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Cognitive behavior during consecutive interpreting: Describing the notetaking process

Christopher D. Mellinger
University of North Carolina at Charlotte, USA
cmelling@uncc.edu

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Abstract: Digital pen technologies have enabled new forms of interpreting and provided new ways to train interpreting students in consecutive interpreting; however, digital pens also provide an opportunity to collect interpreting process data that can serve as a proxy for cognitive behavior. This article examines the extant literature on notetaking and cognition to advocate for using digital pens to document the notetaking process and describes several ways in which this notetaking data can be analyzed to understand interpreter behavior. In addition, several potential research avenues are outlined to enhance the methodological tools available to undertake interpreting process research in dialogue and consecutive interpreting.

Keywords: Notetaking; metacognition; triangulation; process-oriented research; cognitive behavior; consecutive interpreting.

1. Introduction

Notetaking and its relationship to the consecutive interpreting task have long been the subject of reflection by practicing interpreters, trainers, and researchers. Practitioners and interpreting trainers often emphasize the importance of interpreters developing individualized notes over time and espouse the importance of brevity and efficiency in the notetaking task (e.g., Bosch March, 2012; Gillies, 2017; Nolan, 2012; Setton & Dawrant, 2016). More experienced interpreters anecdotally report needing to take fewer notes, while interpreter trainers often make suggestions to students to eliminate unnecessary notes from their notepads as they prepare to enter the workforce. These guidelines are often presented in the context of conference interpreting or unidirectional consecutive interpreting, in which a speech or presentation is made in one language with the interpreter preparing to consecutively render the target language version. In many instances, these resources rely on Rozan's (1956) influential work and Ilg (1988), which have been prominent in training settings.

Dialogue interpreting settings also often require the use of notes. Several resources developed for preparing interpreters to work consecutively in dialogue settings seemingly adopt the notetaking techniques and suggestions from previous work (e.g., Mikkelson, 2016; Dueñas González et al., 2012). Whereas these guidelines have been highly effective in their original setting, they have not been

examined in great detail in a bilateral configuration of the interpreting event, in which an interpreter must regularly render shorter segments between two languages. This type of dialogue interpreting occurs in community interpreting in healthcare, educational, and legal settings and represents an increasingly professionalized area of interpreting (e.g., Angelelli, 2004; Mikkelsen, 2016; Tipton & Furmanek, 2016).

Many of these recommendations are grounded in practice, and researchers have sought to validate these views empirically. In particular, scholars have sought to understand interpreters' note-taking methods and the role those notes play in supporting their work. For instance, previous scholarship has investigated the language in which notes are taken (e.g., Andres, 2002; Dam, 2004; Szabó, 2006), the differences between student and professional interpreters in their notetaking (e.g., Andres, 2002), and the relationship between notetaking and the oral rendition of the source language utterance (Tang, 2018). These studies, when coupled with research related to cognition and cognitive linguistics (e.g., Albl-Mikasa, 2008; Chen, 2016, 2017; Dam, 2004), provide insight into the notetaking behavior and the potential impact that specific linguistic and situational features have on the interpreter.

Recent technological advances, particularly with respect to digital pen technologies, have re-defined what is possible for notetaking when interpreting. The development of digital pens (sometimes called 'smart pens') has given rise to hybrid modes of interpreting (Orlando, 2010), in which digital pens can aid the interpreter by recording a speaker's voice to enable a simultaneous rendition of the speaker's turn (for an overview, see Braun, 2020). Researchers have investigated how these new modes of interpreting and digital technologies can be leveraged to enhance interpreter training (e.g., Arumí & Sánchez-Gijón, 2019; Kellett Bidoli & Vardè, 2016; Orlando, 2010, 2015) and to improve interpreter performance (e.g., Orlando, 2014). Moreover, new mobile computing technologies allow interpreters to pair digital pens with tablet computers to further support the interpreting task. For instance, Goldsmith (2018) presents a qualitative review of technological aspects of what he terms *tablet interpreting* and outlines some of the benefits and drawbacks to moving away from more traditional pencil-and-paper notetaking and toward these fully digital notetaking practices. Goldsmith (2018) describes how notetaking using a tablet can have ergonomic and functionality benefits, such as a smoother writing experience, unlimited paper and ink, and web connectivity to allow multiple resources to be accessed from a single location. However, several cited trade-offs include the increased initial costs to switch to a digital notetaking environment related to equipment purchases and the learning curve to integrate these tools into interpreting workflows. In addition, tablet interpreting introduces a set of different risks than notetaking using pen-and-paper alone since these digital tools only function if they have sufficient battery life and may break if dropped.

