EFFECT OF WORD ORDER ASYMMETRY ON COGNITIVE PROCESS OF ENGLISH - CHINESE SIGHT TRANSLATION BY INTERPRETING TRAINEES

——EVIDENCE FROM EYE-TRACKING

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——Evidence from Eye-tracking

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CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it produces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgment has been made in the text.

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Abstract

The current study examines effects of word order asymmetry between source language and target language on cognitive processes of English-Chinese sight translation (STR) performed by interpreting trainees. Word order asymmetry as one indicator of language-pair specificity is a widely debated topic in interpreting literature (Gile, 2002, 2011; Wang & Zou, 2018), but its effect on cognitive behaviour during interpreting has received virtually no systematic investigation (Wang & Gu, 2016). A set of studies have been conducted to examine how word order differences influence interpreting product but few approach the issue from a cognitive perspective: whether and how does word order asymmetry affect on-line processing during interpreting remains an underexplored area.

It is well-documented that English and Chinese are strikingly different in grammatical rules: the two languages conform to distinctive branching directions. For instance, Chinese is a typical left-branching language in which long strings of modifiers are always located before the nouns while English is mostly right-branching which puts nouns before the modifiers. Differences in word orders may impose extra cognitive burden on interpreting process, which requires more in-depth explorations to reveal mental activities associated with addressing structural incongruences.

This study uses eye-tracking as the primary data collection method to observe and analyze in what way and to what extent word order asymmetry as indicated by relative clauses and passive constructions affects on-line processing during English - Chinese sight translation and to examine the potential role of contextual information and working memory span in offsetting the asymmetry-induced disruptions. In addition, the study also attempts to explore: 1) How do interpreting trainees that have been trained in basic sight translation skills cope with word order asymmetry in English-

Chinese sight translation and will their choices of strategy for processing asymmetric structures affect the cognitive load and on-line reading patterns? 2) Does word order asymmetry negatively impact interpreting performance in English-Chinese sight translation in terms of error frequency and distribution pattern? And is the interpreting trainees' self-perceived degree of structural difficulty related to the actual cognitive load involved?

To answer the above questions, a group of interpreter trainees who had been trained in basic interpreting skills were recruited as the participants. A 2 x 2 quasi-experimental design for sight translation tasks was adopted with sentence type (asymmetric sentences vs symmetric sentences) and task condition (interpreting under single sentence context vs interpreting under discourse context) as independent variables. A set of English sentences containing relative clauses or passives were employed as the asymmetric sentences (critical sentences) and an equal number of comparable sentences that resembled Chinese in word orders were used as the symmetric sentences (control sentences). In Condition 1 (single sentence context), the participants were required to sight translate 12 critical sentences and 12 control sentences which were presented in an individually randomized order; In Condition 2 (discourse context), the participants sight translated 12 critical sentences and 12 control sentences which were embedded in coherent discourses. Each participant sight translated 24 critical sentences and 24 control sentences for the task in both conditions and eye movements during the task were recorded as indicators of cognitive load during on-line processing. To measure the cognitive load in sight translation, eye metrics at both global level (dwell time and fixation count) and local level (first fixation duration, first pass reading time, second pass reading time and regression path duration) were employed; to access the impact of word order asymmetry on interpreting product, an error analysis based on frequency and distribution of errors in the target output was conducted. In addition to the sight translation task, the participants filled in the post-experimental questionnaires to indicate their perception of asymmetry-induced difficulties during sight translation. They also undertook an English reading span test which was designed to test their working memory capacity, in particular the ability to coordinate input storage and information processing. Findings of the study were triangulated based upon both on-line and off-line data.

Major results can be summarized as follows: 1) Word order asymmetry exerted a highly significant effect on cognitive process during sight translation. There was significantly greater cognitive load in the critical sentences than in the control sentences at both sentence-level and word-level. Local eye measures indicated that as compared with the single sentence context, a wider context in discourse condition imposed extra contextual constraints which resulted in considerably higher cognitive load. Besides, the on-line processing of the critical sentences was influenced by contextual information to a greater degree. 2) Segmentation was the primary strategy adopted by the trainees to address asymmetric structures and it did relieve the cognitive burden to some degree as compared with restructuring, the other applied strategy. Different reading patterns in form of the rereading rate were observed between processing through segmentation and processing through restructuring, indicating relations between strategy choice, corresponding cognitive load and reading behaviour. 3) Interpreting quality was negatively affected by word order asymmetry as indicated by significantly more frequent errors made in asymmetric sentences, but there was a mismatch between participants' self-perception of syntactic difficulty and the actual cognitive load devoted.

Theoretically, results of the study enrich the existing knowledge on cognitive constraints during interpreting and on sentence processing in a cross-linguistic scenario. Observation based on eye-tracking data deepens the understanding of mental workings in sight translation, a special hybrid of interpreting and translation. Methodologically, eye-tracking data in the current study provides empirical evidence for a cognitive-taxing effect of language-pair specific factors on interpreting and also complements previous researches based on product-oriented approaches. A distinction of early and late eye measures in data analysis instead of relying merely on overall measures provides a more complete picture of on-line processing at different stages. In terms of pedagogical implications, it emphasizes the role of language pair specificity in shaping interpreting process and product and the need to develop awareness of structural differences between source and target language in daily training.

Publications Arising from the Thesis

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List of Abbreviations

AOI: Area of Interest

CI: consecutive interpreting

EVS: eye-voice span

FFD: first fixation duration

FOA: focus of attention

FRT: first pass reading time

ORC: object-extracted relative clause

PBD: principal branching direction

PC: passive construction

PC: passive construction

RC: relative clause

RPD: regression path duration

SI: simultaneous interpreting

SL: source language

SRC: subject-extracted relative clause

SRT: second pass reading time

STR: sight translation

T & I: translation and interpreting

TAPs: think-aloud protocols

TL: target language

WM: working memory

WMC: working memory capacity

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Chapter 1 Introduction

1.1 Background

This dissertation sets out to investigate effect of word order asymmetry between source language and target language on cognitive process of English-Chinese sight translation (STR), in particular, whether and how English sentences containing relative clauses or passive constructions disrupt interpreters' cognitive process. Sight translation, in this study, refers to the oral translation of a written text. There is no audio input in sight translation, interpreters only deal with the written source texts and translate on the spot without preparation. Sight translation has been seen as a hybrid of interpreting and translation (Agrifoglio, 2004, p.43; Obidina, 2015; Setton & Motta, 2007, p.203), but due to its nature of concurrent input and output as well as the time stress, sight translation appears to have more in common with interpreting and can be considered as a special variant of simultaneous interpreting (Brady, 1989; Herbert, 1952). Although there have been numerous discussions on sight translation skills (Zhan, 2012; Zhao & Yang, 2014), the role of sight translation in aptitude tests for conference interpreting and its pedagogical values in interpreting training (Mikkelson, 1994; Sawyer, 2004; Weber, 1990), sight translation remains an under researched area as claimed by many (Agrifoglio, 2004; Li, 2014; Sampaio, 2007; Weber, 1990).The scant literature on sight translation in striking contrast to its important role in interpreting market and training constitutes one of the factors that motivate this study.

Another motivation for the current study is the issue of language specificity. In any discussions pertaining to difficulties in interpreting, effect of language specificity should never be overlooked. Language specificity can be understood as language-specific factors such as differences in language structures and cultural conceptualization between source language and target language. The relevance of language specificity, in particular, word order differences between the two languages, has been an issue of ongoing debate. Although interpreting, according to the Paris School, is a language-independent process thereby not affected by language-specific factors (Lederer, 1999), most of their claims are made based upon European language pairs such as English/French which do not differ considerably in syntactic rules. Moreover, in interpreting practice, differences between source language and target language in syntactic and other dimensions do indeed affect interpreters' performance (Gile, 2004), which is particularly true for English/Chinese interpreting, an act of transfer between two syntactically distant languages. There is a high frequency of asymmetric structures in English / Chinese interpreting, for instance, relative clauses as post modifiers and passive sentences, which may increase cognitive burden and require certain interpreting strategies. However, only a small body of studies has touched upon this field and most of them rely on product-oriented analysis. There have been little empirical-experimental explorations into effect of word order asymmetry on interpreting process. In response to it, this study attempts to investigate the effect of word order asymmetry on cognitive process during English-Chinese sight translation.

Cognitive process is one of the central research topics in translation and interpreting studies (T&I studies). There has been an increasing interest in what takes places in the minds of translators and interpreters. This curiosity in cognitive workings is making the research focus of interpreting studies shift from subjective reflections and profession-oriented discussions of skills to more scientific and experimental paradigms based on empirical data. Conceptual and methodological approaches from neighboring disciplines including psychology, psycholinguistics and cognitive science greatly facilitate the endeavor towards unveiling the "black box" during translation and interpreting.

Driven by this need for a cognitive inquiry of the “black box”, an array of data elicitation methods widely applied in psychology and psycholinguistics are making their ways into process-oriented T&I studies, one of which is eye-tracking. As compared to other conventional methods used in interpreting process study such as think aloud protocols and retrospective verbalization, eye-tracking is more accurate and less invasive, allowing for a moment-to-moment recording of cognitive behaviour during translation. Eye-tracking measures such as fixation duration and fixation counts have been shown to be indicative of cognitive load, which is expected to offer new insights into mental activities of translators and interpreters. Moreover, eye movement behaviour can be further split into a variety of subcomponents such as first fixation duration and first pass reading time (Carreiras & Clifton, 2004) to inform on different stages of language processing. The past decades have seen an emerging tendency in applying eye-tracking to studying the cognitive processes of T & I. Eye-tracking is being fruitfully adopted as a faithful and effective measure of translators and interpreters’ cognitive behaviour, giving new impetus to the process-oriented approaches to T&I studies.

1.2 Statement of the Problem

Effect of language specificity in interpreting has been a recurring topic (see Guo, 2011; Wang & Gu, 2016). One of the frequently asked questions is whether language specificity impedes interpreting performance. Despite the controversy over its relevance to interpreting, some previous studies on interpreting between linguistically distant languages such as English/Japanese (e.g., Mizuno, 1995), English/German(e.g., Le Ny 1978; Wliss, 1978; Seeber, 2007) and English/Chinese (Dawrant, 1996; Guo, 2011; Setton, 1993; Wang & Zou, 2018) have shown that interpreters are susceptible to language specific factors, especially word order differences between source language and target language.

This disruption triggered by word order differences may be intensified in sight translation due to its mode-specific features. Constant presence of written source texts in sight translation is believed by some scholars to cause additional cognitive load: interpreters have to juggle the visual input and oral output which may conflict with each other, besides, written languages are generally more complex and densely organized than oral input in consecutive interpreting (CI) or simultaneous interpreting (SI), causing greater source language interference (e.g., Agrifoglio, 2004; Gile, 2010; Lee, 2012). However, it is also possible that the availability of source texts in sight translation relieves cognitive load by lessening the dependence on short-term memory (Setton & Rotta, 2007). In addition, interpreters during sight translation can articulate at their own pace, thus having more manoeuvre for on-line planning if language-specific difficulties arise. More empirical efforts are expected to examine how mode-specific features of sight translation interact with language-specific difficulties.

Another difficulty due to word order asymmetry is coordinating source language analysis and target delivery. Interpreting has long been regarded as an extreme case of multi-tasking, characterized by concurrent listening/reading and speaking (Chmiel, 2010). When language combinations differ widely in word orders, interpreters may need wait for one certain segment to conclude a sentence (e.g., German) but that segment has to be interpreted earlier in another language (e.g., English) (Christoffels, De Groot, & Kroll, 2006). To keep a smooth delivery, interpreters need effectively coordinate their comprehension, on-line storage and production, which requires greater working memory capacity. Working memory is a coordination system for temporarily storing and processing information when carrying out higher-order cognitive tasks such as reading, learning and reasoning (Baddeley & Logie, 1999). The role of working memory in interpreting has been extensively researched upon (e.g., Liu, Schallert, & Carroll, 2004; Signorelli, Haarmann, & Obler, 2012; Tzou, Eslami, Chen, & Vaid, 2012; Yudes, Macizo, & Bajo, 2012), however, few studies focus on relations between working memory and syntactic processing during interpreting. It may yield intriguing data via examining whether better working memory facilitates processing word order asymmetry in sight translation and relieves interpreters' mental load.

Given the issues mentioned above, a series of questions remain to be answered: What take place when interpreters encounter word order asymmetry in sight translation? In what way and to what extent do asymmetric structures between English and Chinese disrupt the cognitive process of sight translation? Can better working memory help relieve cognitive burden for processing word asymmetry? How do interpreting trainees cope with English structures that are syntactically different from Chinese? What suggestions for improving interpreting efficiency and interpreter training can be generated based on eye-tracking results and other complementary data sources including questionnaires and output analysis? These questions call for a systematic investigation of effect of word order asymmetry on English-Chinese sight translation within an experimental-empirical paradigm.

1.2.1 Research Objectives and Research Questions

This dissertation ventures into the cognitive process of English-Chinese sight translation by interpreting trainees through eye-tracking. Research goals include:

1) To examine whether and how word order asymmetry impedes cognitive processing during

English-Chinese sight translation and to complement current corpus-based data on effect of word order asymmetry by providing evidence from experimental data.

2) To explore the role of context and working memory capacity in addressing word order asymmetry.

3) To explore relations between certain strategies for addressing word order asymmetry and the cognitive load involved.

4) To explore relations between on-line processing and subjective perception of asymmetry-induced difficulty in sight translation so as to know interpreter trainees' attitudes towards structural differences between source language and target language.

Specifically, this study aims to answer the following questions:

A. Is word order asymmetry a major problem trigger that disrupts on-line processing of English-Chinese sight translation as seen by increased cognitive load in form of eye-tracking metric.

A1. Are there significant differences between critical sentences (sentences containing asymmetric structures including relative clause and passive constructions) and control sentences (sentences that are similar to target language in word order) as indicated by specific eye-tracking measure at global and local level?

A2. Does contextual information facilitate processing of word order asymmetry during sight translation? In other words, will cognitive load for processing asymmetric sentences be significantly lower in discourse context than in single sentence context?

A3. Could higher working memory capacity help reduce cognitive load when processing word order asymmetry? In other words, are there correlations between participants' scores on reading span test and their cognitive load for processing critical sentences as well as the strategy use?

B. How do interpreter trainees (the participants) process word order asymmetry during English-Chinese sight translation?

B1. What strategies do they adopt most frequently when processing word order asymmetry?

B2. Do their choices of strategies (segmentation or restructuring) affect cognitive load when processing word order asymmetry?

B3. Do participants display different reading patterns as indicated by rereading rate when they apply different strategies for addressing word order asymmetry?

C. Does word order asymmetry negatively impact the interpreting performance? In what way and to what extent is the participants' cognitive load related to their own perception of structural difficulty?

C1. Do participants make significantly more errors (meaning error and expression error) when they process asymmetric sentences? And how are meaning errors and expression errors distributed across sentence types and task conditions?

C2. How do participants perceive structural difficulty during sight translation? Is self-perception of syntactic difficulty related to their actual cognitive load involved?

1.2.2 Methodology and Basic Procedures

This dissertation focuses on describing and analysing cognitive process of English-Chinese sight translation under the impact of word order asymmetry. To ensure reliability and validity, conclusions will be primarily drawn from eye-tracking recording and supplemented by results from pre- and post-test questionnaires as well as output analysis to formulate data triangulation.

Basically, a quasi-experimental paradigm is adopted to test the effect and interplay of two major variables: word order asymmetry and amount of contextual information. To control the asymmetry level, two types of English sentences are used as source materials: sentences containing word order asymmetric structures (relative clauses and passive constructions) and sentences which are similar to Chinese in word orders. As for contexts, there are two conditions for sight translation: translating in single sentence context without any background information and translating in discourse context with background information offered. Cautions are required for manipulating language-specific difficulties of source texts: The sentences should be matched in length, word frequency and familiarity across the two conditions. And rewriting should be kept at minimum level to ensure the authenticity and coherence of the source texts.

In brief, the whole study proceeds as follows:

Step 1). Participant recruitment and pre-test questionnaires on their language background and interpreting competence.

Step 2). Experiment session which comprised a working memory span test, sight translation experiment and a post-experiment questionnaire. Participants' on-line behaviour and output during sight translation are synchronically recorded by the eye-tracking program.

Step 3). Data filtering and analysis: different methods of data analysis are performed to answer the research questions listed above.

Step 4). Discussions and conclusions: preliminary discussions, speculations and conclusions are postulated based upon eye-tracking data supplemented with data from other sources.

1.2.3 Outline of the Study

The dissertation is divided into eight chapters.

Chapter One gives an introduction of the research background which highlights the necessity for more empirical study of sight translation, states the problems to be explored and lists the research goals and research questions.

Chapter Two is devoted to an introduction of sight translation by emphasizing its value in interpreting practice and training. In addition, it discusses features that distinguish sight translation from other forms of interpreting and also reviews the progress and limitations of relevant studies.

Chapter Three illustrates word order asymmetry in English-Chinese interpreting. It gives an overview of word order differences between English and Chinese with a focus on two structures: relative clauses and passive constructions. Literature in this field is also introduced. Besides, this chapter also discusses the relevance of working memory to syntactic processing in interpreting.

Chapter Four reviews endeavour in exploring cognitive process of interpreting by means of eye-tracking. Major eye-tracking measures and its applications to process study of sight translation are introduced.

Chapter Five introduces the research design. Four types of data are collected: eye tracking data, results of questionnaires, interpreting output and sores on working memory span test.

Chapter Six reports the findings from the data obtained based on a combination of qualitative and quantitative analysis. Results of descriptive statistics, inferential statistics, output analysis and questionnaires will be reported.

Chapter Seven provides preliminary explanations for cognitive behaviour generated from data results and discusses relations between different variables concerned.

Chapter Eight is a summary of major research findings, research implications and limitations. It also provides suggestions for future study.

Chapter 2 Sight Translation—a Neglected Area in Interpreting Research

2.1 Definition of Sight Translation

Sight translation (STR) generally refers to oral translation of a written text (Chen, 2015; Čeňková, 2010). During sight translation, interpreters are required to render the written source information into an oral target language concurrently in an accurate and fluent manner. Due to this combination of written and oral modalities, sight translation has long been regarded as a hybrid between translation and interpreting (Agrifoglio, 2004, p.43; Setton & Manuela, 2007, p.203). However, sight translation seems to have more in common with simultaneous interpreting since it has to be done in real time, with little possibility of a global perspective (Viaggio, 1995). Therefore, sight translation is considered a special variant of interpreting (Herbert, 1952; Pöchhacker, 2004).

