil dilation and thus, reduce the accuracy of projected cognitive load (Seeber, 2015). Nevertheless, in a controlled experimental environment where external stimuli are minimized and with a meticulously selected sample, the analysis of pupil dilation can serve as a reliable indicator for assessing cognitive load, offering valuable insights into the mental effort and processing demands in IS. An evidence of this is Hyönä et al.’s (1995) groundbreaking study, demonstrating the effectiveness of pupillary responses as indicators of cognitive effort (Hu et al., 2022, p. 8).

## Concluding Remarks

This paper aims to go beyond solely reviewing related works in the field of IS by providing a detailed timeline of the developments in eye tracking technology in general, and presenting the opposing views on eye tracking within the IS literature, so as to provide a broader overview of the subject. At the very beginning, tracking eye movements was not aimed at understanding the cognitive processes. In the 1960s, the first connections between pupil size and cognitive activity were discovered. The following decade witnessed the correlation of fixations with cognitive processes, but it was only in 1981 that interpreting studies began to take an interest in eye tracking. Following the great contributions of the first IS scholars utilizing eye trackers, there was a brief lull. In the last 15 years, however, research has fortunately demonstrated greater diversity, not only in terms of quantity but also across various dimensions, as evidenced by the works mentioned above. However, there is still much ground to cover when it comes to the interpreter's "black box". And, it can be affirmed that, when used with methodological rigor, eye tracking has proved itself as a useful tool in process research. At this point, with reference to the title of the present paper, it is essential to note that "eyes may never lie", but eye data may mislead when collected improperly. Future studies have the potential to enrich the field by enlarging sample sizes, using different comparison groups, utilizing data triangulation, adopting different measures and novel statistical tools, and working with different language pairs.

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Author Details
Yazar Bilgileri

**Nazlıgül Bozok (PhD Candidate)**
[1] İstanbul University, Faculty of Letters, Department of Translation Studies , İstanbul, Türkiye
0000-0003-2214-0963 nazligulbozok@gmail.com

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