These technological advances have influenced not only what is possible for the interpreting task itself, but also how process-oriented data can be collected for research purposes. To date, research on notetaking has been largely product-oriented, examining the interpreter's notes to glean data concerning the interpreter's behavior and cognition. This orientation is somewhat unsurprising, given the difficulties typically associated with recording an interpreter's notetaking process in the moment while maintaining a certain degree of ecological validity. Nevertheless, digital pen technologies allow researchers to record notetaking behavior in real-time (e.g., Chen, 2017, 2020; Kuang, 2019) and

triangulate data streams – e.g., eyetracking data; source and target language renditions; and digital pen recordings – to better understand the process of interpreting.¹

In an effort to investigate notetaking behavior and its potential to reveal cognitive aspects of interpreting, this article advocates for a process-oriented perspective to notetaking (e.g., Mellinger, 2019). In particular, it aims to describe how real-time note-taking behavior that is recorded using digital pen technologies can be triangulated with source text utterances and an interpreter’s oral renditions to identify cognitive behavior. This methodological reflection is argued to provide insights on potential areas of cognitive and meta-cognitive activity related to and influenced by notetaking behavior as they occur during the interpreting task rather than having to rely solely on post hoc inferences derived from the interpreters’ notes after the interpreted rendition is complete.

To do so, the present study first reviews research on notetaking that has occurred in academic and non-academic settings, particularly as it relates to information encoding and retrieval, prior knowledge activation, and recall. Then, current scholarship on interpreting notetaking strategies is reviewed, focusing primarily on their cognitive aspects that have been identified to date. This review of the literature provides the foundation for a method to triangulate real-time process data with interpreter renditions, which in turn, can be analyzed for potential indicators of cognitive and meta-cognitive activity. The article concludes with several potential avenues of research that may benefit from this approach to data collection and analysis.

2. Notetaking across the disciplines

Notetaking has been the subject of inquiry across a range of disciplines – including educational psychology, forensic linguistics, and language learning – with researchers showing particular interest in how notes are taken by students at various stages of their academic career (e.g., Kiewra, 1987, 1988; Peverly & Wolf, 2019). In many cases, notetaking is viewed not as the end goal of learning, but rather as a skill that augments a learner’s ability to engage with material and recall information or support the education as a study aid (Howe, 1974; see also Kobayashi, 2006). Mastery of notetaking as a skill has been argued as a means to enhance a student’s ability to complete an overarching task (see, for instance, Morehead et al., 2019); however, notetaking as an end unto itself is not typically the aim of a student’s learning. Moreover, notetaking has been viewed from the perspective of being highly personalized, with people taking notes in a style that is often particular to their needs (Jansen, et al., 2017). Whereas certain strategies can be taught (Guasch & Castelló, 2002), notetaking as a skill is ultimately one that is personal to the notetaker. The same can be said for non-academic settings, in which people take notes to aid in recall, such as in courtroom and jury settings or counseling sessions (Hartley, 2002). Nevertheless, the extant literature suggests

¹ Triangulation of data sources is not a new approach in translation process research to explore translator and interpreter behavior, with many scholars espousing the benefits of incorporating multiple data collection methods in a single study (e.g., Alves, 2003; Shreve & Angelone, 2010).

that notetaking can have both positive and negative impacts in these settings, depending on a matrix of contextual variables.

Several recent studies have synthesized much of the literature on cognitive processes associated with notetaking in general (e.g., Hartley, 2002; Kodaira, 2017) and in language learning (White, 1996). Some studies on notetaking focused on interpreting recall and the ways in which information was organized and hierarchically processed (e.g., Kiewra & Frank, 1988; Kiewra & Mayer, 1991), while others have discussed the potential for notetaking to hinder comprehension and recall when working in distracting environments (e.g., Lin & Bigenho, 2011) or explored which types of notes are most effective in aiding recall (Olive & Barbier, 2017). Still others examine the role of working memory in relation to notetaking during lectures, with recent reviews suggesting inconsistent findings across the literature as it relates to notetaking modality, quality, and individual traits (Bui & Myerson, 2014).

These broader views of notetaking in which notetaking is considered to be a personalized, supplementary skill in support of another task aligns well with conceptions of notetaking for interpreting. Notetaking is often taught in interpreting training programs, yet the ability to take notes is insufficient to act successfully as an interpreter. Notetaking is a highly personal task: although interpreters can learn strategies and skills to organize their notes, the ability to develop a unique notetaking system more generally as well as for specific interpreting assignments is highly individualized (Albl-Mikasa, 2016). These similarities suggest the potential for notetaking research in non-interpreting contexts to contribute to our understanding of how notetaking may function in interpreting, particularly as it relates to cognitive aspects of the task.