The term "sight translation" can be divided into different categories depending on working conditions. First, unrehearsed sight translation need to be distinguished from prepared sight translation (Lambert, 2004). In unrehearsed sight translation, interpreters have to start their reformulation on the spot without time for prior reading while in prepared sight translation, preparation is allowed for reading in advance. Interpreters have several minutes or even longer to have a quick gist reading and identify some potential problem areas. Second, differences also occur between sight translation and sight interpreting. According to Pöchhacker (2004), when source information is presented both visually and orally, for example, the interpreter at conference may need to sight translate the written speech script while attend to speaker's delivery, it is more suitable to adopt the term *sight interpreting with text*. Sometimes the speakers' words depart from the original written text and interpreters should be aware of the divergences and are urged to follow the speakers (Wan, 2005). In contrast, there is no audio input during sight translation. Interpreters under sight translation only cope with the written input and are paced by themselves. Whatever the actual working condition, sight translation involves a transition from written messages in one language to messages orally presented in another language (Lambert, 2004, p.298). In this study, sigh translation refers to the unprepared on-spot one in which interpreters have almost no time for prior reading.

Sight translation has come into play in professional environment which generally occurs under two settings. First, the skill of sight translation is used as sight interpreting with text in conference interpreting (e.g., Mikkelson, 1994; Gile, 2010). As introduced by Čeňková (2010), sight translation is frequently adopted in bilateral meetings, international conferences and press conference. Second, sight translation is widely practiced in community interpreting. For example, Nilsen and Monsrud (2015) emphasize the use of sight translation in public services, in particular, asylum interviews in Norway where public-sector interpreters report they conduct this type of interpreting almost every day (Felberg, 2015). As a matter of fact, sight translation covers a wide range of areas such as medical interpreting, court interpreting and business interpreting (Phelan, 2001). In recent years, development of speech recognition technology has stimulated a new trend in sight translation practice: professional translators that are trained in speech recognition software have begun to speak their translation to improve efficiency and meet the surging market demand (Dragsted, Mees, & Hansen, 2011; Mees, Dragsted, Hansen, &Jakobsen, 2015).

2.2 Sight Translation as an Important Pedagogical Tool in Interpreter Training

Sight translation is a highly demanding and complex task (Viezzi, 1990) which involves a variety of components such as reading comprehension, language transfer, memorizing, and oral delivery. It is this multi-tasking nature that makes sight translation an important pedagogical tool in interpreting training. Incorporating sight translation to interpreting curriculum has been a reality, with sight translation being taught either as a separate course or as a unit in a translation or interpreting course (Angelelli, 1999; Sawyer, 2004; Zhan, 2012). One methodological advantage of sight translation is that it does not require any special equipment and can be practiced anywhere and anytime (Viaggio, 1995). This may be another factor accounting for the wide use of sight translation by interpreting trainers.

Sight translation is a preparatory component for teaching of both consecutive interpreting and simultaneous interpreting (Li, 2014). In the former situation, sight translation helps familiarize students with basic interpreting skills including quick source information analysis, efficient reading of notes, public speaking and flexible expression (Moser-Mercer, 1994). As for simultaneous interpreting training, sight translation is generally taught to help students transit from consecutive to simultaneous modes since both modes of interpreting require processing in real time. According to Seleskovitch (1978), the shared ground between sight translation and simultaneous interpreting offers a good chance for students to concentrate on essential interpreting skills such as deverbalization and syntactic linearity. Viaggio (1995) and Song (2010) claim that sight translation is perhaps the most effective prelude to teaching simultaneous interpreting. Viaggio (1995) stresses that the crucial differences between sight translation and simultaneous interpreting, i.e. the absence of audio input and possibility of reading forward or backward is a blessing since they allow students to focus on language and sense without “burdening memory or distracting attention to make out the acoustic equivalent of handwriting” (p.34). Therefore, sight translation is often used as a necessary pedagogical exercise for students to get started in techniques of simultaneous interpreting. Having been trained in sight translation, students can learn to react quickly, improve their oral skills, boost their translation skills and acquisition of coordinating different strategies, thus better prepared for training in simultaneous interpreting (Mikkelson, 1994; Spilka, 1996; Weber, 1990).

In addition, sight translation also plays an important role in translator training. Sight translation helps improve translation speed and facilitate acquisition of translation skills and is therefore recommended to be used in translation teaching (Dragsted & Hansen, 2009; Weber, 1990). In recent years, there has been a growing interest in applying sight translation skills to written translation with assistance of speech recognition technology. Baxter (2017) explored how sight translation in combination with speech recognition technology can be applied in translation teaching to improve translation speed and overall product quality. Results showed that there was no significant increase of translation speed when compared to traditional manual translation, but the idiomaticity was enhanced without compromising the overall quality. This may be accounted for by students' lack of familiarity to speech recognition software. In future, sight translation techniques are expected to play a greater role in improving translation speed and quality as familiarity with the technology increases.

Generally, reasons for incorporating sight translation in translation training include: sight translation before writing or typing down target texts facilitates the acquisition of quick text analysis and global reading (Leube, 2000; Weber, 1984), it also saves time and effort without compromising translation quality (Dragsted & Hansen, 2009). More importantly, it helps students to conquer source text interference and divorce themselves from the surface structure of the original text (Li, 2014).

Moreover, sight translation is widely applied to admission and aptitude tests in translation & interpreting training program (Liu, 2009). It can be determined based on a sight translation test that whether candidates are equipped with required aptitude or potential for interpreting or translation learning, for example, whether they are able to quickly grasp the gist of the text and successful convey the main idea (Russo, 2011).

2.3 Mode-specific Features of Sight Translation

Due to the concurrence of language input and output, sight translation appears to have more in common with interpreting. However, sight translation is distinct from consecutive or simultaneous interpreting in cognitive features since the source language is presented visually and this constant visibility of source information may pose additional challenges (Gile, 2010; Lee, 2012). Therefore, the most obvious difference between sight translation and other forms of interpreting lies in the difference between oral modality and written modality: Written language generally exhibits high information density, with more diversified lexical choices, more complex structures and no interaction with the receiver (Shreve, Lacruz, & Angelone, 2010). In contrast, spoken language is more loosely organized, consisting of simpler words and sentence structures. It is cognitively less demanding to grasp the gist of an oral text since stress, intonations and other speech features such as pausing can facilitate language comprehension. Moreover, facial expressions and body languages of the speaker can be used by experienced interpreters to reduce mental load (Gile, 2010, p.168). These differences between written and spoken language may cause additional cognitive burden since sight translators have to not only address time constraints but also to overcome the inherent complexity of written language.

In addition, continuing presence of written texts and efforts in coordinating written input and oral output may increase the degree of source language interference in sight translation (e.g., Agrifoglio, 2004; Gile, 2002; Čeňková, 2015). According to Agrifoglio (2004), listeners and readers tend to have different focuses: listeners pay more attention to the gist while readers, perhaps influenced by the written language interference, are bound to concentrate on individual words and structures. Therefore, written source text in sight translation may be a potential "troublemaker" which increases cognitive load. Martin (1993) argues that compared with other mode of interpreting, sight translation is more susceptible to the interference of source text, therefore, interpreters have to devote a greater amount of energy to resisting the interference of source language. Gile (2002) stresses the significant risk of linguistic interference in sight translation. This interference may take the form of undesirable influence from the grammatical or syntactical structures of source language. His view is supported by Agriofoglio (2004) who believes that cognitive difficulties in sight translation not only derive from complexity of written language but also from the constant presence of the source text. She further explains that if the text remains available in front of eyes, interpreters need to move their eyes back and forth between words during a real time task. To test the cognitive difficulty under different interpreting modes, Agrifoglio (2004) conducted an in-depth investigation by comparing sight translation to both consecutive and simultaneous interpreting and found that "sight translation emerges as a complex and unique technique, whose cognitive demands on the interpreters are by no means less than those of simultaneous and consecutive"(p.43). Results of her study was supported by evidence from eye-tracking. Shreve, Lacruz and Angelone (2010) manipulated linguistic complexity of source texts and examined the effect of syntactic disruption on sight translation. The eye-tracking data reveals that sight translation is more susceptible to syntactic disruption than written translation, which provides cognitive evidence that sight translation is particularly sensitive to visual interference due to constant presence of the text. In a follow-up study, Shreve, Lacruz and Angelone (2011) found that problems encountered during sight translation tended to be more disruptive than in written translation as indicated by not only more errors or inadequate expressions but also disfluencies detected in target speech. These studies demonstrate that constant visibility of source information during interpreting causes more syntactic disruptions as compared to other interpreting/translation modes, which also implies that interpreters are particularly sensitive to visual interference due to presence of the written text.

Discussions above indicate that mode-specific characteristics are believed to cause additional effort including greater difficulty in source text comprehension and the language interference. However, some studies found that the added visual information in sight translation may facilitate the on-line processing. Viezzi (1989) compared the information retention after reading, listening, simultaneous interpreting and sight translation by interpreting students and professional interpreters. Participants were required to answer questions immediately after the language task. Data results showed that information retention rate after sight translation was lower than that after simultaneous interpreting. The author ascribed this unexpected difference to different depths of processing under the two interpreting conditions: in sight translation, source information is constantly available, and interpreters do not have to immediately process incoming message and store them in memory for later integration. In contrast, interpreters in simultaneous interpreting are forced to coordinate comprehension, storage and integration in real-time, which requires greater effort and thus a deeper degree of processing. According to Craik and Lockhart (1972), information retention is related to processing time and depth: the more effortful the processing, the more information would be retained. In this sense, it is the continuing textual information that helps relieve cognitive burden during sight translation. Lambert (2004) reported on a comparative study between sight translation, normal simultaneous interpreting and sight interpreting with text to identify the role of visible source texts during sight translation. The results indicate that in sight translation, attention does not have to be shared and less cognitive load is required. Therefore, Lambert believed that added visual information in sight translation will not necessarily impose a burden on the already overloaded capacity but may in fact facilitate interpreters' delivery. Lamberger-Felber and Schneider (2008) found that the source language inference does not necessarily impede sight translation quality, and the degree of interference depends on individual performance, which implies that expert interpreters are less likely to suffer the visual interference in sight translation. These studies suggest that availability of visual information may reduce memory burden and facilitate processing at macro level. Memory burden will be relieved if interpreters have access to written scripts and they could spare more resources for other aspects of interpreting such as listening and reformulation. If no written scripts were offered, processing may be confined to local level, as Ahn (2005) argues that the linear and on-line processing mode in simultaneous interpreting limits the interpreters' perspective on the unfolding text since they can hardly wait until the end of a full segment or sentence. With written scripts at hand, interpreters would be able to adopt global processing, obtaining an advantage in understanding and anticipating the textual structure, which reduces impact of source language interference.

2.4 Researches into Sight Translation: Limitations and Prospects

Despite its wide application and important role interpreting training, sight translation remains an under researched area and receives much less academic attention than other modes of interpreting (Moser-Mecer, 1995; Lee, 2012; Sampaio, 2007; Čeňková, 2010; Zheng & Xiang, 2014). Only limited amount of literature is devoted to sight translation, most of which are based on product-oriented analysis from a pedagogical point of view: One of the research focuses is skills and techniques of sight translation and suggestions for improving sight translation training

(Viaggio, 1995; Zhan, 2012; Zhao & Yang, 2014). Some scholars examine certain components of sight translation such as reading comprehension (Nilsen & Monsrud, 2015).

In recent years, more empirical studies have been conducted to explore cognitive features of sight translation: one approach is to compare behavior and product between sight translation and other modes of translation/interpreting (e.g., Agrifoglio, 2004; Jakobsen & Jensen, 2008; Lambert, 2004; Shreve et al., 2010, 2011), with the aim of identifying mode-specific features of sight translation and how the features are related to on-line processing and production. Another approach is to conduct comparative study among participants with different levels of interpreting experience. For instance, the frequently adopted expert-novice paradigm is to find behavioral patterns that distinguish experienced interpreters from interpreting novices so as to improve efficiency of sight translation teaching (Lee, 2012). Lastly, empirical approaches have been used to explore effect of sight translation training on acquisition of other interpreting modes. Researchers are interested to see whether and how sight translation skills would be transferred to other interpreting conditions (Liu, 2011; Song, 2010; Wan, 2005). Development of relevant research indicates an emerging trend of empirical approaches, but more systematic efforts are expected for cognitive inquiry into sight translation at deeper levels.

Chapter 3 Word Order Asymmetry in Sight Translation

3.1 Word Order Asymmetry as One Indicator of Language Complexity

There are generally two different approaches to view language complexity: one is absolute complexity which is a theory-internal concept reflecting language reality; the other is relative complexity understood as an empirical reality (Kusters, 2008; Miestamo, 2008). According to Miestamo (2008), absolute complexity is the inherent property of language which is not related to experience of specific language users. LindstrÖm (2008) describes absolute complexity as a system that can be computed mathematically. Hence, it could be said that absolute complexity is derived from the internal and autonomous systems of languages. However, "complexity" in absolute terms still remains a quite vague concept that is largely not clearly defined (Juola, 2008; Miestamo, 2008). This is partly due to the intuitive perception of complexity since anyone with reading and writing competence is able to name a few features of linguistic complexity, such as low word frequency or long and complex sentence. Another possible reason is perhaps a lack of agreed-upon measures of complexity (Hild, 2011). Scholars have proposed different approaches to complexity measurement from perspectives of linguistic, psycholinguistics and natural language processing (e.g., Roark, Mitchell, & Hollingshead, 2007; Sampson, Gil, & Trudgill, 2009), but no consensus has been achieved on how to define and measure the degree of language complexity (See Hild, 2011).

In contrast, relative complexity often presupposes a perspective or point of view from which a certain language phenomenon is considered as simple or complex (Kusters, 2008). The concept of relative complexity, therefore, is closely linked to perception and attitudes of language users. It is highly possible that those deemed as complex by one language community is the least complex for another community, which mirrors the remarkable differences between language systems and language user groups. This type of complexity resides in native language speakers' perception when they ponder on which language or which aspect of a certain language is complex or simple. For other non-native languages, the native speakers always take an "outsider perspective (Kuster, 2008, p.9)" to evaluate complexities of those languages and this evaluation may take place at various level including phonemic, lexical, syntactic or discourse level: Pronunciation of some French words are regarded as challenging by Japanese learners; Modern English readers often find it difficult to understand morphology of Latin in Cicero; and native Chinese speakers may have problems in learning certain grammatical structures of English. Or we might examine "what kinds of word orders are difficult for native speakers of SVO languages when confronted with a VSO language". Therefore, according to Kuster (2008), if we view complexity from the perspectives of non-native speakers or an outsider, the complexity could be defined as the amount of effort outsider speakers have to devote to familiarize themselves to the language in question.

The distinction between absolute complexity and relative complexity offers a new perspective to view difficulties in translation and interpreting. Teachers, practitioners and researchers in translation and interpreters often need deal with source materials with different levels of complexities, but there has not been any agreed-upon yardstick for measuring source language complexity. Sometimes the complexity is judged based on personal experience or intuitions while in some cases, objective and quantitative input variables such as word frequency and sentence length are employed (Liu & Chiu, 2009). One of the widely applied measures in translation study is to calculate readability of source texts, i.e. the ease with which that a text can be read and comprehended (Jensen, 2009). Readability formulas primarily rely on easily measurable variables such as word length and sentence length (Nation, 2005), which gives a quick way to mirror the difficulty of source materials. However, this method as an indicator of absolute complexity is not without flaws. The concept of difficulty can be subjective and elusive (Jensen, 2009), varying from different language communities and even from individuals. In other words, complexities in translation are language-specific. If relative complexity was not considered, translators may not have any problems in dealing with a sentence judged as difficult or complex by readability indexes. It only makes senses when scope of discussion is narrowed down to groups with certain linguistic and cultural backgrounds and to certain language pairs. Although a systematic exploration of language complexity is beyond the scope this study, it is noteworthy to give more weight to relative complexity in translation and interpreting and to focus on difficulties within certain contexts.

Bearing this in mind, this study sets out to examine word-order asymmetry as one typical indicator of relative complexity in interpreting. Some structures, for example, long and complex relative clauses as post modifiers will not be considered as difficult by native English speakers, but they are more likely to trigger comprehension problems for native Chinese speakers since this right-branching structures are not tolerable in Chinese. In this sense, an interpreter dealing with language pairs that are similar in word orders will have little difficulties in converting the source language sequentially into the target language. However, if the language combinations are syntactically divergent, such as English (head-initial language) vs Chinese (head-final language), greater difficulties and higher mental load may be induced. Therefore, asymmetric structures in view of relative complexity may have a greater impact on interpreting processing as compared with variables based on absolute complexity.

3.2 Word Order Asymmetry between English and Chinese—Language-pair Specific Difficulties

3.2.1 Language Specificity in Interpreting

As mentioned above, complexity has been understood either from an absolute theory-based perspective or relative user-based point of view, which challenges the conventional view that all languages are equally complex (Miestamo, 2008). Instead of studying language complexity in an objective and theory-based way, scholars are increasingly interested in the relative complexity as a result of variances between languages. Therefore, a cross-language perspective is required.

A relative approach from cross-language perspectives is defined as the cost or difficulty for a language user to process certain language phenomenon (see Hawkins, 2004). Seen from a relative view, native Mandarin Chinese speakers may find it difficult to process language structures in English that are rare or even absent in Mandarin Chinese. Therefore, based on the concept of relative complexity, we can consider syntactic complexity in sight translation as the difficulty or cognitive cost for interpreters to process structures in the source language (SL) that are strikingly different with or absent in the target language (TL).

This processing difficulty or cost is a result of "language specificity (Gile, 2010, p.182)" from the perspective of interpreting and translation studies. Language-specificity refers to language-specific factors such as differences in language structures and cultural conceptualization between source language and target language. The notion of language specificity has been frequently used in various literatures on interpreting research to highlight the difficulties in overcoming linguistic or cultural barriers.

There has been an ongoing debate over the interference due to language-specificity during interpreting. The two camps, namely, universalists and bilaterists hold opposing views on whether language-specificity negatively affects interpreting performance (Setton, 1999). The Universalists Hypothesis, advocated mainly by the Paris School Scholars, believes that comprehension and production in interpreting are not essentially different from those in everyday communication and that applies to all languages. All language-specific problems can thus be avoided by "deverbalization", in other words, reformulation of the sense instead of surface structures (Seleskovitch, 1978). According to universalist, due to the similar processing mechanism in interpreting and daily communication, only factors that hamper monolingual daily conversation will be considered sources of problems in interpreting and more attention need be paid to extra-linguistic factors.