The context-dependent nature of notetaking research suggests that interpreting research involving notetaking will likely need to account for the various settings in which dialogue and consecutive interpreting occurs (Englund Dimitrova & Tiselius, 2016). Indeed, much of the extant scholarship on notetaking in interpreting focuses primarily on conference interpreting, with long consecutive being the primary mode under consideration. In contrast, the research literature is somewhat limited in its engagement with notetaking in dialogue interpreting that occurs primarily in community settings and relies on bidirectional interpreting. That is not to say that conference interpreters do not perform short, consecutive interpreting into the various languages of the speakers; indeed, interpreters working in this context do perform this kind of work when required. The focus here, however, is primarily on community interpreting which regularly requires interpreters to work in both directions on a regular basis. In addition, scholarship on notetaking has yet to account for the various configurations and working conditions of community interpreters. Consequently, the current scholarship on notetaking and interpreting is useful as a point of departure, but more specific research on consecutive interpreting specific to interpreters working in both directions and in community settings is needed.

3. Process-oriented approaches to note-taking research in interpreting

As noted above, product-oriented approaches to note-taking research ultimately rely on an examination of interpreters' notes *post facto* in an effort to identify evidence of cognitive activity. Researchers have investigated the interpreting task with evidence based on different features of an interpreter's notes, such as

corrections, abbreviations, or symbols (Ahrens, 2005; Allioni, 1989). Much of this research draws on previous guidance from practitioners on notetaking systems for symbols (e.g., Matyssek, 1989; Rozan, 1956). From a cognitive perspective, corrections in an interpreter's notes might allow researchers to glean insight about language encoding and comprehension (e.g., Alexieva, 1994; Han, 2002 as cited in Chen, 2016). For example, a crossed-out word with the revised term next to it (e.g., ~~store~~ mall) might allow researchers to investigate these corrections in relation to comprehension of a source language utterance. In a similar vein, abbreviations or symbols in an interpreter's notes might be hypothesized as an indicator of language encoding and comprehension. Commonly-used symbols in specific settings for particular parties, such as a defendant or a physician, might reveal an interpreter's ability to encode information into a single symbol or abbreviation without needing to include additional information (Kohn & Albl-Mikasa, 2002). Still other notes, such as symbols that are used to indicate a class of word, such as insults or invectives, might show further evidence of language processing (Kohn & Albl-Mikasa, 2002). Nevertheless, these product-oriented perspectives alone only allow for supposition based on a theoretically-motivated operationalization of the variables of interest. For instance, Kohn and Albl-Mikasa (2002) theoretically ground their work in relevance theory, providing a theoretical framework to interpret notes taken by participants after the task is complete.

The manual nature of notetaking – i.e., the physical recording of notes by hand – complicates the ability of researchers to collect process-oriented data that creates a record of the notetaking process as it unfolds, particularly if the goal is to balance ecological validity with sufficient data granularity (Mellinger & Hanson, 2022). In some instances, eyetracking technologies and video recordings may allow this type of data to be collected and triangulated, their use is likely at the expense of ecological validity. For instance, interpreters are not likely to be confined to a static notepad that cannot be moved while being recorded to ensure that all their behavior is captured during the interpreting task, thereby raising questions about how natural the interpreter's behavior is under these conditions. That is not to say that tightly-controlled experimental conditions are not without merit; quite the contrary. Researchers such as Chen (2017, 2020) have begun to experiment with varied data collection methods such as eyetracking and digital pens to provide data such as pen speed and distance, time metrics, and ear-pen spans to examine specific cognitive behaviors that occur during notetaking.

One benefit of process-oriented data is that data captured during notetaking can be used to disambiguate notations or symbols while providing clarity about their provenance. If we re-consider the previous example of a crossed-out word with a revised term '~~store~~ mall', this notation might be indicative of a correction, showing that an interpreter has detected a mistake in understanding and has corrected the note to aid in recalling the correct information. Nevertheless, the same note may also be indicative of negation – i.e., not the store, but rather the mall – thereby introducing the potential to incorrectly analyze this note after the fact. A process-oriented approach to data collection that allows the notation data stream to be triangulated with the interpreter's rendition will help avoid this type of misunderstanding on the part of the researcher. The interpreter's rendition alone may be sufficient to determine whether the note is a revision or negation; however, the temporal information about when the note or correction is made is not recoverable with these two products (i.e., the rendition and the notes) alone. Synchronized recording of the interpreter's notes and the various interlocutors alongside the interpreter's rendition provides temporal information about when

the notation has been made. For instance, an interpreter who immediately notes ‘~~store~~ mall’ upon hearing the interlocutor’s utterance is perhaps exhibiting cognitive behavior that is different from an interpreter who initially writes ‘store’ and later returns to correct the note.

Another important consideration of process-oriented data that pairs real-time, synchronized datastreams with tasks that are closer to authentic interpreting conditions is the ability to collect data during dialogue interpreting encounters. Some previous studies focusing on consecutive interpreting have predominantly employed consecutive interpreting tasks from one language into another without allowing for a continuous bidirectional exchange of speakers. However, a growing interest in cognitive aspects of dialogue interpreting raises questions regarding how data involving interpreting in both directions during a single communicative event can be obtained (see, for instance, Herring, 2019; Tiselius & Albl-Mikasa, 2019; Tiselius & Englund Dimitrova, 2019). The ability to record real-time notetaking behavior during bidirectional dialogue interpreting provides an additional proxy for cognitive behavior during this task. Synchronized voice and pen data that allows temporal dimensions to be considered concomitantly to product data is complementary to existing data collection methods.

In order to collect process-oriented data on interpreter notetaking, this article aligns with previous process-oriented studies to adopt and advocate for the use of digital pen technologies. Several digital pen technologies are currently available (e.g., LiveScribe, Bamboo Folio, Neo, Newyes, Rocketbook), but rather than reviewing the pros and cons of each product, one tool – namely, the LiveScribe 3 Smartpen – will be described along with the various features that may prove useful in collecting interpreter notetaking behavior. The rationale for selecting this pen to describe here is four-fold: First, the features of this particular pen are indicative of several of the technologies currently available, thereby allowing this particular product to serve as proof of concept. The potential measures and notation elements described for this particular pen are likely akin to many of the digital pen and tablet technologies that researchers may wish to use in their research. Second, this particular pen combines two elements that are necessary to elicit the type of data described in greater detail in subsequent sections: namely, the integration of a recording device (i.e., microphone) with a writing implement that allows for the synchronous recording of both pen and audio data. Third, the LiveScribe 3 Smartpen is readily available to researchers interested in working with digital pen technology. Fourth, this pen has been used in previous studies using digital pen technologies, and workshops dedicated to its use in professional practice are regularly offered by practitioners and interpreting organizations. Therefore, this pen serves as a prototypical example of what digital pens allow researchers and interpreters to do, rather than describing digital pens in abstract terms.

As previous studies and its documentation indicate, the LiveScribe 3 Smartpen has a form factor similar to most writing implements, and it contains a microphone at one end to record the voices and ambient sound simultaneously with writing. The ability to record audio at the same time as pen strokes is key to the discussion in the present article, since it is the simultaneous, synchronous nature of the data that allows researchers to glean greater insight into the notetaking process. Additional information about the triangulation and interpretation of these data appear in subsequent sections, but the combination of these recording devices is of paramount importance.

Given that these pens must accommodate additional recording devices, the pens are perhaps somewhat thicker than their non-digital counterparts. Questions

of ecological validity are often raised when discussing potential means to collect data (e.g., Gile, 2016), and here, the slight change in form factor is an important point of reflection. Previous research has shown how specific tools can influence the translation task (e.g., Ehrensberger-Dow, 2020), and as noted above, ergonomic factors related to working with digital tablets are often noticed by interpreters (e.g., Goldsmith, 2018). Consequently, researchers who choose to use digital pens as a data collection method may want participants to write a few sentences or notes before recording to allow participants to get used to the pen and the way that it writes.

To record the notes as they are written, many digital pens are used with dot matrix paper in several form factors and sizes. The sizes are similar to many commonly-available notepads, so participants will be able to work with paper that is similar in size to their preferred or typical material with which they work. When the pen is recording a notetaking session, the audio file and notes are synchronized, allowing the researcher to see what is recorded, at what time, and the context in which it was written. The synchronized recording is available for immediate playback on a tablet or computer device, which may be useful for retrospective cued recall of an interpreting event. The video files or retrospective interviews can then be coded for qualitative analysis.