In contrast, the bilaterists represented by the Information Processing School believe that language-specificity, for example, differences in syntactic structures, can be a prominent problem in interpreting and require specific strategies (Gile, 2005, p.141). As Donato (2003) introduced, interpreters can never easily forget the surface structures and other language features of the source text. Therefore, linguistic distances between source language and target language may cause additional difficulties in interpreting. It is acknowledged among psycholinguists that similar syntactic structures facilitate cross-language comprehension and structural differences reduce the possibility of anticipation or impose greater cognitive load (Macdonald, 1997; Richaudeau, 1981). Therefore, structural asymmetries between source language and target language (e.g., between SVO and SOV languages) may result in additional challenges for interpreters (Li, 2015). And these difficulties could be amplified due to the high cognitive pressure during interpreting. Gile (2010, p.182) stresses that although daily speech communication and interpreting share similar fundamental mechanism, interpreters at work could be more sensitive and vulnerable to small language-specific differences that do not pose significant problems in daily situations. Seeber and Kerzel (2012) investigated the impact of morphosyntactic differences between source language and target language on cognitive load during simultaneous interpreting and found that when verb-final and verb-initial structures in German were interpreted to verb-initial language such as English, the former structure triggered greater pupil dilation, suggesting higher cognitive load induced by word order asymmetry.

The notion of language specificity and language-pair specific factors have been frequently brought up and investigated in interpreting literature. Interpreting is a cross-language verbal activity which is quite sensitive to language-specific factors. And the effect of these factors on interpreting process and product can be much greater in language pairs such as English/German, English/Japanese and English/Chinese (Gile, 2004; Setton, 1993; Wang & Gu, 2014). Attempts have been made to examine the relations between language specificity and interpreting performance (e.g. Ahn, 2005; Riccardi, 1995; Wliss, 1978). German as a source language has been the main focus of research in this aspect. There is a significant amount of SOV or left-branching structures in German (Setton, 1999), which contrasts the canonical SVO word order in English. German/English interpreting is thereby believed to be more effortful than interpreting between syntactically similar languages and has become one of the most extensively studied language pair (Lederer, 1981; Wliss, 1978).

3.2.2 An Overview of Word-order Differences between English and Mandarin Chinese

Chinese, as one of the six official working languages of the United Nations, is a major non-European language widely adopted in interpreting practice. However, there has been few studies that systematically examine how language-pair specific factors impact on-line processing and production in English/Chinese interpreting. Setton (1999) gave an overview of the structural differences between modern standard Chinese and English and listed several features of Chinese that contrast most saliently with English such as the "pervasiveness of topic-comment structures", "the apparent fluidity of lexical categorical distinctions", "high lexical homophony" and "sparse referential tracking". Based on corpus-data, he also analyzed interpreters' on-line strategies when coping with asymmetric structures during Chinese-English interpreting. Only few empirical studies touch upon structural disparities between SL and TL in English/Chinese interpreting: Dawrant (1996) investigated cognitive difficulty derived from word order asymmetry in Chinese -English SI. With a focus on several specific Chinese sentence structures such as the DE structure, the ZAI structure and the CV structure, the author conducted a small-scale experiment to observe the strategies used by professional interpreters. The study found that word order difference was a major source of cognitive capacity constraint and interpreters tended to use cognitive load relieving strategies such as preserving linearity and anticipation to render Chinese-specific structures into English. Guo (2011) combined qualitative and quantitative analysis of word order patterns in both English-Chinese and Chinese-English SI by professional subjects and explored interpreting strategies to deal with structural asymmetry. Following a product-oriented approach, she found that most interpreters tended to adhere to original word order when they identified the information profile of source language; but when the source language information profile was not decided, interpreters preferred to wait until they decide the profile. The studies above highlight the structural divergence between English and Chinese and how these differences impact interpreting output and use of strategies. However, these limited literatures on structural differences are predominantly product-based analyses which focus on description of end product but do not uncover the on-line processing and its relations with the degree of word order differences. These gaps are expected to be filled in the present study.

This section gives an overview of the structural differences between English and Mandarin Chinese, in particular, the differences in terms of word order. In general, Chinese has been considered a topic-prominent language while English is subject-prominent language (e.g., Huang, Li, & Li, 2009; Li & Thompson, 1976, 1981). A Chinese sentence is generally composed of a topic and comment (Loar, 2011): Topic is what a sentence is about: "It always comes first in the sentence and it always refers to something about which the speaker assumes the person listening to the utterance has some knowledge" (Li & Thompson, 1976, p.15). Topic is also described as a component which sets a spatial, temporal or individual framework within which the main predication holds (Chafe, 1976). Topics are usually located at the initial position of the sentence to establish something of current interest or concern. And the rest of the sentence is the comment, which provides information relevant to the topic. Topic-comment structures play an important role in explaining the "flexibility" or "looseness" of Chinese sentence structures and also the difficulties in translating between Chinese and English: In Chinese, relationship among different elements is loose, open and pragmatic (Lambrecht, 1994). There are no absolute relations between topics and comments and their relations can only be understood as pragmatic relations which depend heavily on contexts. In contrast, relations between elements in English sentences have to be clarified and governed by strict grammatical rules. Therefore, problems may arise when translating sentences from Chinese to English or vice versa. For example, a topic-comment

Chinese sentence “bangongshi buzhun xiyan (辦公室不准吸煙)” would be implausible if literally translated into “The office does not allow smoking”in English since the topic “bangongshi (the office)” is neither syntactically nor semantically related to the rest of the sentence. Relations between “the office” and the comment can only be constructed as a relation of “relevance” or “aboutness”. To reconstruct this relations in English, word reordering and additions are required. In addition to grammatical relations, locations of different elements in Chinese sentences can also be highly flexible. Topic in Chinese generally appears at the initial position of the sentence but can take different linguistic forms such as noun phrases, verb phrases (including adjective phrases), prepositions and even clauses (Loar, 2011, p.395). In other words, although SVO is the canonical order of modern Chinese, other sentence structures such as OSV are also allowed as shown in the following example.

Example 3.2.2-1

OSV

這 本 書 我 很 喜 歡。

Zhe ben shu wo hen xi huan.

This CL book I very much like.

SVO

我 很 喜 歡 這 本 書。

Wo hen xi huan zhe ben shu.

I very much like this CL book.

Seen from the example above, the position of subject in Chinese sentences is more flexible. Sometimes, subjects in Chinese can even be omitted depending on the contexts as demonstrated in the following example:

Example 3.2.2-2

在天山的高處，常常可以看到巨大的天然湖, 湖面清澈見底。

Zai tianshan de gaochu, changchang keyi kandao judade tianranhu, humian qingchejiandi.

(At the high place of tianshan, (you) can often see huge natural lakes, the water is so clear that you can see the bottom.)

In this example, the subject "you" in its English version is omitted and the prepositional phrase is an adverbial of place which is also the topic of the sentence. The rest of the sentence, or the comment, conveys the information relevant to the topic.

In contrast to Chinese sentences, nearly all English sentences must have a subject and the subject typically comes before the verb (Chen, 2015). In contrast, topic appears to be prioritized in describing structure of Chinese sentences and there is no fixed position for the subject in Chinese (Li & Thompson, 1976, p.16). Therefore, sentence structure in Chinese and English are respectively characterized as "flexible" and "rigid" since most linguists agree that Chinese grammar is loose and covert while English is governed by strict grammatical rules. That is why Wang (1957) claimed English is a language under the rule of law and Chinese language is under the rule of man.

Li and Thompson (1976) listed three basic types of word orders in a sentence: SVO, SOV and VSO. For example, a language in which most sentences follow SOV order can be seen as a SOV language or verb-final language. But that does not mean that other word orders are not allowed, only that putting verbs at the end of the sentence is the typical and characteristic of the language. English is claimed to be a SVO language with verb generally occurring before the object. However, word order in Chinese is somehow elusive since the language itself is not established on very solid grammatical grounds. According to Li and Thompson (1976), no basic word order in Chinese can be established. Two reasons may account for the difficulties in identifying Chinese word order: 1) The way words and phrases are governed in Chinese depends to a larger extent on the topic or meaning of the sentence rather than on the grammatical rules. In other words, it is primarily semantic factors instead of grammatical ones that determine word order (Dawrant, 1996). 2) The notion of subject in Chinese has not been well-defined syntactically. Position of subjects in Chinese is very flexible: they can occur before or after the verb, and sometimes subjects are omitted if meaning can be inferred from contexts instead of being expressed syntactically by subjects (Li & Thompson, 1976, p.16). As mentioned before, Chinese is a topic-prominent language in which sentences can be more accurately described in terms of topic-comment relations rather than subject-predicate relations.

3.2.3 Relative Clauses in English and Chinese: Subject-extracted Structures vs Object-extracted Structures

This section reviews the frequently discussed issues regarding processing structural asymmetry of relative clauses in English/Chinese interpreting. Among all types of structural phenomena in the two languages, relative clauses are claimed to one of the most challenging structures for translating between English and Chinese in that they are more likely to cause errors, omissions or awkward expressions (Tsai, 2015). A relative clause (RC) is a clause that modifies the noun, such as “the boy that I met yesterday”. Relative clause occurs frequently in both languages but displays different syntactic properties, consituting a major problem trigger in English-Chinese interpreting. From the perspective of absolute complexity, it remains an open question how to define what counts as complex word orders in human processing system (Hsiao & Gibson, 2003). However, in terms of relative complexity, it is possible to explain why relative clauses can be regarded as complex word orders and certain type of relative clauses is more complex than others in English/Chinese interpreting.

First, in terms of correlations between the modifiers and the head noun, English and Chinese conform to distinctive branching directions. The most salient contrast regarding the word order of RC between the two languages is their preference in the principal branching for modifiers: Chinese is a left-branching language in which long strings of modifiers are located before the nouns while English is mostly right-branching which puts nouns before the modifiers (Setton, 1999; Shlesinger, 2003). To interpret relative clauses between the two languages, additional efforts are often required for restructuring, increasing risk of cognitive overload. And this risk may be amplified when original relative clauses are long and complex, with embedded inner structures (e.g., Shlesinger, 2003; Wang & Gu, 2016).

Second, relative clauses can be further divided into two types: one is the subject-extracted RC (SRC) and the other is object-extracted RC (ORC). In the former, the noun that the RC modifies is extracted from the subject position; in the latter, the noun that the RC modifies is extracted from the object position (e.g. Hsiao & Gibson 2003; Sung, Cha, Tu, & Wu, 2016). The following two examples demonstrate the subject-extracted RC and object-extracted RC in Chinese and their corresponding English versions:

Example 3.2.3-1

SRC structure:

上个月 拜訪 我們 的 *朋友* 出席了 这次 活動。

Shanggeyue baifang women de pengyou chuxile zheci huodong.

Last month visit us DE friend attended this activity (Literal translation).

The friend that visited us attended this activity (SRC in English).

ORC structure:

我們 上個月 拜訪 的 *朋友* 出席了 這次 活動。

Women shangeyue baifang de pengyou chuxile zheci huodong.

We last month visit DE friend attend this activity (Literal translation).

The friend that we visited last month attended this activity (ORC in English).

In SRC, the noun *pengyou* (friend) which is extracted from the subject position of the embedded verb, is understood as the head noun of the relative clause; in ORC, the noun *pengyou* (friend), is the head noun extracted from the object position. Matthews and Yip (2016) summarized several basic properties of relative clauses in Chinese, one of which is the “rigidity” of position of relative clauses: In both types of clauses, the relations between the head noun and the RC are restrictive: relative clauses that are introduced by the relativizer DE consistently precede the head noun and this feature also applied to other clauses that modify a noun. In contrast, relative clauses in English adhere to a reversed word order: relative clauses that serve as post-modifiers, always occur after the head nouns, and the relations between RC and head nouns can be either restrictive or non-restrictive (Chen, 2015).

Processing difficulty with respect to object-extracted RC and subject-extracted RC is subject to a variety of factors including cross-language variations, relations between head noun and relative pronoun and individual differences in processing speed, comprehension accuracy or working memory capacity. But it is commonly established that in English SRC is easier to comprehend than ORCs (Matthews & Yip, 2016) as evidenced by data behavior methods such as self-paced reading, eye-tracking and lexical decision tasks (e.g., Ford,1983; Gordon, Hendrick, Johnson, & Lee, 2006; Wanner & Marstasos, 1978). Generally, this SRC preference in English can be explained from two major theoretical accounts (Staub, 2010): the first is memory-based account which attributes greater difficulties in ORC processing to the greater working memory load imposed by ORCs (e.g., Ford, 1983; Frazier & Fodor, 1978; MacWhinney, 1987). In a relative clause, the head noun (such as friend/ pengyou in the above example) leaves an empty position called gap and the extracted head noun serves as the filler to fill the gap. Degree of difficulties for RC processing is largely dependent on the gap-filler distance as measured by number of nodes between these two elements (Hamilton, 1995; O'Grady, Lee, & Choo, 2003). In the case of ORC, the gap-filler distance is larger. Therefore, the gap (the head noun) has to be held in memory for longer to be integrated with the relative clause verb. In other words, the integration is further back in ORC constructions, which indicates greater memory burden (e.g., Gibson, 1998; Grodner & Gibson, 2005). The other explanation is made from perspective of expectation-based account which emphasizes the (in)congruency between comprehenders' expectation for upcoming sentence structure and the actual input (e.g., Levy, 2008). According to this claim, the relative pronoun is more likely to be followed by a SRC rather than an ORC and an SRC is thus preferentially expected by the comprehenders. To them, an ORC is more unexpected and difficult.

However, opinions vary regarding the processing preference in Chinese relative clauses. Previous studies that adopt corpus analysis, self-paced reading and linguistic models have yielded mixed results: for example, Lin and Bever (2006, 2011) conducted a series of studies on processing of embedded RCs in Chinese and found that the participants always spent significantly shorter time on reading SRCs than on ORCs; This SRC preference, however, was challenged by results of Hsiao and Gibson (2003) who demonstrated an ORC preference in Chinese.

These differences and controversies over the RC processing preferences in English and Chinese may impact the on-line comprehension and production of RC structures during English - Chinese interpreting. One major task is how to decode SRCs and ORCs in English and reformulate them in Chinese?

Example 3.2.3-2

Interpreting SRC from English to Chinese

Source speech: Afghanistan is suffering and its people demand *solutions* <u>that are practical, verifiable and durable</u>.

Target speech A: 阿富汗人民正飽受磨難，他們需要<u>實際，可行，持久的</u>解決方案。

(Literal translation: Afghanistan is suffering, they need practical, verifiable and durable DE solutions.)

Target speech B: 阿富汗人民正飽受磨難，他們需要方案，這種方案應該是實際，可行，持久的。

(Literal translation: Afghanistan is suffering, they need solutions, these solutions should be practical, verifiable and durable.)

Example 3.2.3-3

Interpreting ORC from English to Chinese

Source speech: Addressing the migration crisis is an enormous *challenge* <u>which we are working hard to resolve.</u>

Target speech A：解決移民危機是一個我們正在努力解決的巨大挑戰。

(Literal translation: Addressing migration crisis is an <u>we are working hard resolve DE</u> enormous challenge.)

Target speech B：解決移民危機是一個巨大挑戰，我們正在努力解決這個巨大挑戰。

(Literal translation: Addressing migration crisis is an enormous challenge, we are working hard to resolve this great challenge.)

Different strategies may be involved to interpret SRCs and ORCs from English to Chinese. As mentioned before, SRC is much easier to process than ORC in English. Subject-extractions involve shorter gap-filler distance and less integration cost, in other word, the integration is more local when processing subject-extraction structures, thus requiring less cognitive resources.

Therefore, interpreters may have fewer problems in performing comprehension-oriented operations when processing SRCs in English. As for target production, one solution to SRC in English-Chinese interpreting is restructuring, putting the English RC before the head nouns as shown in version A of Example 3.2.3-2. To restructure, interpreters have to first hold the head noun in storage and then integrate it to the incoming relative clauses. This is believed to impose greater memory burden on interpreters, particularly when RC as post-modifier is long and has embedded structures. The other option is to adhere to the original word order (linear preservation) and segment the sentence into two clauses as shown in version B of Example 3.2.3-2. This is actually one of the interpreting strategies emphasized in English-Chinese interpreting curriculum, which is supposed to avoid cognitive overload due to restructuring. The availability of segmentation implies that restructuring is only optional when dealing with English SRCs: interpreters can either resort to restructuring at the price of greater cognitive load or adhering to original word order by segmentation.

Situations may be more complex when confronted with ORCs in English-Chinese interpreting. First, evidence from psycholinguistics and neurolinguistics studies have shown that object-extraction structures in English are more difficult to comprehend than subject extractions. Second, at most cases, restructuring is compulsory to ensure that target language adheres to the norm of Chinese. As demonstrated in Example 3.2.3-3, interpreters also have two major options: they either put the ORC before the head noun or divide the original sentence into two clauses but addition ("this great challenge/這個巨大挑戰") is required to complete the clause and ensure coherence. That implies that ORCs consume more cognitive resources and are more likely to trigger capacity management crisis in English-Chinese interpreting.

To sum up, relative clause is a typical indicator of word order asymmetry between English and Chinese. Interpreting relative clauses, in particular, object-extracted relative clause from English to Chinese, involves restructuring beyond word or phrase level and is supposed to present greater difficulties. The on-line processing of ORC structures during interpreting remains to be systematically examined.

3.2.4 Passive Constructions in English and Chinese

In addition to relative clauses, another structure that merits attention in English/Chinese interpreting is passive constructions (PCs). Passive sentences are used in both languages, but they exhibit different syntactic and semantic features in English and Chinese. First, passives in English and Chinese take different linguistic forms: A typical passive sentence in English involves a subject, a copular verb and a past particle (Borsley, 2014; Xiao, McEnery,& Qian, 2006). The structure "be + past particle" is regarded as the norm for English passive constructions. In addition to "be", words such as "get" "become" "look" "feel" can also be used to form passive structure (Xiao et al., 2006, p.111). An English passive can be followed by a by-phrase which represents an "agent" and passives with agents are often referred to as "long passives". Sometimes agents of passives are omitted but implied by the context.

Compared with English, passive structures in Chinese are manifested by a wider range of devices. The most frequent and important passive form is formed with Bei(被). In Chinese passives, the nominal phrase that bears the role of patient occurs at the subject position while the agent phrase is located either in a position marked by the passive marker or merely does not show up

(Chappell & Shi, 2016, p.467). A typical passive sentence in Chinese is shown in the following example:

Example 3.2.4-1

小明　　被　　小王　　打了。

Xiaoming BEI Xiaowang hit-LE.

Xiaoming was hit by Xiaowang.

小明　　被　　打了。

Xiaoming BEI hit-LE.

Xiaoming was hit.

In Chinese, passives are introduced by passive marker “BEI” which expresses passive meanings with or without the Agent. “BEI” sometimes are replaced by other markers, such as “GEI（給）”, “JIAO(叫)”, and “RANG（讓）” . For example, the sentence in Example 3.2.4-1 can also be expressed as “Xiaoming RANG Xiaowang hit-LE”. One special phenomena concerning Chinese passives is “unbounded” dependency (Huang et al., 2009, p.124) as shown in the following example:

Example 3.2.4-2

小明被小王派人打了一頓。

Xiaoming BEI Xiaowang send people hit-LE.