4. Potential indicators of cognitive behavior in interpreters' notes

The ability to record these notetaking sessions with synchronized audio and visual files has previously been explored as a tool for interpreter training (e.g., Orlando, 2014), yet it remains an untapped source for data collection for process-oriented interpreting studies, particularly with respect to interpreter behavior and cognition. While not an exhaustive list, the sections that follow represent a number of notetaking elements that merit additional scrutiny given the availability of this data source that allows notetaking behavior to be analyzed synchronously with the various interlocutors' utterances and the interpreter's rendition. These include symbols and alingual notes (i.e., notes not written in either the source or target language, see, for instance, Dueñas González et al., 2012); ear-pen span; hesitations; omissions; and stray pen or scratch marks. Many of these data types have been explored in studies focusing on conference interpreting and notetaking, yet their use in community and dialogue interpreting remains limited. How these data are epistemologically motivated and operationalized will ultimately depend on the nature of specific research questions and studies. However, these data types are provided as a starting point for reflection as potential elements worth reflection in community interpreting studies that address cognitive behaviors. A final section is dedicated to turn boundaries, which allows notetaking behavior to be triangulated with turn management and communication strategies. This area of research has been explored extensively in the literature to date (e.g., Roy, 1996; Wadensjö, 1999; Licoppe et al., 2018), yet the cognitive dimension of turn-taking requires further inquiry. This broader view of notetaking recognizes the situated nature of interpreting and allows questions of embodied, extended, and distributed cognition to be brought to bear on dialogue interpreting.

4.1. Symbols and alingual notetaking

Based on the previously-cited examples, the use of symbols may provide insight into interpreter comprehension or information encoding. As the research on

notetaking suggests, notetaking can be used as a means to organize information hierarchically in an effort to aid recall of information. Symbols can be used to structure information in an interpreter's notes, lending support to this type of cognitive behavior.

Yet a product-only perspective does not take into account the means by which these symbols are created, recorded, or recalled. For instance, researchers who have access to an interpreter's notes can only see what has been written on the page after interpreters have completed their work. Missing from this product-only perspective is whether the notes were written fluidly or with hesitation as well as the order in which they were notated. On the one hand, some commonly-used symbols may be used by interpreters without hesitation, suggesting a certain level of automaticity in their production and therefore faster, more efficient cognitive processing of the source language utterance (Shreve & Diamond, 1998). Fluid, uninterrupted notes and symbols may also be the result of deliberate practice, in which interpreters have regularly reflected on their work and the task at hand in order to develop a certain degree of expertise in the notetaking task (Ericsson, 2010; Tiselius & Hild, 2017). On the other hand, less fluid use of symbols – i.e., irregular or less fluid pen strokes to note these symbols – may be suggestive of meta-cognitive behavior in which an interpreter is attempting to resolve a potential problem, such as a long or terminologically-dense utterance, by using a symbol or non-language-specific notation, but is encountering difficulty in determining which solution may be most appropriate. This type of meta-cognitive behavior has been examined in written translation (e.g., Angelone, 2010), and the tripartite model of problem recognition, solution proposal, and solution evaluation may be of utility in understanding these types of notations. Of course, these data may be operationalized differently depending on the research question at hand. If the participants are students, then quick notation may not necessarily be indicative of automaticity or expertise, but rather shallow or incomplete processing of the utterance. This type of epistemological ambiguity can only be resolved with studies being grounded in the extant scholarship, and researchers will need to be mindful to operationalize how potentially observed behavior could be understood prior to data analysis.

In contrast, other symbols may be created on an ad hoc basis during the interpreting event itself. This online processing to hear, process, and generate a new symbol or abbreviation may be reflective of problem-solving strategies or cognitive efficiency. For instance, researchers may be able to determine if a new symbol has been created by looking at the temporal progression of the notes – initially an interpreter may note an object, person, or name in full (i.e., writing out the full word), to later reduce this name to a specific symbol or abbreviation. Reviewing the notes as they appear in conjunction with the interpreter's rendition allows for greater inferences to be drawn with respect to symbols and notetaking behavior. In addition, the way in which the notes are rendered on paper are potentially suggestive of increased meta-cognitive activity of cognitive dissonance between what has been taught as appropriate interpreting notetaking and what comes most readily to the interpreter as a potential notation – akin in some respects to Halverson's (2019) conception of default translation. The unique context in which interpreting occurs may also provide the opportunity for researchers to examine cognitive plasticity via the observation of notetaking behavior over a period of time (Moser-Mercer, 2010).

Although much of the notetaking literature on the language of notes and symbols has to date addressed conference interpreting, the questions raised here

are equally applicable to community interpreting. This is particularly true with respect to bidirectional dialogue interpreting, insofar as interpreters take notes based on source language utterances in two different languages. In some cases, pedagogical and training guidance suggests that notetaking should be taken exclusively in one language or using symbols alone. While this guidance may be useful for interpreters working in only one direction, the situation is more complicated when observing interpreters working in both directions. As Tiselius and Englund Dimitrova (2019) note, dialogue interpreters may have different language proficiencies in their working languages, requiring methodological reflection on the part of researchers to account for demographic and linguistic differences of their participants. This asymmetrical language proficiency may ultimately impact notetaking behavior, too, allowing digital pens to capture the influence of source language input when notating what has been heard – notations in a specific language may be generated differently or less fluidly than in another. In some studies, researchers seek to eliminate potential confounds of the variable of interest by asking community interpreters not to take notes. For instance, Tiselius and Englund Dimitrova (2021) seek to understand potential cognitive constraints of interpreters during dialogue interpreting with respect to working memory, and therefore do not allow their participants to take notes. This experimental control is appropriate, in that researchers do not yet have sufficient insight into the process of notetaking during dialogue interpreting and its relationship to cognitive behavior. Having a better understanding of how interpreters take notes, and the cognitive dimensions thereof, may allow future studies to incorporate this commonly-employed task in research designs when applicable.

4.2. Ear-pen span

The ability to synchronize the audio of a source language utterance and the start of a pen notation provides researchers the ability to examine ear-pen span. This metric has already seen some use by researchers such as Andres (2002) and Chen (2017, 2020), who have postulated that ear-pen span is a potential proxy for cognitive load. Indeed, the ability for an interpreter to store certain amounts of information in short-term or working memory before requiring notation may in fact be reflected in ear-pen span. This interpretation of the measure is particularly salient in the initial onset of a source language utterance and the first pen stroke. Nevertheless, the measure may not be fully comparable to other measures of cognitive load seen in cognitive interpreting studies (e.g., Seeber, 2011; Seeber & Kerzel, 2012) in that the interpreter has yet to begin rendering his or her interpretation in the target language and is instead using the notepad to create visual cues for potential recall. Consequently, researchers must exercise caution to ensure that the underlying philosophical foundation is not incommensurate when comparing measures (for a review of potential means by which to resolve this issue, see Marín García, 2022). The metric also requires reflection since it is potentially susceptible to individual differences among interpreters. Moreover, an interpreter may pass the threshold of cognitive saturation and be unable to note what was said at the outset and instead begin the notation much later than had been initially intended. These caveats notwithstanding, ear-pen span as a metric may provide insights on cognitive behavior as a vector to understand working memory capacity or cognitive load when used in conjunction with other previously-validated measures. Triangulation is particularly important when looking to use these types of measures as a proxy for cognitive constructs, and a synchronized

datastream that couples product and process data is a likely complement to other methods that have been employed in the literature.

Much as ear-voice span in simultaneous interpreting has been used as a potential indicator of task complexity (e.g., Timarová et al., 2011), so too might ear-pen span be useful as a means to determine the influence of source language utterances on interpreter cognition in consecutive interpreting. For instance, specific types of source language utterances that appear at the start of a turn may result in discernible patterns in interpreter performance and notetaking behavior. Documenting notetaking behavior in this manner – be it in conference or community settings – provides another means by which to indirectly observe cognitive behavior that occurs during the interpreting task. For instance, frozen language or set expressions – e.g., welcoming remarks, honorifics, and standard questions – may result in longer initial ear-pen spans given the ability of the interpreter to process these utterances as fewer lexical or semantic items and therefore do not require notes shortly after hearing the utterance, while unfamiliar terminology or large amounts of detail at the start of a turn may precipitate a much shorter ear-pen span. Variation in the metric could be suggestive of an interpreter’s awareness of how specific language features can influence their ability to perform their task. Self-awareness and self-monitoring in interpreting have been explored (Bakti & Bóna, 2016; Magnifico & Defrancq, 2019; Shen & Liang, 2021) in relation to simultaneous interpreting, and this measure may provide opportunities to explore similar constructs in dialogue interpreting.