Xiaoming was hit by people gathered by Xiaowang.

According to Example 3.2.4-2, Xiaoming was not hit by Xiaowang but it was Xiaowang who gathered the people to hit him. So the real agent of the event is Xiaowang and with the people serving as the agent of the sub-event that Xiaoming experienced. This unbounded dependency is a characteristic property of Chinese passives and has no direct correspondence in English.

In addition to the typical structure with explicit marker, there is another structure that does not have any passive markers or agents but fulfils semantic function of passives.

Example 3.2.4-3

產品　　都　買光了

Products all   sell out.

All products are sold out.

Seen from the example above, both passive markers and agents are missing, but akin to English sentence “the products sell well”, this sentence can be interpreted as a passive sentence.

Second, although passives in Chinese and English have some shared features, they perform different interpersonal functions. Passives in English are adopted primarily to "mark an impersonal, objective and formal style (Xiao et al., 2006, p. 143)" while PCs in Chinese are usually adopted to express adverse situations, indicative of negative semantic meanings (Chao, 1965; Xiao et al., 2006; Chappell & Shi, 2016). Chen (2015) classified the use of PCs in a Chinese novel and found that among 46 events described by passives, more than half expressed an unfortunate or undesirable event that happened to the subject, for instance:

Example 3.2.4-4

屋頂被颱風吹走了。

Wuding bei taifeng chuizou le.

(The roof was blown away by the hurricane.)

Third, passive constructions occur much more frequently in English than their counterparts in Chinese. Passives are nearly ten times as frequent in English as in Chinese, with short passive (passives without agents) as the norm of passive construction in English (Xiao et al., 2006, p.141-142). In contrast, Chinese exhibits a tendency to avoid passives or use passives in unmarked forms (Xiao & Dai 2010; Xiao 2010, p.28). For example, "This certificate must be issued", a typical English passive construction can be literally translated into "該證書就必須被頒發", but a native Chinese speaker is more likely to use "該證書就必須頒發(this certificate must issue)" to express the passive meanings (Xiao, 2010; Xiao & Dai, 2010;). These striking differences in frequency make passive construction a major problem trigger in English-Chinese interpreting since English passives have to be transferred to either non-passive structures or unmarked passives so as to adhere to the norm of Chinese.

These differences in language properties, functions and frequencies make passive, especially long passive a major problem trigger during English-Chinese interpreting: In most occasions, original English passives have to be reordered when translated/interpreted into Chinese (Qin & He, 2009, p.225) as illustrated in the following example:

Example 3.2.4-5

Interpreting PC from English to Chinese

Source speech: Our foreign policy is supported by the people all over the world.

Target speech A: 我們的外交政策受到了世界各地人民的支持。

(Literal translation: Our policy gets people all over the world DE support.)

Target speech B: 我們的外交政策受到了支持，世界各地人民都支持。

(Literal translation: Our policy get the support, people all over the word support.)

As shown in the above sentence, it is necessary to retain the passive voice when translating or interpreting English long passives into Chinese, which requires changing position of the agent. However, linear processing is also acceptable by segmenting the source sentence into two clauses, which is recommended in interpreting but may impact the naturalness of the target expression. The choice of strategy to deal with long passives in English-Chinese interpreting is constrained by a variety of factors such as interpreters' expertise, the available cognitive resources and interpreting norms.

Drawing upon categorizations in previous literature and the specificity of interpreting (e.g., Qin & He, 2009; Tsai, 2015), I divide strategies for interpreting English passives into four major types: a). Converting passive voices into active voices/converting passive structures into active structures; b). Retaining the original passive structures; c). Replacing passive voice with other structures: one possible way is to translate passive sentences into "BA"constructions (把字句), for example, "The hotel was destroyed by this big fire" can be interpreted into "大火把這家旅館燒毀"; d). Omission of the passive sentence, which is quite possible due to cognitive overload or interpreters' strategic decisions.

3.3 Effect of Word Order Asymmetry on Interpreting

3.3.1 Exploring Relations between Source Language Complexity and Interpreting Performance

Language complexity has been studied as a potential problem trigger in interpreting. Many scholars pointed out the possible relevance of source language complexity to interpreting process in that complexity may result in additional processing effort (e.g., Goldman-Eisler, 1972; Gile, 1997). Most studies in this field deal with complexity at a more general level: complexities are either manipulated based on certain linguistic metrics or simply determined on judgement made by researchers themselves.

Shreve, Lacruz and Angelone (2010) manipulated syntactic complexity of the stimuli texts and used eye-tracking to investigate whether interpreters would suffer a syntactic effect during sight translation. Eleven students enrolled in translation program took part in the study and were instructed to sight translate two Spanish texts into English. One paragraph was manipulated to create two versions: version A and version B. The two versions were identical in meaning, length and vocabulary excerpt for a specific AOI (Area of Interest) segment that was syntactically manipulated. Version A consisted of a first paragraph with syntactically non-complex sentences and a second paragraph with complex sentences, and vice versa for version B. But as stated by the authors, "operational definitions" of syntactic complexity was quite informal, primarily based upon the researchers' perception and experience. Eye-tracking was used to record participants cognitive behaviour when they sight translated these two versions of source texts and eye movement data was analysed by text version. Results showed that the version A revealed an expected syntactic effect as seen by more and longer fixations and more regressions, but no similar pattern was found in version B. The researchers ascribed this to the interaction between syntactic complexity and other confounding factors such as task orders and fatigues.

However, further studies based on different manipulation methods of source language complexity have yielded mixed results. Some researches failed to detect disruptive effect of syntactic complexity on interpreting process and product while some found that complexity effect was modulated by level of expertise. Hild (2011) reported on the effect of increased linguistic complexity on processing during simultaneous interpreting by examining skill-related variation as a result of changes in syntactic complexity. Different approaches including linguistic approach, psycholinguistic approach and approach of natural language processing were introduced to illustrate difficulties in creating one single assessment yardstick. A variety of methods for complexity measurement grounded in these approaches have been proposed, and in this study textual redundancy was adopted as one dimension of language complexity. Transcriptions of two audio recordings were first controlled on a set of lexical, syntactic and discourse parameters to ascertain that the source texts are comparable and similarity between the two texts were confirmed by the Flesh-Kincaid grade index of readability. Then the texts were submitted for manipulation of redundancy based upon cohesion, new information units as well as pleonastic and parasitic discourse segments. Blind analysis by the raters showed that one of the texts has a notably higher level of redundancy than the other, thus being supposed to pose greater challenges for high-order language processing. In addition, four measuring metrics with a focus on syntactic control, i.e. amount of embedding, developmental level (DL), clause type and subordination type were employed to further control the linguistic complexity. The study adopted a quasi-experimental design with two variables: text complexity and expertise. Two groups of populations, expert interpreters and novice interpreters were tested separately and were required to interpret the manipulated English materials into their A language. Data analysis revealed a strong relation between linguistic complexity and interpreting performance: as the level of complexity increased, there was a systematic degradation of interpreting quality indicated by more errors and omissions. The study results demonstrated that all four syntactic metrics increased cognitive load and affected interpreting performance, in particular, the novice group was consistently impacted by these metrics, indicating the importance of syntactic awareness in daily training. However, expert processing was less susceptible to syntactic complexity, which suggests that performances of advanced interpreters are more related to factors other than syntactic properties.

Conclusion made by Hild (2011) appears to deny the intuitive belief that syntactic complexity contributes to the rise of cognitive load and degrading performance in interpreting, and this was replicated in another study by Chimel and Muzur (2013). One of their research goals is to measure the relations between on-line cognitive load and sentence types during sight translation. A group of first and second year interpreter trainees whose A language was Polish and B language was English participated in the study. Considering the syntactic divergence between Polish and English, two types of English source sentences were designated: simple SVO sentences and complex non-SVO sentences. It was assumed that translating non-SVO sentences into Polish would involve greater cognitive load as compared with translating SVO ones. Eye-tracking was adopted to record the on-line processing of the participants. Data analysis showed that simpler sentences generated greater cognitive load for both first and second year students, as evidenced by more and longer fixations than the complex sentences, which contrasted the previous assumption and intuition. The authors then decided to redesign the source variables by replacing structure complexity with degree of readability. Average sentence length and word length were manually calculated and tested by Flesch Formula. And it turned out that readability was a better indicator of processing difficulty than SVO vs non-SVO sentence distinction in interpreting.

Results of studies above are at variance with each other, which can be accounted for by a series of factors, such as level of expertise, control of linguistic complexity, language combinations and different task designs. It comes as no surprise that word order difference did not stand out as one single prominent issue in these studies, even though some touched upon it and adopted asymmetric sentence structures (SVO vs SOV) as one of the parameters. One possible reason could be that language pairs discussed in studies above (English/Spanish, English/Polish) are not as structurally divergent as language combinations such as Chinese vs English or English vs German, word order asymmetry itself does not constitute a major challenge when compared with complexity measures at more general level such as sentence length, syntactic rules and readability.

Therefore, to gain a deeper view of language complexity, especially word order asymmetry, it is necessary to consider language pairs who differ strikingly in linguistic systems.

Among the limited amount of literature on word order issues in interpreting, only few are devoted to structural differences between English and Chinese and mainly examine the issue with a product-oriented approach and focus on interpreters' use of strategy. One of the first empirical attempts was made by Dawrant (1996) who conducted a small-scale experiment on professional interpreters in Chinese-English simultaneous interpreting and observed how strategies were used to address specific Chinese sentence structures. Several asymmetric structures were first identified as potential problem triggers including the coverb (CV) structure, the DE structure and the locative construction introduced by "zai" (the ZAI structure). Results showed that the interpreters tended to use cognitive load relieving strategies such as anticipation and preserving linearity (interpreting following the word order of the original message) to address word order differences. The findings also revealed that source language interference due to structural asymmetry prevailed in interpreting and constituted a major source of cognitive load. To cope with word order asymmetry in simultaneous interpreting, efficient use of interpreting strategies was required. Following the basic design of Dawrant, Guo (2011) conducted an analysis of word order patterns in Chinese-English and English-Chinese simultaneous interpreting. A combination of quantitative and qualitative was adopted based on transcription of audio files and time points calibration. Uncertainty and memory load due to SV and SVO structures were measured under a set of formulas. A group of professional interpreters took part in the study and word order patterns of their target expression were systematically examined. Results showed that the strategy use was primarily constrained by the information profile of source speeches and memory load induced by word order differences also played a role in interpreters' decision making.

Two recent studies examine effect of word order asymmetry in English/Chinese interpreting. Wang and Gu (2016) focused on the structural asymmetry between English and Chinese in simultaneous interpreting. One prominent difference regarding syntactic rules is that English sentences are dominated by right-branching structures while most Chinese sentences are governed by left-branching structures. It is thus assumed that the distinct structures would cause additional difficulties and impact interpreting performance. They analysed on-site interpretations of three interpretations of the same speech based on naturalistic observation. A small corpus was set up consisting of one English source speech and three target speeches rendered by three Chinese interpreters. And all right-branching sentences in English and their corresponding Chinese texts were extracted from the corpus for further analysis. The results confirmed the adverse impact of word order asymmetry on English-Chinese interpreting, which was evidenced by higher frequency of pauses and more unnatural pauses in the interpretations. And to cope with structural differences, interpreters adopted different tactics such as waiting and segmentation but use of certain strategies increased the risk of information loss and more errors. Similar patterns were found in interpreting into the other direction: Wang and Zou (2018) conducted a corpus-based approach to the role of word order asymmetry in Chinese-English interpreting. It was one of the first systematic explorations that focus on structural asymmetry in consecutive interpreting from Chinese to English. Data analysis was based on the parallel corpus of Chinese-English Interpreting for Premier Press Conferences (CEIPPC) and the focus of analysis was how attributive modifying structures in Chinese, which is generally located before the modified element, are interpreted into English, a typical back-loaded language. Results showed that most pre-loaded structures in Chinese were translated into back-loaded English structures or a mixture of front- and back-loaded structures. This suggested that additional cognitive load was required to cope with these asymmetric structures, which was corroborated by data results from a study of comparable corpus made up by the interpreted English texts from CEIPCC corpus and also the original English texts from the corpus of daily press briefings by the U.S. government. These two descriptive studies prove that word order asymmetry between English and Chinese disrupt interpretations into both directions. In addition, they emphasize the necessity to consider structural asymmetry as an important factor in both interpreter training and theories with respect to interpreters' cognitive behaviour.

However, few attempts have been made to explore effect of word order asymmetry on cognition process during English/Chinese interpreting. More empirical data from experimental research is expected to enrich the current product-oriented knowledge on word order asymmetry by revealing the cognitive mechanism involved in addressing asymmetric structures.

3.3.2 Major Strategies to Address Word Order Asymmetry in English-Chinese Interpreting

Linguistic studies suggest that syntax is one of the decisive factor that impacts the choice of processing strategy (Kirchhoff, 2002). Although the role of word order asymmetry remains an issue of ongoing debate, Donato (2003) argues that interpreters can never easily forget the structures of source language and language-specificity. Word order asymmetry increases burdens on cognitive resource management and thus need be addressed by specific strategies.

A considerable amount of discussions have been devoted to strategies in interpreting. The notion of "strategy" in interpreting studies was first developed based on concepts from other fields such as second language acquisition (Bartłomiejczyk, 2006). Lörscher (1991) borrows the concept by Færch and Kasper (1984) and defined translation strategy as a conscious procedure for solving a problem; Kalina (1998) emphasizes that a strategy is intentional and goal-oriented. To highlight its relevance to interpreting, Bartłomiejczyk (2006) further defines interpreting strategies as methods that help solve specific problems encountered during interpreting, facilitate interpreting performance and prevent potential errors.

There are different classifications of interpreting strategies depending on interpreting contexts, interpreting modes, language combinations and different stages of interpreting. Strategies to cope with word order differences are generally seen as language-pair specific strategies (Li, 2015). Many scholars support the notion of language specific strategies in response to syntactic asymmetries in interpreting (e.g., Donato, 2003; Gile, 2002; Kalina, 1998). And language-specific strategies can be generally divided into two types: segmentation and restructuring. Gile (1990) believes that syntactically divergent languages impact the use of on-line strategies: interpreters have to chunk the original sentence or to restructure the source sentence. Setton (1999) proposes four major strategies for simultaneous interpreting, i.e. waiting, stalling, chunking and anticipation. Guo (2011) reclassifies these strategies into two main types: chunking (or segmentation) and restructuring from the perspective of English-Chinese structural asymmetry:

1) Segmentation

Segmentation, also known as chunking, is a coping tactic that divides original sentence sequentially into several shorter segments (Jones, 2014; Ahrens, 2017) and has been widely taught as an effective strategy to deal with structural differences in sigh translation (e.g., Wan, 2005; Qin & He, 2009). Yang (2005) regards segmentation as one of the most critical strategies to acquire in sight translation when long and complex sentences are encountered. One important principle of segmentation is that interpreters typically process the sentence by following the original word order, which is labelled as "preserving linearity" by the Beijing School (Setton, 1999; Zhong, 1984).

Segmentation should be based on unit of meaning. It is the smallest unit that triggers a meaning representation and can be interpreted into target language. The size of meaning unit in interpreting is not only determined by interpreters' expertise but also the available amount of cognitive resources. Thus Jones (2014) suggests that a meaning unit can be a short word but should not be longer than a sentence. To connect the units of meaning, flexible linking methods are required (Qin & He, 2009) and in sight translation, segmentation primarily is driven by syntactic cues (Ahrens, 2017). But there are no fixed rules on where to segment and how to segment since the segmentation method varies from one to another.

2) Restructuring

Restructuring is another strategy frequently adopted to address word order asymmetry (Donato, 2003; Wliss, 1978). By restructuring, certain phases or elements in source language are put into different locations in target language. In most situations, restructuring is compulsory due to the fundamental differences in sentence orders. For example, to interpret English back-loaded structures into Chinese, interpreters need change the order of the post-modifiers to formulate a front-loaded structure so as to obey the grammatical rules of Chinese.

Restructuring is believed to increase cognitive load during interpreting (Guo, 2011; Wan, 2005) in particular, the short-term memory load. When coping with syntactically different languages, interpreters have to first store certain processed segments in short-term memory and at the same time attend to the unfolding message so as to integrate the stored part to the new information, which may have a taxing effect on the limited cognitive resources.

The following example illustrates how a sentence can be processed with both segmentation and restructuring:

Example 3.3.2-1

Source speech: Addressing the migration crisis is an enormous challenge which all European countries should face up to and work hard to resolve.

Target speech A (Segmentation): 解決移民危機是一項巨大的挑戰，所有歐洲國家都應直面并努力應對這項挑戰。

(Literal translation: Addressing the migration crisis is an enormous challenge, all European countries should face up to and work hard to resolve this challenge.)

Target speech B (Restructuring): 解決移民危機是一個所有歐洲國家都應直面并努力應對的巨大挑戰。

*(*Literal translation*:* Addressing the migration crisis is an <u>all European countries should face up to and work hard to resolve DE</u> enormous challenge.)

The above example shows that both strategies can be used to cope with the relative clause (back-loaded structure) in English. By segmentation, the whole sentence is divided into two separate clauses with "which" as the cutting point. When restructuring is applied, the back-loaded relative clause in source speech is relocated before the "challenge (挑戰)" in the target speech. In real interpreting, the choice of strategies can be affected by a variety of factors such as source speech difficulties, cognitive resources, and interpreting expertise. One of focuses in the current study is on interpreting trainees' use of strategies when they deal with asymmetric structures, in particular, how interpreters' on-line decision is related to cognitive processing.

3.4 Working Memory and Processing Word Order Asymmetry in Interpreting

3.4.1 Working Memory and its Role in Syntactic Processing

Working memory (WM) is defined as a system for temporarily storing and processing information while performing higher order cognitive tasks including comprehension, learning and reasoning (Baddeley & Logie, 1999). According to the best-known and most widely applied model of WM (Baddeley & Hitch, 1974), WM is made up of three major components: Two parallel storage-based subsystems called the phonological loop and the visuospatial sketchpad which are regulated by a higher-level control system—central executive. The central executive, understood as "a limited capacity pool of general processing resources (Carroll, 2008, p.48)", is responsible for regulating and controlling information obtained through the two subsystems. The phonological loop generally refers to a temporary store of verbally mediated information including sound and language and can be further split into the phonological store and the articulatory rehearsal system. It is generally assumed that information has to be sub vocally articulated by the articulatory system before being retained in the phonological store. The visuospatial sketchpad temporarily maintains visual and spatial information (Baddeley & Hitch, 1974; Baddeley & Loggie, 1999). In other words, Baddeley and Hitch's WM model has two subsystems for information storage in verbal and visuospatial domains and one supervisory system which controls and coordinate the information flow through the two slave systems (e.g., Baddeley 2000, Baddeley & Hitch 1974, Hitch, 2005;

Kim, 2010; Kim, Christianson, & Packard, 2015). Among the three major components, the central executive is critical: Considering the limited mental resources available for the cognitive task, the allocation of these resources becomes crucial for whether the task could be completed successfully. That is why the function of central executive is of paramount significance in cognitive processing.