4.3. Hesitations

Hesitations and false starts are well-suited to process-oriented analyses given that they can be captured by the audio recording of the interpreter. Previous research on sight translation has indicated that the visual presence of a source text may result in speech disfluencies during the oral rendition of the text (Shreve, et al., 2011). In some respects, this argument may hold true for the presence of an interpreter’s notes during the oral rendition of the target language utterance; however, there may need to be additional nuance in the analysis. Research on interpreter’s notes has previously shown that the language in which notes are taken can vary based on the interpreter, the setting, and the context (e.g., Dam, 2004; Szabó, 2006). This variation may even occur during the same interpreting event, with interpreters using different notetaking strategies to aid their performance. As a result, the ability to review the interpreter’s notes as they are produced at the same time as the delivery of their renditions can help resolve whether there is the potential for visual influence that impacts the interpreter’s ability to resolve lexical, syntactic, and strategic interpreting problems, akin to those found in Shreve, Lacruz, and Angelone’s (2011) study. This situation is particularly true if interpreters continue to mark their notepad as they provide their rendition; this behavior can be observed when interpreters are keeping track of where they are in their rendition or to indicate that they have rendered a particular utterance. Based on the notetaking behavior, researchers may be able to make inferences about cognitive resource allocation during notetaking as well as the production of their rendition. In a similar vein, hesitations may also be indicative of parsing issues of the source language segment that were then recorded in the notes. As interpreters provide their rendition in the target language, these parsing issues may manifest in their production, requiring additional time to resolve or reformulation to resolve syntactic issues. While a product-oriented study might consider this mark as a stray pen mark, a real-time pen recording may provide clues as to the interpreter’s

behavior since these marks can be temporally located during production to determine if they are stray marks introduced during notetaking or during the rendition. When paired with a retrospective cued interview in which a participant may be asked about these extraneous marks that occur concomitantly with a hesitation, these pen recordings can provide evidence of continued cognitive processing throughout the task. In doing so, researchers have a better view of the interpreting task as a whole, allowing greater insight into possible cognitive behavior that cannot otherwise be inferred using a product-only approach.

4.4. Omissions

A perennial challenge of examining notetaking behavior in interpreters is linked to what is *not* notated along with what is *not* uttered in the interpreter's rendition despite its presence in the source language (Barik, 1971; Napier, 2004). Whereas hesitations provide an indicator that the interpreter may have encountered a problem, omissions are challenging for researchers to interpret given that there is no verbal record that an issue occurred. A record of the pen strokes may provide insights into cognitive behavior that occurred around a particular omission. For instance, a source language element that was omitted may appear in the interpreter's notes, either as a correctly noted piece of information or an erroneous notation. In the first instance, the interpreter may have simply missed the notation during the rendition, indicative perhaps of a lapse in concentration, a visual miscue in which the interpreter looked in the wrong location (i.e., indicated by the introduction of additional marks during their rendition that do not align with the utterance), or an issue with the organization of the notes. Of course, the researcher would likely need to revisit this segment with the participant to get his or her perspective, but the presence of a note paired with an omission is likely a point of discussion.

In the second instance, in which information is incorrectly notated, the interpreter may have strategically chosen to omit this element given the disconnect between what the interpreter remembered from the utterance and what was included in the notes. This type of problem-solving behavior may precipitate an interpreter's intervention in subsequent turns to clarify what was missed. The interpreter may also be relying on the information being revisited by the interlocutors at a later time. In many cases, product-oriented studies alone can reveal this information; however, digital pen recordings allow a temporal dimension to be incorporated into the analysis that is absent from a post-task review of interpreter notes. In addition, the discourse environment and subject matter may be at play, and the interpreter is relying on background knowledge to omit notated information that does not align with this information (Napier, 2004). Again, a triangulated retrospective interview would provide greater clarity. However, documented evidence in the note record allows for more targeted lines of inquiry during these follow-up interviews specific to the strategies employed by the interpreter.

There is, of course, a third scenario in which information was omitted in the target language – the interpreter did not take note of the information nor did the interpreter provide a verbal rendition in the target language. In these cases, there may be limited evidence present to speak to an interpreter's cognitive behavior or activity. Even so, researchers may be able to posit a connection with comprehension of the source language utterance. As with the previous cases, retrospective cued interviews might allow researchers to inquire as to the observed behavior and the decision to not take notes in specific instances and not provide a

rendition in the target language. A considerable body of scholarship on listening and comprehension in interpreting may also be brought to bear on these questions (see, for instance, Díaz-Galaz, 2020), allowing researchers to probe the relationship between source language listening and comprehension and notetaking behavior.