WM, an integration of storage and ongoing processing, is critical in language comprehension and production. Consider a very common situation: during a daily conversation with others, we try to hold onto the message conveyed by others and at the same time ponder on how to respond, which is a simplified but typical example of storage and processing. As the previous literature indicated, WM is clearly associated with language processing tasks including both L1 processing and L2 processing. Since the establishment of WM concept, psycholinguists have been intrigued by the relations between WM and language processing, in particular second language acquisition. Issues such as whether WM has a direct impact on language processing and the magnitude of potential WM effect in language tasks have been one of priorities of WM-related studies.

It is well-acknowledged that WM is closely linked to sentence processing but the strength of that link depends on the language mode: Evidence from neuroimaging studies demonstrates that brain activation patterns in working memory tasks are more complex when the tasks are performed in L2 than in L1 (Ardila, 2003). This can be attributed to the fundamental differences between the underlying mechanism in L1 processing and L2 processing (Meisel, 2011): In most cases, processing in L1 is implicit, unconscious and effortless (Wen, 2015, p.47), which places little demand on the cognitive resources such as WM. In contrast, demand during L2 processing for WM resources can be much greater due to limited language proficiency (e.g., Hernandez & Meschyan, 2006). It has been proved that WM effect is more significant in L2 processing tasks such as sentence comprehension (Chun & Payne, 2004; Harrington & Sawyer, 1992) and syntactic parsing (Juffs, 2005; 2015). That is why increasing attention has been paid to relations WM and L2 processing. A clearer understanding of relations between WM and L2 sentence processing can offer information about L2 learners' processing preferences, on-line decision-making, cognitive constraints and individual variations (e.g., Dai, 2015; Juffs & Harrington, 2011).

One major concern of studies on WM and sentence processing is the effect of WM on syntactic processing. A large body of studies focus on the relations between working memory capacity and efficiency of processing complex syntactic structures. Researchers are interested in whether processing mechanism in L1 is transferrable to processing under L2: It is generally assumed that as compared to processing simple and unambiguous structures, processing of complex sentences, which involves longer reading time and perhaps reanalysis, may increase the storage and integration cost and is thus impacted by WM resources to a larger extent (Juffs, 2015, p.126). Complex structures such as long distance why-movement and relative clause attachment ambiguities are widely adopted as stimulus in this line of research (Dussias, 2003; Juffs, 2005).According to King and Just (1991), part of individual differences in syntactic processing can be accounted for by variation in working memory capacity: readers with lower working memory span spent more time reading objective relative sentences and their comprehension was also less accurate although provided with pragmatic information. Follow-up studies show that readers with higher WM have processing advantages when parsing syntactically complex sentence structures since they can retain information longer and integrate information more efficiently (Santamaria & Sunderman, 2015, p.207). However, studies on L2 learners indicate that individual differences in WM cannot explain L2 learners' response to certain complex structures. For example, Juffs (2015) deployed self-paced reading task to compare the reading time between learners of English as second language and native speakers of English when they process why-extractions but found no marked WM effect. Similarly, Felser and Roberts (2007) examined on-line processing of why-dependencies in a cross-modal task by native speakers and advanced L2 learners and found that L2 learners were not affected by working memory capacity when processing experimental sentences, which implies that strategies and cognitive mechanism for syntactic processing differ between L1 and L2. The different results from studies on native speakers and L2 learners motivate explorations of mechanism in L1 and L2 parsing by the same group of participants. It is assumed that WM will play a more substantial role in syntactic processing when readers' second language is typologically distant from their native languages. Dai (2015) combined on-line self-paced reading tasks and off-line questionnaires to investigate how low-intermediate Chinese L2 English learners process relative clause attachment in both English and Chinese, two typologically different languages. Results show that there is not any noticeable WM effect in L1 parsing but in L2 RC attachment, higher WM elicited significantly longer reading time, contradictory to previous findings that WM facilitates RC processing or has no effect. Dai's study suggests that the role of WM is quite limited in L1 parsing since processing in native language is not highly demanding and syntactic processing in L2 is not purely structure-based but influenced by semantic and pragmatic information. As for the adversary role of WM in L2 parsing, one possible explanation is that individuals with high WM span maintain all information in parallel, which increases their processing load and elicits longer response time, while those with low span generally process faster (Just, Carpenter, & Keller, 1996).

3.4.2 Working Memory and Interpreting

Interpreting is one of the most demanding language processing task: Source information is presented continuously, and the interpreters have to comprehend and store it in short memory. At the same time, they also need to reformulate this input to the other language accurately and fluently (Christoffels, De Groot, & Kroll, 2006). SI is an extreme manifestation of multi-tasking with comprehension and production taking place concurrently, which requires not only information storage but also efficient switching between different sub-tasks. It is established that interpreting is a complex cognitive task in which both information retention and cognitive management are involved. Therefore, WM is considered as one of the cognitive cornerstone of interpreting (Darò, 1989). Although WM is thought to be critical in success of interpreting, it has been seldom applied to interpreting aptitude test, neither has WM training been incorporated to existing interpreting curriculum. This discrepancy is a reflection of controversies over relations between WM and interpreting.

Actually, the concept of WM has been brought up by some interpreting process models to highlight the importance of attention control. Based upon the classical WM model by Baddeley and Hitch (1974), Daro and Fabbro (1994) proposed the process model for SI to illustrate how WM and long-term memory interact during interpreting. Different from the model by Baddeley and Hitch, Cowan (1988, 1995) proposed the embedded-processes model of memory. According to Cowan, within human-memory system, most of elements are relatively inactive but some elements are above the threshold of activation which is the short-term memory. Among the activated short-term memory, only a small part falls into the focus of attention (FOA), which are highly activated and directly assessable to consciousness. Inactive elements in long-term memory are not WM, but if they receive enough attention and are activated, they can become part of WM.

In Cowan's model, WM is conceptualized as an activated subset of long-term memory and the threshold of activation, thus the flow of information in and out of FOA is regulated by a central executive component. The influential Efforts Model by Gile (2010) also echoes the concept of WM. Effort model is proposed to depict the non-automatic operations and emphasize the limited processing capacity during interpreting. In all types of effort models, M stands for memory efforts which supports the functioning of other efforts but Memory Effort should be distinguished from the concept of WM despite some shared ground between the two. The Memory Effort is more generic, referring to the short-term memory operations in interpreting (Gile, 2010, p.154-155) while WM is more specific. Working memory, based on contemporary views, is responsible for not only maintenance of information but also the control and coordination of information in the face of distractions (e.g., Conway et al., 2005). The scope of Memory Effort is much narrower since it only refers to a temporary store of information while WM is assumed to be "a cognitive component combining storage, processing and executive control (Timarova, 2008)" of the cognitive task. Although Memory Effort and WM differ in constructs, the essential role of WM, especially the management of mental resources, is recognized in the Effort Model. As stressed by Gile, this "intuitively recognizable (2010, p.156)" model was established mainly for pedagogical purpose to help interpreters and interpreting students better understand the cognitive operations in interpreting.

WM is not only speculated in theoretical models but also examined by considerable amount of empirical studies. Dong and Cai (2015, p. 63) categorized existing WM-related interpreting studies into three types: 1) studies testing whether expert or professional interpreters have advantages over novice interpreters or non-interpreters in WM; 2) studies exploring the relationship between WM and interpreter training; 3) studies that investigate how WM as one crucial sub-component of interpreting expertise relates to the complex operations of interpreting and other interpreting-related sub-skills.

The majority of current studies focus on discovering the relationship between interpreting expertise/proficiency and working memory and testing whether professional interpreters outperform novices or non-interpreters in WM-related tasks (Timarova, 2008). Some studies find evidence for interpreters' superiority in working memory, for example, Padilla et al. (1995) used free recall tasks with/without articulatory suppression, digit span and reading span to measure memory skills of professional interpreters, non-interpreters, students who received some interpreting training, and student who had been trained only in translation. Results revealed that professional interpreters performed better than the other groups in memory span tasks and free recall with articulatory suppression, which suggests that as compared with non-interpreters, well-trained interpreters have advantages in working memory and are less disrupted by phonological interferences. This result was replicated by Padilla et al. (2005) using similar design and participants with similar background. Interpreters' superiority in WM was also detected in other tasks: Christoffels et al. (2006) compared performances of trained interpreters, high proficient language teachers and bilingual students in word retrieval tasks, reading and speaking span test and control tasks. Results showed that the interpreters outperformed the students in both language tasks and memory tasks but they only scored better than the teachers in memory measures, implying that performance in language tasks are primarily driven by linguistic proficiency and working memory advantage is the result of interpreting training. More evidence in favour of interpreters' WM advantage has been found in further studies (e.g., Signorelli, Haarmann, & Obler, 2012; Tzou, Eslami, Chen, & Vaid, 2012). However, not all studies confirm interpreters' superiority in WM related tasks. For example, no WM advantage of interpreters was found by Liu et al. (2004). The participants in this study included professional interpreters, advanced student interpreters and beginning student interpreters. The authors measured their WM capacity by listening span tasks and also examined their SI performance. Although the groups differ strikingly in terms of interpreting performance, inter-group differences in WM capacity failed to reach significance. The results suggest that it is interpreting skills rather than WM capacity that lead to differences in SI performance. Similarly, no interpreter advantage was detected in digit span or word span by Köpke and Nespoulous (2006). The contradictory results regarding interpreters' WM advantage as mentioned above can be attributed to a series of confounding factors including participants' selection, interpreting experience and age, L2 proficiency and some methodological factors (Dong & Cai, 2015; Morales, Padilla, Gómez-Ariza, & Bajo, 2015; Yao, 2012), which highlights the importance of better variable control to ensure research validity.

In addition to studies on interpreters' memory advantage, another line of research focuses on the role of WM in development of interpreting competence. Researchers are keen on identifying the relations between WM capacity and interpreting training. Some believe that WM capacity development is the result of extensive interpreting training while some others only consider WM capacity as a prerequisite for interpreting training: only those with inherent great WM capacity decide to pursue this profession (Christoffels et al., 2006). One approach to this controversy is longitudinal study to test whether there is noticeable improvement of interpreter trainees at the beginning and at the end of the training (Tzou et al., 2012): Zhang (2008) conducted a longitudinal study on participants with different levels of interpreting competences: WM capacity of all participants was tested twice, with the two tests separated by six months. Results showed that extensive interpreting training was more conductive to beginning interpreting students, their WM capacity improved significantly in half a year. In contrast, the effect of interpreting training/practice was not noticeable on professional interpreters and advanced interpreting students. Similar results were observed by Chmiel (2016) who adopted a longitudinal study to explore effect of interpreting training on working memory of conference interpreter trainees. The author compared the performance of professional interpreters, interpreting trainees and non-interpreter bilinguals in L2 reading span task, L1 reading span task and listening span task. The trainees were tested at the beginning of their training and at the end of the training two years later. The study indicated that prolonged interpreting training can boost working memory capacity, which also predicted interpreting performance. Cai, Dong, Zhao and Lin (2015) approached the issue from the other way around to see if WM capacity plays a part in development of interpreting proficiency. Longitudinal data was collected from interpreter trainees on WM span tests, language proficiency tests and consecutive interpreting performance. The students were tested twice, at the beginning and at the end of a 10-month academic year. The authors controlled the starting point for the interpreting skills so as to see whether progress in interpreting differs among students with different WM capacity. Statistical analysis revealed that as compared with WM capacity, language proficiency was a stronger predicator of students' variance in consecutive interpreting, in other words, students' progress in interpreting skills was not directly related to WM capacity.

As compared to the first two types of research, there is a dearth of studies on the role of WM in specific interpreting sub-skills. WM is actually a hierarchical construct that taps into both domain-general elements and domain-specific elements. This hierarchical view suggests that more work is to be done on relationship between WM and certain components of interpreting including meaning integration, syntactic processing and production. The issue of whether and to what extent WM affects processing syntactically complex sentences in interpreting has remained unresolved.

3.4.3 Working Memory and Syntactic Complexity in English-Chinese Sight Translation

The widely held view on L2 acquisition is that if learners have great WM capacity, they would be equipped with larger amount of processing resources which enables them to process syntactic forms and semantic meanings at the same time. Besides, learners with larger WM capacity can make full use of contextual information to integrate forms and meanings. (Macdonald, Just, & Carpenter, 1992). Based upon the literature introduced above, WM capacity partly explains variation in processing complex sentence structures, which has been supported by studies in both L1 and L2 condition. However, there is a scarcity of studies on relations between WM capacity and syntactic processing in interpreting, in particular, whether interpreters with great WM capacity can better cope with complex structures in sight translation.

WM is not only limited by the number of concurrent tasks being operated but also by the amount of information that can be kept available for processing (Timarova, 2008). This limited nature of WM resources poses a several challenge to syntactic processing in sight translation. In normal comprehension or production, retention of some chunks and integrating them to incoming input is largely effortless (Kamide, Altmann, & Haywood, 2003) without time constraint. But previous studies on L2 syntactic processing indicate that complex structures elicit longer response time for comprehension and this syntactic effect is more salient when the language to be learned is typologically different from the learner's L1 (Williams, 1999). It is highly possible that this syntactic disruption would be amplified under sight translation, leading to not only longer response time but also comprehension failure or disfluency. Constrained by both time and WM limit, parsing becomes more difficult and this difficulty might be reinforced during English-Chinese sight translation when interpreters have to struggle with both visual interference and word order differences.

WM capacity is of major relevance to syntactic processing, in particular when sentences are syntactically complex. Some structures in English that are rare or absent in Chinese can be more difficult to process and understand. Wan (2005) believes it is possible that when working between two distinct languages like Chinese and English, interpreters have to adopt a wait-and-see approach, by keeping some information in mind until the enough meaning information has unfolded. Christoffels et al. (2006) point out that many language combinations differ in word orders. Therefore, the interpreter may have to wait for the verb that may conclude a sentence in one language (e.g., German) but that needs to be produced early in the translation in another language (e.g., English). This also holds true for English/Chinese interpreting. According to Gile (2010, p.168), syntactic complexity of source language is one major obstacle in sight translation: when sentences are long or contain a high frequency of embedded clauses, the sight translator may have to "read much more than one translation unit" before reformulation, and this can increase the time and memory effort since interpreters have to retain more information before having enough input to re-express it in the target version. Similarly, Christoffels et al. (2006) illustrate this paradox between "waiting" strategy and memory load: On one hand, the longer the time lag is, the more likely it is that potentially occurring ambiguities or misunderstanding have been resolved by the context since interpreter store more information in memory which ensure a more complete understanding. However, when the lag is long there is more information to be held in memory than when the lag is short. In short, the problems in sight translation caused by syntactic complexity can be narrowed down to one issue: how to coordinate the storage of previous information and integration with later information to formulate a complete target version.

In terms of syntactic complexity, relative clause is a case in point: Although relative clauses exist in both languages, they employ different word orders in the two languages and require restructuring when transferred between each other. Chinese RCs consistently occur before the head nouns while in English, RCs are always placed after the head noun. Due to this difference, interpreting RC structures from English to Chinese may trigger extra switch cost and it is under this condition that WM may play a crucial role: The storage and integration cost for coordinating two distinct linguistic systems might reduce the available cognitive resources, moreover, interpreters need effectively allocate their limited attention between "waiting(storage)" and "seeing(integration)". WM thus becomes quite crucial since interpreters with larger WM capacity can store longer segments in mind while waiting for the new information and also better coordinate different sub-components in STR.

In discussions on greater difficulties induced by complex sentence structures such as relative clauses, memory-based account has been adopted as one major explanation: it highlights the role of cognitive resources or working memory in sentence comprehension and parsing: the difficulty increases when the sentence structure becomes more complex (e.g., Ford, 1983; Frazier & Fodor, 1978; MacWhinney, 1987; Wanner & Maratsos,1978). The basic underlying assumption is that certain words or segments have to be held in memory until being integrated into the incoming words during which storage cost and integration cost are required. The more complex the structure is, the greater cognitive load is generated.

Therefore, it is feasible to assume great WM capacity is conductive to syntactic processing during STR. By examining how individuals with different levels of working memory competence deal with syntactically complex sentences, especially when SL and TL differ significantly in word order, we could have a better view of the relations between working memory and sentence processing in STR, which may have some pedagogical implication and also shed new light on interpreting aptitude test.

3.5 Summary

The key notion of this chapter is word order asymmetry, an issue of ongoing debate in interpreting studies. Despite the conflicting views on its negative effect, evidence from empirical studies has supported that word order asymmetry should be seen as a potential problem trigger during simultaneous interpreting.

This chapter first approaches word order asymmetry from the perspective of language complexity. Definition of complexity in linguistic study has been elusive since complexity is a multi-dimensional concept. This study emphasizes the relative complexity of languages in that some language properties labelled as complex by objective indexes do not necessarily cause difficulties for certain groups of language users. Word order asymmetry is just a case in point. As the typical manifestation of language specificity, word order asymmetry is supposed to increase cognitive burden when translating between language pairs that differ strikingly in sentence structures.

The author gives an overview of word order differences between English and Chinese by highlighting two specific structures: relative clauses and passive constructions, and previous studies indicate that processing English object-extracted relative clause is more effortful than processing subject-extracted ones.

Some studies examined the structural complexity or word order differences between European language pairs with mixed results. There is also a limited amount of literature on word order asymmetry in English/Chinese interpreting, but most studies rely upon product-oriented approaches: The primary focus of analysis is interpreter' performance in dealing with asymmetric structures such as accuracy and delivery speed (Barik 1973; Darò, 1989). In recent years, descriptive studies are conducted based on corpus data at authentic working conditions (e.g., Wang & Gu, 2016, Wang & Zou, 2018) with a focus on specific strategies to address structural problems. Although most of these studies have offered evidence favoring negative impact of word order asymmetry, there is no direct measure of the cognitive load during interpreting process, thus failing to identify the relations between the syntactic asymmetry between the languages involved and the mental effort experienced by interpreters. Moreover, how on-line processing is related to interpreters' end product remains an uncharted territory.

At the end of this chapter, working memory is singled out as one factor that may impact processing word order asymmetry during interpreting. Interpreting scholars generally examine the overall relations between working memory and interpreting performance to see whether better working memory facilitates interpreting quality or whether professional interpreters possess larger working memory span than interpreting students or untrained bilinguals. But there are fewer studies focusing on the role of working memory in one specific aspect of interpreting processing. Whether working memory is related to syntactic processing in interpreting and to what extent working memory capacity predicts cognitive load in coping with word order asymmetry call for more academic attention.

Chapter 4 Exploring Cognitive Process during Sight Translation through Eye-tracking Experiments

4.1 The Construct of Cognitive Process in Interpreting

4.1.1 Emerging Trend of Process-oriented Approach to Interpreting Studies

Interpreting as a discipline has been strongly grounded in practice. As the need for cross-linguistic communication such as international meetings, and culture exchange activities surges, interpreting as a special profession has attracted increasing attention. At the earlier stage, interpreting research was mainly conducted by practitioners or interpreting teachers whose major interest lies in the pedagogical aspects. The methods they primarily relied on were observation and speculation which were strongly shaped by personal experience and standpoints. As translation studies gradually developed into a fully-fledged discipline, there has been an emerging interest in the mental processes of translation or interpreting. Scholars attempt to observe and record what actually happens during T & I, which stimulates the shift of research focus from product to process.

One prominent challenge in peeking inside the "black box" of interpreters is to study the cognitive mechanism that allows for concurrently performing different tasks. Early endeavour in this dimension was carried out mainly by psychologists and psycholinguists who viewed interpreting, especially simultaneous interpreting as a unique case of bilingual language activity. Their major interests fell upon the frequent code-switching and greater interference of interpreting as compared to non-interpreting communication (Chmiel, 2010; Gile, 2015). The synergy between interpreting and psychology-related fields yielded a series of process-oriented studies from the cognitive perspective, covering topics including attention dividing mechanism (e.g., Gerver, 1971), cerebral lateralization (e.g., Fabbro & Gran, 1994) and storage (e.g., Isham, 1994). Driven by the approaches and methods from these neighbouring disciplines such as psycholinguistics and neurolinguistics, interpreting studies was experiencing an "empirical turn" (Snell-Hornby, 2006, p.115), with growing numbers of researches relying upon empirical-experimental data to explore mental process during interpreting.

The most important contribution of psycholinguistics to process-oriented interpreting researches include the theoretical models, concepts and methodology for data-based empirical studies. Key concepts in psychology or psycholinguistics such as memory, cognitive load, strategy, expertise and attention are making ways into process-oriented studies, opening up new possibilities of interpreting studies. For instance, model of working memory (see Baddeley, 2000; Baddeley & Hitch, 1974) has been introduced to T & I studies and enriched the cognitive basis for empirical inquiries into interpreting process.

What is noteworthy is that cross-disciplinary approaches have updated the pool of data elicitation methods for interpreting studies, supplementing the verbal protocols prevailing in earlier stage of this field. Mental workings during interpreting that used to be elusive to direct observation can be recorded and measured by tools widely adopted in psycholinguistic research. More rigorous methods including eye-tracking (e.g., Shreve et al., 2010), EEG and imaging techniques (e.g., Ahrens, Kalderon, Krick, & Reith, 2010; Kurz, 1994) facilitate the accurate measurement of interpreters' on-line behaviour or mental activities.

However, most process-oriented researches focus on simultaneous interpreting (Ahrens, 2017) since the overlapping of different sub-tasks in SI presents a unique case for studying cognitive processing under stressful conditions. By contrast, other interpreting modes, particularly sight translation, have received much less attention in terms of mental workings involved. Given the wide use of sight translation in real-life conditions and its prominent role in interpreter training, it is necessary to devote more efforts in this aspect.

4.1.2 Definition and Measures of Cognitive Load in Interpreting

Study on cognitive processes of interpreting is expected to shed new light on human information processing mode by revealing the underlying mechanism that governs on-line behaviour of interpreters. The main goal of process-oriented interpreting study is to explain the development and workings of the cognitive behaviour that make complex processing task like simultaneous interpreting possible (Shlesinger, 2000). And one fundamental approach to this cognitive exploration is to study the amount and allocation of cognitive load required for certain interpreting tasks.

"Cognitive load" (also known as "cognitive effort" or "mental load") (Paas & Van Merriënboer, 1994, p.353) is one of the central notions in process-oriented interpreting studies. Cognitive load is generally understood as a multidimensional construct used in psychology. Its basic assumption is that cognitive resources in human brain available for a number of task processing is limited (Miller, 1956). To be more specific, cognitive load can be considered as the processing load imposed on the performer by a certain task or the mental effort devoted to a specific activity. The notion of cognitive load and its explanatory power in interpreting were first highlighted by Gile (2002) who proposed the Tightrope Hypothesis to describe the limited processing effort during interpreting. The Tightrope Hypothesis assumes that interpreters "work close to saturation (Gile, 2010, p.17)" in terms of cognitive load requirement. When total load of interpreters surpasses the threshold for maximum load, interpreting may be impeded by errors and frequent pauses or even break-down. Therefore, how to manage the limited cognitive load remains a prominent issue in cognitive study of interpreting. To better illustrate this cognitive requirement, Gile (2010) established the Effort Models which modeled interpreting process into a combination of different types of Effort including listening and analysis, production, reading comprehension and memory. Although the model was set up primarily for pedagogical purpose, its implication has evolved beyond its initial function and the model has become a powerful theoretical framework to describe cognitive process of interpreting (Seeber, 2013).

More attention need to be paid to the construct and measurement of cognitive load due to at least three reasons: first, cognitive load mirrors the underlying mental workings of interpreters. It offers new perspective for understanding multi-tasking in interpreting; second, cognitive load, closely related to skills and strategies, serves as a good way to observe and analyze certain behaviors during interpreting, which is conductive to the further study of interpreting competence (Chen, 2015); third, cognitive load is an indicator of on-line processing difficulties. Thus by measuring cognitive load, scholars can identify specific variables responsible for changes of cognitive load, which may have some pedagogical implications.

Cognitive load can be affected by a variety of factors. Chen (2015) listed several major factors that impact the amount of cognitive load: task-specific characteristics such as the interpreting mode (e.g., SI or CI), language combinations (languages with/without similar grammatical rules), interpreting directions (interpreting into A or B language), features of original speeches (e.g., presentation rate, duration, topic, word frequency and syntactic complexity), features of the speakers (e.g., native/non-native speakers, accents) preparation (with/without preparation, time of preparation), and task novelty (how familiar are the task to interpreters). In addition, there are interpreter-related characteristics which include interpreters' level of expertise, age, cognitive abilities, motivation and experience.

The focus of discussions on cognitive load in interpreting is measurement. Cognitive load cannot be directly accessed. To accurately measure cognitive load, observable and measurable variables are required for quantification. As a multi-dimensional construct, cognitive load can hardly be measured by one universal method. Paas et al., (2003) and Schultheis and Jameson (2004) proposed four methods to assess cognitive load and also specified their merits and disadvantages respectively. The four methods include: analytical methods, subjective methods, performance methods and psycho-physiological methods. Analytical methods are conducted based on expert opinions, task analysis or mathematic models. The advantage of analytical method, according to Seeber (2013, p.19), is that it can "take place at purely theoretical level thus avoiding sometimes cumbersome empirical testing", but the drawback is that it heavily depends on previous knowledge, not being able to consider individual difference.

Subjective measures are generally produced on self-reported data, broadly referring to self-observation and verbal reports. The data are collected via introspection as well as retrospective and concurrent verbalization. The results of subjective measures are often presented by psychometrics rating scales which can be either multidimensional or unidimensional (Chen, 2015). Subjective measures are first developed in the field of psychology, which require subjects to verbally describe or talking about what they are thinking and have been widely used to observe mental process in empirical studies of translation and interpreting. The advantage of subjective method is that it provides data on how task performers perceive the cognitive load. But there is also a risk of influence from memory constraints since the response is usually time-delayed (Seeber, 2013). One weakness, as Saldanha and O'brien (2014) points out, is that some processes of interpreting or translation can hardly be verbalized, in particular those procedures that have been internalized or automatized (Angelone, Ehrensberger-Dow, & Massey, 2015). It is argued that only concurrent verbalization can accurately reflect participants' cognitive status (Bernardini, 2001) on grounds that post-hoc verbalization, constrained by memory resources, may lead to incomplete recall. However, concurrent reporting is not allowed during interpreting considering its working mechanism. In addition, results of studies employing subjective measures are inconsistent (see Seeber, 2013). This leads support to further doubts over the feasibility of introspection. Shlesinger (2000, p.3) concludes that "for all intents and purposes, TAPs (think-aloud protocols), in the ordinary sense, are not a viable tool for us". Despite its limitations, subjective methods represented by introspection still make its way into cognitive study of interpreting as a supplementary data elicitation method. The subjective perception of interpreting process, although may lack objectivity or accuracy, is expected to complement data collected by objective methods.

Performance measures derive an index of workload from some aspect of the participant's behavior or activity (Sun, 2015). They usually involve two tasks: primary task measures and secondary task measures, with the focus on examining to what extent that the secondary task affects the first task.

Typical performance measures include performance speed and performance accuracy (Seeber, 2013), among which ear-voice span is a frequently adopted measure in interpreting studies. Ear-voice span provides useful insight into the temporal characteristics of interpreting and also reflect the cognitive load of interpreting (Timarová, Dragsted, & Hensen, 2011). It is believed to offer insight into not only the temporal characteristics of translation/interpreting but also into the cognitive activity underlying the delay (Pöchhacker, 2004; Shlesinger, 2000). In studies of interpreting processes, in particular the process of simultaneous interpreting, time lag, also called "ear-voice span", is defined as the temporal delay between source message reception and the utterance of its target version. There has been a long tradition of measuring interpreter's ear-voice span during SI since ear-voice span is seen as an indicator of simultaneity of interpreting. Researchers generally measure the basic temporal range of ear-voice span to identify the cognitive constraints on interpreters and a trade-off between output quality and EVS has been found since longer ear-voice span may cause the declining in accuracy (Lee, 2002; Podhajská, 2008; Timarová et al., 2011). Earlier literature reveals that ear-voice span during simultaneous interpreting is around 3 seconds (Lee, 2002). A number of issues on ear-voice span in SI have been studied, such as impact of text types on ear-voice span (Lamberger-Felber, 2001; Podhajská, 2008); relations between specific language pairs and time lag (Chang, 2011); and effect of processing strategies on ear-voice span (Gile, 2002). Fruitful results have been achieved in terms of time lag in SI, but little research has been conducted so far to specify the time lag of STR, it remains unclear whether factors such as expertise and linguistic complexities will affect the temporal lag in STR. Another widely-used performance measure is the pause pattern during translation. Previous researches have indicated that a pause is a measure of cognitive processing and the location of the pause may be related to the complexity of processing units (e.g., Jääskeläinen, 1999). Pauses are therefore also assumed to mark cognitive processing units (Kruger, 2016). The size and nature of cognitive processing unit in translation are in general impacted by the limited amount of cognitive resources. Lots of other factors are believed to impact the size of pause. For example, Englund-Dimitrova (2015) found that professional translators tended to operate at larger units while novices focus more on smaller units. Moreover, text difficulty also plays a part since translators working on a more difficult text may have shorter segments and more pauses at word or phrase level (Dragsted, 2005). There has been a substantial body of literature on pause in translation or interpreting. Performance measure is a holistic approach to cognitive load, without de-composing the task (Haapalainen, Kim, Forlizzi, & Dey, 2010). But the disadvantage is that relations between the two tasks may be confounded by uncontrolled factors.

Psycho-physiological methods measure cognitive load by obtaining physical responses of human body. Psycho-physiological measures generally include cardiac, hematic, ocular, muscular and cerebral responses (Seeber, 2013). Eye movement or pupil response is a typical psycho-physiological measure of cognitive load in translation. As compared with subjective and analytical methods, psycho-physiological methods offer a more accurate and objective moment-to -moment measure of cognitive load (Blascovich, 2004). But data collection methods of this type are usually complex and invasive, interfering with the task itself. Psycho-physiological measures are sensitive to change of environment and participant's physical state (Sun, 2015), which might cause problems in experiment design. When collecting data by psycho-psychological measures, more attention need be paid to factors such as invasiveness, cost, sensitivity, validity, practicality, and reliability.

Each type of measure discussed above has its own strength and weaknesses. To merely rely upon only one measure can hardly gain a holistic view of cognitive process during interpreting. Considering the multi-dimension of cognitive process, more researchers opt for a combination of different measures to obtain a more complete picture of cognitive load (Tsang, 2006).

4.2 Applying Eye-tracking to Studying the Process of Sight Translation

4.2.1 Unveiling the "Black box" of Translators/Interpreters by Eye-tracking

Chesterman (2017, p.332) emphasizes the distinction between translation act and translation event: the former refers to what takes place in translators' mind during translation whereas the latter is the observable public and social environment under which the translation act occurs. In translation process researches, translation act is generally understood as the cognitive process which scholars lack direct access to. Cognitive processes during translation, also known as the “black box”, thus becomes one of the main interests for translation studies. Toury (1985) highlighted the notion of “black box” , which was first brought up by Holmes(1978), to describe the unobservable and even unfathomable features of translation cognition:

> Translating processes, i.e. those series of operations whereby actual translations are derived from actual source texts (...), are only *indirectly* available for study, as they are a kind of ‘black box’ whose internal structure can only be guessed, or tentatively reconstructed(p.18).

For years, researchers in interpreting studies have been trying to devise multiple ways to observe and measure what actually takes place in interpreters’ mind as they perform this special task. Making observation on “translation act” during interpreting poses one of the methodological obstacles since most data collection methods conventionally used in translation studies cannot be directly applied to interpreting study (Shlesinger, 2000). Think-aloud protocols (TAPs), which require translators to speak out their thought during translation, is a case in point. Relying on TAPs, researchers obtain explicit information about translators’ decision making and problem-solving and thus inferring their translation processes (Simon & Kaplan, 1989, p.23). Therefore, TAPs have been one of the core data elicitation methods in translation process research (see Jääskeläinen, 2002). However, this method can hardly be expected to make observations on interpreting process since no one can concurrently verbalize his/her mental process and perform the interpreting task, which is in every way against the ecological validity of interpreting. A possible alternative is immediate retrospective accounts which requests interpreters’ verbal reports of their cognitive processes right after interpreting and sometimes interpreters are allowed to use their interpreting output as retrieval cues (Ivanova, 2000; Shlesinger, 2000). Methodologically, this is quite feasible but still cannot fix the problem of close interaction between experimenters and participants

(Bernadini, 2001). Verbal reports can only be obtained under the step-by-step guidance of experimenters during which interactions are inevitable, which may contaminate data results.

It could be seen from above that data elicitation in interpreting process study is never an easy task. Suitable candidates need be not only accurate but also non-invasive, with little interference with interpreting task and objective. It is in recent years that eye-tracking has been introduced into the cognitive explorations of interpreting processes. As the eye-tracking technology becomes more and more sophisticated, researchers are getting closer to understanding the "acts" during interpreting and making more detailed inferences about the cognitive processes of interpreting.

Eye-tracking refers to the process of measuring the movement and position of eyes (Seeber, 2013). Eye movement is probably the commonest intentional human behavior, which occurs three times per second on average (Wu & Shu, 2001). Eye-tracking has been widely applied by psychologists, psycholinguists and cognitive scientists to study human cognitive behavior for many years. The analysis of eye-tracking technique is based upon the notion that human's cognitive behaviors are to some degree reflected by the eye's movements (saccades), stops (fixations) and backward movements (regressions) (Conklin & Pellicer-Sánchez, 2016). In other words, there is an assumed link between the observable and measurable visual patterns and underlying cognitive processes (Hvelplund, 2017a, 2017b). Resting on this relationship, a wide range of cognitive activities including reading comprehension, prediction, and attention focus can be monitored by eye-tracking (Soluch & Tarnowski, 2013). One of the major areas where eye-tracking is frequently used is language processing such as reading and second language acquisition: researchers use eye-tracking to record where participants fixate and how they move their eyes during reading, looking at a static scene or watching a video (Conklin & Pellicer-Sánchez, 2016).

By recording and analyzing participants' eye movement patterns, researchers can probe into the underlying mechanism of language processing. Despite its time-honored application to the neighboring disciplines such as psycholinguistics and second language acquisition, eye-tracking has only found its way into translation and interpreting studies in the recent decade as an increasingly popular data elicitation method. Eye-tracking has been considered as an effective way to make observation on moment-to-moment processing during translation or interpreting (e.g., Seeber, 2013). As compared to the traditional data collection methods such as TAPs and retrospection, eye-tracking is better positioned to monitor and analyze translation & interpreting processes: its non-invasive feature allows for an accurate on-line measure of participants' performances without interference in their translation. According to Blascovitch (2004, p.881), eye-tracking, as a physiological measure, is typically "online, covert and continuous" and "providing simultaneous evidence of strength and operation of the state or process". The growing interest in eye-tracking is propelled in part by the rich data sources and great research possibilities that eye-tracking can offer: eye-tracking allows for an accurate recording of multidimensional data, which reveals deeper and more subtle cognitive processes (Staub, 2010; Traxler et al., 2002). Moreover, this popularity is also inspired by the neighboring research fields in which eye-tracking has been adopted for many years and reliable paradigms and methodologies have been established (Hvelplund, 2017a).

A growing number of studies have attempted to raise intriguing questions and propose insightful research guidelines pertaining to translation and interpreting processes by means of eye-tracking (e.g., O'brien, 2009; Hvelplund, 2014, 2017a). For example, O'brien (2009) reviewed methodological challenges facing eye-tracking studies such as participant recruitment, data analysis, ethical considerations and research validity, some of which are specific to translation process studies while some are general across disciplines. According to O'brien, to reflect upon the existing problems and methodological challenges is a good way to optimize the research design and fully unleash the potential of eye-tracking. Hvelplund (2014; 2017a) went through progresses in translation studies by eye-tracking and discussed some basic methodological issues regarding theoretical foundation, participant profiles, data collections; moreover, the author highlighted the relevance of eye-tracking to research purposes of translation studies.

The development of eye-tracking technology with the constant refining of research designs and increasing availability of more affordable, user-friendly eye-trackers opens up possibilities of tapping into the "black box" during translation & interpreting processes. Thanks to eye-tracking, a variety of issues have been discussed and examined, ranging from translation expertise, cognitive load, human-machine interaction and translation directionality. Hvelplund (2017a) summarized several topics in translation process researches that have been frequently addressed : translations interaction with tools and information (e.g., Mellinger & Shrever, 2016; O'brien, 2009); interpreting and sight translation (e.g., Dragsted & Hansen 2009; Chmiel & Mazur 2013; Shreve et al., 2010, 2011); reading in translation (e.g., Jakobsen & Jensen 2008; Hvelplund, 2017b); distribution and coordination of cognitive resources in translation processes (Hvelplund 2011; Schaeffer et al., 2017), translation expertise (e.g., Hvelplund 2011; Dragsted & Carl 2013) and post-editing in translation (Carl, Gutermuch, & Hansen-Schirra, 2015). In addition, eye-tracking has also been widely used in combination with key-logging to investigate the cognitive behaviours of translators (e.g., Carl & Dragsted, 2012; Jakobsen, 2011).