4.5. Scratch marks, stray pen marks

One area of research that has not been examined in detail with respect to interpreter's notes are scratch marks or stray pen marks that appear on the page. While many of the potential interpretations of these marks have already been discussed in the previous sections, the marks may indicate corrections or indecision in the interpreting task. One additional avenue worth exploring is the possibility that doodling or scratch marks may be linked to cognitive monitoring and information processing, in line with previous research on this type of writing behavior in other contexts (Andrade, 2010). Research that explicitly addresses this topic is needed to see whether this type of work is applicable in interpreting studies contexts, but the noted benefits of increased cognitive monitoring and information processing in other contexts outside of interpreting is suggestive that these types of written marks may be of use to interpreting studies researchers. This type of pen data remains untapped to date in interpreter notetaking, but given its utility in notetaking research more generally, researchers should not discount its potential as a window into cognitive behavior. Future studies might incorporate these types of marks into classifications of interpreter notes, drawing on the literature outside of the field to establish potential indicators of cognitive behavior in conference or community interpreting.

4.6. Turn boundaries

To this point, the potential notetaking elements that have been discussed are expressly related to what appears in the written and audio record created by the digital pen technologies. In addition, the temporal juxtaposition of the multiple data streams provides an opportunity to examine turn boundaries that occur in bidirectional consecutive interpreting. The ability to examine dialogue interpreting in this manner is overdue, as process-oriented research on notetaking during interpreting has focused on interpreting into a single language. Cognitive research on turn boundaries may take various forms and can address questions related to turn-taking, conversation management, and overlapping cognitive processing of comprehension and output. That is not to say that turn-taking research in community interpreting has not been conducted – as noted above, research by a broad range of scholars (e.g., Roy, 1996, Wadensjö, 1999) have addressed turn-taking from a number of angles. The cognitive mechanisms that underlie this behavior, however, remain relatively underexplored.

This type of research has been done to an extent in written translation, particularly with respect to cognitive segmentation. Much as Dragsted (2005) identified how translators cognitively segment texts differently from more traditional sentence boundaries (such as punctuation marks), so too might we examine how interpreters segment source text utterances. The use of digital pens to record interpreter notes is likely to document where these boundaries exist and can augment existing studies that rely on transcribed interpreter interactions. The ability to investigate turn boundaries in this way ultimately relies on the researcher's ability to observe interpreters notating alternating turns, which are typically presented in different languages, as they move between utterances.

Dragsted's work in translation studies is illustrative of how cognitive processing is not neatly confined to specific text segments in a translation, and interpreters may exhibit similar cognitive processing behavior as they alternate between different utterances and languages. The ability to observe when interpreters notate information in relation to the source text utterance allows a level of granularity that extends beyond our current understanding of how notes are recorded and used to aid memory and recall.

As suggested in the previous subsections, research on consecutive and dialogue interpreting can be augmented by looking at interpreter notes as they unfold during the notetaking process. A range of different types of notes – including symbols, ear-pen span, hesitations, omissions, and stray pen or scratch marks – provide possible indicators of cognitive behavior that cannot necessarily be inferred from a product-only perspective. A process-oriented approach to interpreting that allows researchers to pair the temporal dimension of notetaking with the final product may provide opportunities for additional reflection on interpreter cognition during dialogue interpreting and new means by which cognitive behavior can be inferred. These types of data potentially allow cognitive aspects of turn boundaries to also be explored, which, to date, has seen limited attention from a cognitive perspective.

5. Conclusion

As technologies that aid interpreters in their work continue to develop, there are new opportunities to collect data and provide insights into interpreters' cognitive behavior. In the case of digital pen technologies, these tools have been used to enable new forms of interpreting and to train interpreting students to be more effective in the consecutive mode. These tools also represent an opportunity to document interpreter cognition by facilitating real-time recording of notetaking behavior simultaneously with source language audio and target language renditions. This synchronized set of data requires researchers to re-think what these data mean in line with current literature on notetaking so that cognitive behavior might be better understood during dialogue interpreting.

This article set out to identify various elements of notes that, when recorded using digital pens, can be interpreted in line with cognitive research on interpreting. While some of these indicators can be observed in product-only data, the temporal dimension provided by digital pen technologies allows greater insight into the interpreter's progression through the task. Moreover, the synchronized datastreams of utterances, renditions, and pen data allow researchers to be more attuned to specific behaviors as they occur, which is not always possible with product-oriented data alone. These lines of inquiry can be pursued independently, but their triangulation with other data collection methodologies present an opportunity to document cognitive behavior that has been difficult, if not impossible, to observe. Future research is needed to describe not only the notetaking process, but also how notes are embedded in the interpreting task. This type of work will benefit from these digital pen technologies through real-time documentation of a task that was previously only observable after an interpreted event had come to a close. In sum, digital pens are a relatively new methodological addition that will allow interpreting process researchers to observe a broad range of cognitive behaviors and constructs and refine previous scholarship that relied solely on product data.

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