However, the above overview indicates that there has been a dearth of studies on interpreting by eye-tracking. This is perhaps due to the fact that there is no constant visual presence during interpreting while the prerequisite for eye tracking test is the presence of visual stimulus whose perception can be captured by an eye-tracker (Grabowska, 2013). Considering this requirement, typical interpreting (oral input and oral output) can hardly be tested through eye-tracking. For example, during consecutive interpreting, interpreters generally shift their visual attention among their notes and the speakers. Some interpreters may even close their eyes occasionally to resist distractions in simultaneous interpreting. Stable visual stimulus thus becomes quite important for eye-tracking studies, which makes sight translation an ideal research object: An eye-tracker could be employed to measure sight translation since source texts offer visual stimulus for eye movements. Another factor that makes STR suitable for eye tracking test is that interpreters are always under great time pressure during the task. Mind wandering or moving eyes off the textual stimulus rarely occurs since interpreters are racing against time to comprehend the source message and search for their appropriate equivalents.

4.2.2 Eye-mind Assumption: Bridging the Gap between Eye Movement and Cognitive Process

In translation research using eye-tracking paradigm, eye-mind assumption generally serves as the theoretical ground which sets up a link between "visual focus and cognitive focus" (Hvelplund, 2014). This hypothesis was first proposed by Just and Carpenter (1987, p. 331) who believed that "there is no appreciable lag between what is being fixated and what is being processed" and "the interpretations at all levels of processing are not deferred; they occur as soon as possible". Similarly, Richardson and Spivey (2004) claimed that when the eyes focus on an object (e.g., a word), the brain is engaged in some sort of cognitive processing of that word. Eye-mind assumption enables researchers to unveil information about moment-to-moment processing by examining the position and movement of eyes. However, it has been cast into some doubts recently.

Eye-mind assumption holds that one's fixation is indicative of the focus of cognition; however, this might not always be the case. Jakobsen (2017) and Hvelplund (2014) point out that a straightforward correspondence between visual focus and cognitive focus is not without problems since human minds can function independently of the visual attention (e.g., Posner, 1980). Holmqvist et al. (2011) stresses that eye-tracking data need be interpreted with cautions: although the analysis of eye movement is generally based on eye-mind synchrony, in real situations this synchrony is subject to many "exceptions": sometimes the mind may be ahead of the eyes and processes the information that the eyes have not fixated upon; sometimes the eyes can be faster than the mind, preselecting the information to be processed in the parafoveal region (McConkie & Yang, 2013). Besides, it is also possible that the mind drift unconsciously, for example, subjects may think of something unrelated to the word they gaze during translation or even the task at hand and such mind wandering is actually quite frequent and common (Smallwood & Schooler, 2006). It is thus impossible to ensure synchronic correspondence between visual attention and cognitive focus.

Another problem arises from the possible mismatch between attention and object of cognition (See Hvelplund 2017a): while eye-tracking technology can indicate where the fixation falls, it can hardly tell the object of thought. For example, during translation, a fixation upon a certain word in source text area may reflect either the processing of that word or the processing of other parts. In this sense, researchers cannot rush into the conclusion that the translator is processing that word when he/she fixates on it. Furthermore, conventional ways to distinguish source text comprehension and target text production during translation is to count the fixations within source text area and target text area respectively. But this approach is not flawless since translators may be looking at some parts in source text while considering possible target equivalent of certain source words or sentences (Zheng & Zhou, 2018).

This problem of potential disagreement between cognition and fixation merit more attention, but it does not mean that eye-mind assumption should be overridden. Although the mismatch may takes place during translation, it is likely to be neglected owing to the high cognitive demand during translation (Hvelplund, 2017a). During sight translation, interpreters are constrained by both mental load and time stress and thus are less likely to have mind wandering. Hvelplund (2014, p.209) believes that eye-mind assumption still depicts “an approximation of the relationship” between gaze activity and cognitive processing. And considering the mode-specific features of sight translation, we can be fairly certain that the interpreters will process whatever they are fixating upon. Few theoretical frameworks are flawless and eye-mind assumption therefore still serves as a very powerful operational basis for conducting eye-tracking researches.

4.2.3 Major Eye Movement Measures in Reading and Translation Research

A wide range of eye movement measures have been adopted to depict and quantify cognitive processes during different tasks. This is because eye movements are natural behavioral data which are sensitive to certain linguistic and cognitive factors. In reading studies, for example, word-based eye movement measures are subject to changes in word frequency, word predictability and word length (see Rayner,1998; Rayner et al., 2004), enabling a closer look at relationship between one’s cognitive process and textual linguistic factors. There are different ways to categorize eye movement measures: they can be divided into fixation-based measures, saccade-based measures, pupil-based measures and transition-based measures (Hvelplund, 2014; Jakobsen, 2017); Yan et al. (2013) distinguished time-based measures (such as fixation duration and gaze time) from location-based measures (such as number of fixations, saccadic size and landing position). In terms of processing levels, eye movement measures can be global or local, that is, based upon fixations on individual words or fixations covering an entire sentence/text. To temporally differentiate processing stages, eye movement measures can also be early or late. Early measures generally reflect the initial stages of processing associated with automatic mechanism whereas later measures are indicative of conscious and higher levels of processing such as meaning integration and reanalysis (Schaeffer et al., 2016).

In translation researches, fixation-based measures and pupil-based measures have been most frequently adopted to make observation on cognitive processes. Among all fixation and pupil-based measures, average fixation duration, total fixation counts, and pupil size have become the most popular global-level eye movement measures in translation process studies: 1) Average fixation durations and total fixation counts: fixation refers to the maintaining of a visual gaze upon a single location; the purpose of a fixation is to "bring an object of interest into visual focus" (Duchowski, 2007, p.46). Here, the average fixation duration refers to the mean time used for per fixations in a specific area and total fixation counts is the total number of fixations made across an entire sentence or text. Fixations have been taken to signal the cognitive load for processing a particular item, and fixations tend to be longer and more frequent on items that require more effortful processing (Dragsted, 2012). For example, a pilot study of metaphor translation found that participants have more fixations on processing of metaphorical expressions (Sjørup, 2011). 2) pupil size: pupil size in eye-tracking settings typically refers to the diameter of pupil during a given task. Relative change in pupil dilation has been considered as an indicator of change in cognitive load (Holmqvist et al, 2011, p.393). Gile (2015, p.52) believed that "pupillometry is perhaps the most promising physiological measurement tool taken from psychology to date" and is expected to reveal more about cognitive load, one of the central issues in interpreting studies. A set of studies have used pupil size to reflect on-line changes of cognitive load during translation or interpreting (e.g., Chang, 2011; Hvelplund, 2011; Hyönä et al., 1995; O'brien, 2009). For example, Hyönä et al. (1995) found that pupil dilation can be employed as a reliable measure of interpreters' cognitive load during SI and also confirmed the positive correlations between pupil size and the level of task difficulty: words that were supposed to cause translation difficulties elicited higher degree of pupil dilation than more translatable ones. In addition, pupil size is seen as an indicator of automatic processing during translation. It is believed that experienced translators will be subject to lighter cognitive load and as a result their average pupil size will be smaller than those with less experience (Hvelplund, 2016). However, it remains unclear whether this also holds true for automatic processing in sight translation.

Despite the wide use of pupil size in translation studies, further caution is required since results of some studies challenge the reliability of pupil size as a stable measure of cognition. For example, Carver (1971) found that participants' pupil size reported no significant changes when they listened to texts differing in complexity. In a study on syntactic effect during STR, Shreve et al. (2010) found that participants had smaller pupil size when they were processing complex texts while exhibited larger size when processing non-complex ones, which was against the previous hypothesis and counterintuitive. These inconsistencies can be explained by variances in experiment setting since pupil response are highly sensitive to light intensity and the emotional/physical condition of the participant (Hvelplund, 2011). Although it is not possible to control the physical or emotional state of mind, researchers can still have a better control of other factors. Another possible reason is the delayed pupillary response or pupillary latency (Hvelplund, 2014) which requires individual baseline measurement of all participants before recording pupil data in the actual process.

In addition to fixations and pupil-based measures, other eye measures such as blink rate and attention shifts between different subtasks are also employed to study cognitive load and cognitive management in translation (e.g. Chang, 2011; Hvelplund, 2011) but are used less frequently since they are not as easily accessible as fixations or pupil sizes. However, it is necessary to enrich the existing lists of eye movement measures if researchers need a deeper and multidimensional understanding of translation cognition. According to Hvelplund (2014, p.215), translation research could "benefit from exploring the possibilities of measures rarely used in translation process studies but often used in neighbouring research disciplines such as reading research".

Below are the major eye indices frequently used in reading and sight translation research, among which measures that reflect temporal stages and levels of STR processing are of major concern for the current study. With respect to reading at local level, for example, reading individual words, researchers generally examine how readers process the word during the very early stage when they first encounter that word, that is, on the first pass. First fixation duration and gaze durations are typical early measures during the first pass: first fixation duration refers to the duration of time the eyes first fixate upon a target word irrespective of how many fixations the word ultimately receives (see Inhoff & Radach, 1998). Gaze duration, also known as first pass reading time is the sum of all first-pass fixations on a word before the eyes move to a different word (Rayner & Liversedge, 2004, Schaeffer et al., 2016). When there is only first-pass fixations upon a target word, the first fixation duration equates to gaze duration. In translation and interpreting studies, gaze duration can be taken as a useful indicator of processing effort related to word processing or reformulation. These two first-pass fixations are considered to be associated with immediate/early cognitive processing (Rayner 1998). They tend to be very short and are sensitive to a variety of linguistic variables such as word length, word frequency, orthographic and phonological properties and other factors such as reading competence, age of acquisition and contextual predictability (see Rayner,1998).

As for late stages of processing when reading single words, researchers generally investigate readers' eye movement behaviours beyond the first pass fixations. Frequently adopted late measures include total reading time (total duration that readers spend on looking at a word, including both first pass and second pass fixations), second-pass time, also known as rereading time (total reading time but excluding first-pass fixations) and regression in/out probability. Regression is also called backward saccade, which refers to the re-fixation after the previous fixation on a certain area (Rayner, 1998; 2009). Regressions constitute a deviation of eye movements from the normal forward reading and are often caused by failures in comprehension, for example, when the reader misunderstands a sentence. Rayner (2009) points out that most regressions are related to insufficient comprehension or certain difficulties of the text. For example, Frazier and Rayner (1982) found that readers tend to make regressions when they encounter a word that indicates their understanding of the prior sentences is in error. Although some trainers of speed reading advocate against making regressions during reading, regressions are actually crucial in ensuring reading comprehension rate: readers would maintain their misinterpretations if they are required to keep reading forward and their comprehension rate suffers dramatically (Rayner et al., 2016). Previous studies report that generally 10%-15% of the fixations are regressions (Yan & Bai, 2012). In translation studies, novices are found to have a considerably higher amount of regressions than the expert translators (Dragsted, 2010), implying that novice translators encountered more difficulties during translation. Similar to early measures, late measures are also influenced by linguistic and contextual factors. This is perhaps because the processing at lower level extends up to higher level comprehension, meaning integration or revision (Titone, Whitford, Lijewska, & Itzhak, 2016).

4.3 Eye Movement as an Indicator of Reading Behaviour during Sight Translation

One of the most salient characteristics of sight translation is that source texts are visually presented, making reading an indispensable component of STR. Reading comprehension serves as the basis for other sub-activities in STR: in order to deliver accurate and smooth renditions, interpreters have to read ahead and identify the sense of key words and units of translation before considering target language production (Agrifoglio, 2004). Extra processing resources are required when they read low frequency word (e.g., terminologies) or long and complex sentences. In this section, I am going to review major research findings on reading with a focus on its cognitive mechanism and variables in reading, then I move to a brief introduction of reading researches, in particular speed reading, by means of eye tracking; lastly I will discuss the role of reading in STR to see how much has been done in exploring reading patterns during STR.

4.3.1 Cognitive Process of Reading: Characteristics of Skilled Readers

Reading is seen as a "psycholinguistic process involved in reconstructing the message intended by the author on visually encoded information (Koda, 2012, p.158)". This ability to identify the letters and words in a text, according to Cain and Parrila (2014), is one of the most remarkable achievements of mankind. Successful reading is beyond identifying a sequence of words but requires comprehension of the relations between individual words and making inferences about the entities that are not stated but might be involved in the context (Rayner et al., 2016).

Reading strategies and differences between skilled and poor readers have been one major area of reading researches. Studies in this area have revealed a number of important facts about behavioral and cognitive features of proficient readers (see Just & Carpenter, 1987). One manifestation of skilled reader as compared to beginning readers is a high degree of automatic decoding (Field, 2004) since skilled readers possess larger amount of working memory which allows them to free up more resources for higher-level processing such as meaning construction. In addition to working memory, skilled readers are also believed to have advantages over their novice counterparts in perceptual span. Rayner (1986) used the moving window paradigm to investigate the perceptual span of skilled and beginning readers and found that the perceptual span of skilled readers was approximately 20% larger than that of beginning ones. For some, reading speed serves as one indicator of reading skill since most skilled readers are also fast readers who fixate less and skip more. But this has been questioned since what is primarily crucial in reading is not speed but accuracy and a high degree of automaticity (Field, 2004). Readers with adequate training can more or less increase their reading speed but very high speed cannot be sustained for long time and may affect comprehension rate. The alternative view is that skilled readers are not always conducting fast reading but are able to adjust their reading speed to better adapt to the task in hand: they may speed up when the text is easy while slow down for deeper reading in difficult sections (Field, 2004).

To better illustrate the strategic choice of skilled readers, notions of “top-down” and “bottom-up” have often been brought up. Goodman (1967) first put forward the concept of “top-down approach” which refers to the use of contextual information by skilled readers to anticipate incoming message and facilitate reading. Readers adopting this approach tend to reduce their dependence on decoding single words and pay more attention to the context including world knowledge, textual mental models and schemas. This contextual information can be used to help build global sense of the text and compensate for inadequate decoding if readers have problems with decoding (Stanovich, 1980). In contrary to “top-down” approach, poor readers generally stick to a “bottom-up” strategy by overwhelmingly concentrating on individual words (Davis & Bistodeau, 1993). In other words, less skilled readers rely more on decoding at lower level while skilled readers opt for contextual processing at higher level (Koda, 2005).

4.3.2 Eye Movements in Reading Process

It has been well established that eye movements are indicative of on-line processing during language tasks, which explains the long tradition for studying eye movement during reading (See Rayner, 2009). Eye-mind assumption offers a theoretical basis for researches on language processing under eye-tracking paradigm. Thanks to this assumption, researches could set up relations between readers’ eye behaviors and their cognitive load during reading. For years, researches in this area has yielded fruitful results with respect to issues such as eye movement characteristics and effect of different variables on eye movement in reading and individual differences among readers (Rayner,1998).

Eye-tracking has been recognized as a rich source of information about reading processes. Researchers are primarily interested in relations between processing difficulty and cognitive load reflected by eye movement during reading. Studies indicate that cognitive load in reading can be influenced by text-related and reader-related factors (de Leeuw, 2016). Typical textual factors include word length, word frequency, word predictability and text difficulty. For example, Rayner et al. (2006) found that readers exhibit more and longer fixations when they encounter low-probability word in text. Words are more likely to be skipped if they are very short, highly frequent or predictable from the previous context (Rayner et al., 2016). In English reading, the word "the" is a case in point: it is skipped about 50 % of the time or more (Angele & Rayner 2013). In general, an increasing text difficulty leads to longer fixations, shorter saccades and more regressions (Rayner, 1998). Reader-related factors, for instance, skills and capabilities of readers, also impact the mental model building as evidenced by their eye movement. Previous research demonstrates consistently that eye behavior changes with increasing reading experience and skill (Rau et al., 2016). Proficient readers and novice readers differ remarkably in many eye-movement measures such as fixation count, fixation duration, gaze time and regression (e.g., Just & Carpenter, 1987). Thus, comparison of eye behavior has been considered as a useful method to distinguish "good" readers from "poor" readers. Novice readers have longer fixations, more regressions and shorter saccades than more advanced readers (Ashby, Rayner, & Clifton, 2005). It has been shown that experienced readers skip more words and have more regressions than less experienced ones (e.g., Rayner et al., 2006). Reading skill also accounts for differences in size of perceptual span: beginning readers generally have smaller perceptual span than more skilled readers (Häikiö et al., 2009).

Based on eye behavior characteristics, researchers attempt to categorize different reading styles. For example, Olson, Kliegl, Davidson and Foltz (1985) identified two reading styles among dyslexic readers: one is plodder reading style and the other explorer reading style: Plodders generally display few regressions between words or skip less, but move forward in the text steadily with frequent forward saccades while explorers make more regressions, skip more frequently with fewer intra-word and inter-word movements. Rau et al. (2016) found that this classification of reading style may also be suitable in depicting cross-linguistic differences in eye movement.

4.3.3 Increasing Reading Speed during Sight Translation

Concurrent reading and production during STR imposes a much higher cognitive load on interpreters, making reading in STR different from that in normal conditions. Reading comprehension in the normal sense can be completed after reader completes reading a sentence or even a whole paragraph since there is no time constraint. Sometimes, the reader could pause for a long time, dwell upon certain words or sentences, or even reread the prior parts for better understanding. However, reading in sight translation is more stressed and cognitively more demanding since time and cognitive constraint of interpreting disrupt the reading process during STR: interpreters cannot begin the reproduction after completely reading a whole sentence but resort to linear mode, reading segment by segment. They store the segments that have been identified and comprehended in memory, continue the linear reading until receiving more visual information to form a meaningful unit and integrate the stored segments to the incoming segments through certain interpreting strategies. In addition, long pauses, too many fixations on the same word, miscomprehension should be avoided during STR, which indicates that reading in STR has to be fast, accurate and efficient.

One way to increase reading speed is to learn techniques of speed reading (See Rayner et al 2016). Speed reading was introduced as a method to dramatically increase reading speed without sacrificing reading comprehension. Advocators of speed reading claim that after extensive training, normal readers could take in more information in a single fixation that they used to do. To increase reading speed, readers are recommended to reduce regression numbers and expand their peripheral vision so that they can process larger chunks of information with one single glance. At the extreme, they could zigzag down one paragraph or one page, processing much more efficiently than normal readers do.

However, this proposal has been subject to doubts and criticism since an array of studies have found that although fast readers tend to have better comprehension (Dyson & Haselgrove, 2001), there are within-individual negative correlations between reading speed and comprehension: if individuals increase their reading speed considerably, their comprehension will suffer (e.g., Calef, Pieper, & Coffey,1999; Just & Carpenter, 1981).

In addition, regressions are crucial for readers to fix comprehension failures. Thus, regressive eye movements actually facilitate reading rather than causing reading problems (Schotter, Tran, & Rayner, 2014; Rayner et al., 2016). Lastly, reading is more than taking in visual information as much as possible but the capacity to recognize words and understand the text (e.g., Miellet, O'Donnell, & Sereno, 2009). Therefore, reading ability cannot be enhanced by simply changing the eye movement pattern, for example, making fewer or no regressions.

Although speed reading is not likely to improve reading performance, some elements or skills recommended by speed reading courses may be employed selectively for more efficient reading during STR, one of which is skimming. By skimming, the reader goes through the text very quickly to obtain a general idea about the topic and the content (Nation, 2009; Rayner et al., 2016). One suggestion for skimmers is to spend more time on critical sections of the text while skipping the less important parts. But crucial information may also be lost during skimming: Masson (1982) found that readers who skim were less likely to correctly identify statements of the text, regardless of whether the statements are primary or secondary information. That suggests that skimming does not lead to effective reading since some important details can be ignored.

A more effective way might be first to scan the whole text, grasp the gist and locate potentially critical information, then adopt selective, careful reading. For example, readers spending more time on headings are more likely to write accurate summaries (Hyönä, Lorch, &

Kaakinen, 2002). Selective reading by focusing on headings and first sentence of each paragraph helps readers quickly locate important information (Konstant, 2010). Eye movements demonstrate that skimmers make more fixations at the earlier paragraphs, suggesting that they rely on initial parts of the text to obtain the main idea, which is an effective way to maximize the comprehension rate under time pressure. The above findings suggest that effective readers are not those who merely rely on skimming but those who flexibly switch between skimming and careful reading of critical parts. Despite the potential trade-off between speed and comprehension accuracy, skimming can still be used as an important way to deal with large amount of information within a short time (Rayner et al 2016).

4.3.4 Reading in Sight Translation

As mentioned above, reading in sight translation is cognitively more challenging than normal reading. Although the unit of processing varies with individuals, meaning has to be extracted to accurately produce the message in target language. Hence, the quality of target expression is highly dependent on comprehension (Yudes et al., 2012). Nilsen and Monsrud (2015) suggest that one major obstacle in STR is interpreters' reading skills. Highly automated reading skills is crucial for STR: interpreters' reading speed and reading patterns may influence the flow and speed of on-line translation while efficient reading comprehension boosts the target production. Reading effort forms the basis of an accurate and fluent target delivery: previous experience shows that if interpreters read fast and efficiently, they are likely to perceive more information through larger unit of meaning, thus leaving more space for their chunking, planning and thinking (Wan, 2005). On the contrary, if interpreters are poor readers, they can hardly collect enough messages under time pressure for segmentation and thus are forced to adopt a quite rigid manner of translation by "chopping up a sentence in a piecemeal (Wan, 2005, p. 39)" which may influence their output quality. Therefore, the role of reading skill should never be underestimated for successful sight translation.

Reading during STR is not only a matter of efficient identifying the source information but also involves on-line planning since interpreters have to read the source text while thinking of its target expression (Weber, 1990). To ensure the smooth delivery, interpreters sometimes have to read ahead, for instance, having a quick glance through text structures or topic sentences, to identify key words and translation units, so as to facilitate their on-line planning of translation (e.g., Agrifoglio, 2004). When source texts contain long and complex sentences, extra cognitive load may be required for reading and planning. In particular, the greater the syntactic distance between the source and target language, the greater cognitive load imposed upon the interpreters to synchronize reading comprehension and target production (Lee, 2012).

Studies indicate that reading skills is crucial for both interpreting trainees and professional interpreters. Lee (2012) compared STR performance of student interpreters with that of professional interpreters. One focus of the comparison was the reading speed of the two groups since reading speed serves as "a good indicator of reading skills" (p.699). The comparison of professional and student interpreters revealed notable differences: some student participants even could not finish reading the source text within the required time for preparation while professional interpreters completed the reading and also had time for pondering some translation issues. Moreover, the study found that students' slower-than-expected reading speed may be attributed to their tendency to read carefully and concentrate on individual words. By analyzing and inferring the reading behavior of both groups, the author highlighted the importance of reading strategies during sight translation such as top-down strategy and the need for further training to improve interpreter trainees' reading strategies. Actually, there is even a need for specific training in reading among professional interpreters, which runs contrary to conventional thinking that for sight translators, reading skill is taken for granted as a natural result of development of interpreting proficiency. Nilsen and Monsrud (2015) proposed that sight translators' lack of reading proficiency may one major cause of interference. They conducted a small-scale study among professional interpreters working in public service sector and found that more than half of the interpreters did not exhibit sufficient reading skills in the reading test as confirmed by their low reading fluency and decoding-related reading problems. And vast variations across individuals were also reported, indicating uneven reading skills development between the interpreters. These results strongly prove that reading skill training should be included in the interpreter training program while a reading test need be included in the admission test.

4.4 Study of Sight Translation based on Eye-tracking Data

With the increasing popularity of eye-tracking as a research methodology in T&I studies, a variety of topics have been addressed and analyzed through eye-tracking data. Sight translation is seen as one of the major areas where eye-tracking has played an important role in describing and inferring the mental workings in this special mode of interpreting (Hvelplund, 2017b). This section gives an overview of STR studies under eye-tracking paradigm with a focus on the mode-specific properties of STR and certain reading behavior during STR.

4.4.1 Cognitive Load in Sight Translation induced by Mode-specific Factors

Different modes of translation and interpreting share common cognitive constraints in comprehension and production. They all require analytical reading/listening, efficient management of attention and accurate delivery. However, interpreters may encounter more extreme conditions as a result of concurrent performance of source input and target output. Besides, as compared with translation, there is greater memory burden in interpreting since source information is paced by the speaker and transient for interpreters.

The intriguing questions arise regarding the mode-specific characteristics of sight translation. As introduced before, sight translation is a hybrid between interpreting and translation shaped by cognitive features of both working modes. Would cognitive processes in sight translation notably differ from those under other modes of translation? Shreve et al. (2010) manipulated the language complexity of source texts and adopted eye-tracking to examine the cognitive load under sight translation and written translation. Results demonstrated that there were more and longer fixations, as well as more frequent and longer regressions during sight translation, which indicated that on-line processing in sight translation was affected by linguistic complexity to a greater degree. The authors attributed these differences to more language interference in sight translation due to constant presence of written texts and also less requirement for working memory resources in written translation.

Another line of research focuses on cognitive differences between sight translation and other monolingual processing such as reading comprehension or reading for translation. One pioneering attempt was made by Jakobsen and Jensen (2008) who investigated cognitive load across four different types of language processing: reading comprehension, reading for translation, sight translation and reading during translation. Comparison of participants' fixation counts, gaze durations and average fixation durations showed that there is a gradual increase from reading comprehension to written translation. Therefore, it can be concluded that sigh translation involves greater cognitive load than reading comprehension and reading for translation. This may be explained by greater effort to coordinate reading and production in sight translation. Ho (2017) not only compared the cognitive load under reading comprehension, reading aloud and sigh translation but also examined how task modes interact with interpreting training and experience. Three groups of participants took part in the study: experienced interpreters, interpreting students and untrained bilinguals. Eye-tracking was employed to record participants' on-line processing under the three task conditions. The results were in line with previous studies that reading purpose did change the cognitive load required and sight translation involved more effort than general reading. Global eye-tracking measures including total fixation duration and fixation counts as well as local measures such as first fixation duration clearly outlined different cognitive patterns across the three tasks. A more refined analysis of eye-tracking data was conducted by distinguishing first pass and second pass of the reading. First pass reading time is generally believed to indicate language processing at very early stage while second pass reading time reflects reanalysis and processing difficulties. The findings showed that reading comprehension was similar to sight translation in terms of earlier processing but the two diverged in second pass. The additional effort at the later processing stage in sight translation, according to the author, is caused by the extra burden of coordinating comprehension and reproduction.

4.4.2 Reading Behaviour during Sight Translation

Thanks to eye-tracking, researchers can not only have an accurate recording of interpreters' cognitive load, but also identify their reading patterns via data visualisation. One of the visualisation method is heat maps or gaze plot map of the eye-tracking data. Heat maps serve as a straightforward way to show attention focus during the task: attention is presented by colours on a scale from green to red. Green colour representing less intensity and sections in red colour reflects the most concentrated area. Gaze maps are visualisation of fixations which take the form of spots on the screen and the gaze intensity is reflected by the size of the spots: the larger the spot, the longer the gaze. Generally, a quick glance at the heat maps or gaze maps outlines participants' attention distribution during translation which can be further used for generalizing reading patterns.

Wan (2005) stressed that although reading does not have a direct impact on sight translation quality, efficient readers in sight translation can obtain more information by fewer fixations than those who lack reading skills, which is crucial for source language comprehension under time constraints. Chimel and Mazur (2013) used eye-tracking to detect the reading behaviour during preparation for sight translation to examine whether training experience would influence reading patterns. Two groups of students varying in their training experience in interpreting participated in the study (first year student vs second year student). They were required to sight translate a source text that had been lexically and syntactically manipulated. One of the research focuses is on the students' reading behaviour during the warm-up period in which they were allowed to quickly go through the whole text to obtain information as much as possible. The authors hypothesized that advanced students would exhibit a more efficient reading pattern as indicated by fewer and shorter fixations, which however was refuted by the data results: first-year participants fixated less frequently than second-year participants and there were no significant differences in fixation counts between the two groups. But a further analysis by heat maps did reveal some differences in reading patterns: first year student adopted less scanning during warm-up than the more advanced group. The first-year students appeared to have a more efficient reading pattern since their frequent scanning and more widely distributed fixations mirrored better ability to search for useful information under time stress. But the fact that differences between the two groups runs against previous assumption suggests that one year of training is not enough fundamentally change students' reading behaviour. Dragsted and Hansen (2009) studied the strategic reading behaviour by professional interpreters and professional translators in translation. Hotspot analysis based on heat maps reveals different reading patterns between interpreters and translators: most interpreters preferred "linear reading" by processing the source texts from left to right sequentially while translators tended to move their eyes up and down, with fixations scattered through the whole text. It can be inferred that the interpreters were more likely to concentrate on local processing and translators preferred a more global reading strategy with plenty of regressions and saccades. In addition, during sight translation interpreters tended to make less frequent fixations but longer average fixation durations and the opposing pattern was found among the translators. The visualized data results indicated different on-line reading behaviour between interpreters and translators. However, output analysis suggested that production by translators were not significantly better than that by interpreters even though translators devoted more time and effort during the tasks. Therefore, the author believed that oral modality improves translation efficiency without compromising translation quality, which offers evidence for enhancing the status of sight translation training in translation program.

4.4.3 Other Topics

In addition, more refined and deeper analysis has been adopted to explore other issues in sight translation such as translation errors, cognitive activities during pauses and strategies in sight translation.

Although there has been no consensus upon definition and classification of translator errors, it is acknowledged that mistakes and omissions are very common during interpreting. Gile (2002) attributes it to the inherent cognitive difficulties of interpreting: reading effort and production effort constitute the foundation for sight translation but the coordination between the two components would increase the risk of cognitive saturation when effort required for these exceeded interpreters' available cognitive resources. This cognitive deficit would inevitably result in errors or omissions. Eye movements have been proved to be sensitive to task difficulty. In reading comprehension, an increase in text difficulty would cause longer fixation durations, more fixations and regressions as well as shorter saccadic size (Rayner, 1998). Considering the essential role of reading in sight translation, it is plausible to use eye-tracking to identify which part of the source text posts most difficulties and to what extent that interpreters are affected by these difficulties. Pluzyczka (2013) explored the relations between fixation profiles in sigh translation and errors in output. The study indicates that eye-tracking can help locate text areas where most problems take place. As shown by the eye-tracking data, there were significantly more and longer fixations in "problem areas" at which more production errors were spotted. The study confirmed the link between on-line processing measured by eye-tracking and the off-line product analysis. Combining the identified most-frequently fixated areas and their corresponding interpretation, the author classified participants' errors and found that source language interference ranked first as the source of translation errors, besides, highly frequent grammar errors suggested that the participants were impeded by lack of language proficiency during sight translation.

Despite numerous discussions of pauses as indicators of cognitive difficulties in interpreting, most pause-related studies take a product-oriented approach by measuring duration, frequency or distribution of pauses but few studies are devoted to on-line processing taking place at within the pausing itself. A cognitive exploration of pauses via eye-tracking may shed some new light on underlying mechanism during sight translation. Su (2013) examined locations of fixations and directions of saccade within pauses during Chinese-English sight translation and analysed eye-movement data in sight translation in combination with oral production. By identifying cognitive patterns during pauses, the study offers a new perspective to view relations between pauses and cognition and is expected to offer pedagogical suggestions on pause control during interpreting.

In addition, eye-tracking has been adopted to study on-line strategies during sight translation. Although eye movement data is not directly correlated to strategic choice, an in-depth analysis of certain eye measure may help researchers infer the strategies made to cope with specific translation problems. Yang et al. (2011) conducted a preliminary eye-tracking study on a group of professional interpreters during Chinese-English interpreting to see whether strategies widely applied in written translation would also be used in sight translation. The data analysis was mainly based upon the timestamps of interpreters' fixations and production which are synchronized on the same time line. Eye-voice span, the temporal gap between the onset that first fixation is made on certain parts and the onset that target production of that part was first articulated (Jakobsen, 2017), was used as the indicator of interpreters' on-line coordination. The findings suggested that apart from syntactic linearity, the mode-specific strategy, a variety of translation strategies such as addition, omission and conversion were also frequently used in sight translation and the time required for implementing each strategy ranged between 0.5 second to 2 seconds.

4.5 Summary

This chapter reviews the evolvement of process-oriented interpreting study by highlighting the relevance of eye-tracking to examining cognitive load during sight translation. Theoretical foundation and major eye movement measures in reading and translation research are introduced. Special attention is paid to relations between eye movement and reading behaviour, which is expected to reveal the underlying mechanism of sight translation since reading activity plays an essential role in STR. More importantly, the chapter has an overview of process-oriented study of sight translation by means of eye-tracking. The major research topics in this field focus on either cognitive load induced by mode-specific features or on-line reading behaviours during sight translation, along with several studies addressing strategies and pauses during sight translation. Most studies approached these issues by recruiting expert/professional interpreters and interpreting students with different levels of experience. The expert-novice paradigm has been widely applied to relevant studies to examine differences between expert/professional interpreters and novice interpreters in terms of cognitive behaviour under manipulated task conditions. In some cases, untrained bilinguals were also recruited as an extra control group to examine the effect of interpreting training on mental mechanism.

In terms of methodology, almost all above-mentioned studies rely on data triangulation, namely making interpretation based on data from multiple sources to increase validity and reliability. Eye-tracking data was complemented by qualitative data from questionnaires, interviews and output evaluation, which seems to be the agreed-upon approach in process-oriented translation study (Shreve & Angelone, 2010).

Thanks to eye-tracking, progress has been made in cognitive inquiry into sight translation, characterized by increasing diversity of research topics, scientific design and more in-depth and multi-dimensional analysis.

However, there are still some limitations with respect to research design, data analysis and interpretations.

First, in some of the studies, core notions such as “complexity” in Shreve et al. (2010) are not defined in clear manners. As mentioned by the authors themselves, operational definition of linguistic complexity was informal, which may increase potential confounding effect of irrelevant variables thus impacting reliability of data results. For discussing manipulation criteria pertaining to language complexity, a possible better solution is to combine measures in both objective and subjective dimensions and to draw on knowledge from other disciplines such as syntax and psycholinguistics.

Second, despite the richness and depth of eye-tracking data, eye movement measures in most related studies are confined to fixation durations (total fixation or average fixation duration) and fixation counts which only indicate overall effort. It is necessary to enrich the existing list of eye measures in order to yield deeper insights into mental workings of sight translation. Actually, there is a wide range of eye-tracking measures that offer more valuable information on translation processing and should be selected depending on research objectives and research questions. Generally, eye-tracking measures can be divided into two dimensions: the temporal dimensions and spatial dimensions (Yan et al., 2013). Under these dimensions, there are respectively further divisions of eye tracking measures which indicate cognitive processing at different levels. Some of them have been illustrated and are applied to the data analysis in this study.

Third, in light of the its relevance to focus of the present study, word order asymmetry between English and Chinese as one prominent source of translation difficulties has received very limited attention in cognitive studies of interpreting. Applying eye-tracking to sight translation study is expected to yield new lights on this widely debated issue. However, only few studies introduced above address this issue via eye-tracking. Ho (2017) gave a general introduction of linguistic differences between English and Chinese by focusing on principal branching direction (PBD) in sight translation which basically concerns the asymmetric locations of modifiers in the two languages and assumed that PBD was the major disruptive factor in sight translation. A comparison of cognitive load between PBD units and non-PBD units was conducted to see whether structural differences would increase cognitive burden on sight translation. The results partly confirmed the disruptive effect of PBD but that effect was modulated by level of expertise. This is one of the first eye-tracking studies that investigate relations between structural differences and cognition during English/Chinese interpreting. However, the author did not have any special control of syntactic structures but only marked modifiers in source materials that might cause additional problems for further analysis. It is thus possible that final data results might be contaminated by other linguistic factors. More efforts are required to further investigate structure asymmetry in English/Chinses sight translation by covering different asymmetric structures, specifying manipulation of source texts and exploring potential relations between on-line decision making and cognitive load for coping with word order asymmetry.

Lastly, eye-tracking studies of translation & interpreting at the infant stage are likely to be characterized by data analysis and data results description while lose the sight of its theoretical concern or practical implications. Some of the above-mentioned studies depend heavily on reporting eye-tracking data but fail to intensify the relevance of eye-tracking data to interpreting practice or training. Process-oriented studies should be more than presenting data results but seek to address the most fundamental issues in translation profession or pedagogy by description, explanation, generalization, and speculation based on empirical data.

Chapter 5 Research Design

5.1 Overview

The current study is going to explore three major questions: 1) Is word-order asymmetry a major problem trigger in process of English-Chinese sight translation? And can more contextual information and greater working memory span override or offset the disruption of word order asymmetry? 2) How do the interpreter trainees cope with word-order asymmetry during English-Chinese sight translation? Are choices of strategies related to significant differences in cognitive load and on-line reading pattern when asymmetric sentences are processed? 3) Will participants' interpreting performance be affected by word-order asymmetry and modulated by task condition? And how do the participants perceive asymmetry-induced difficulty? To investigate these questions, one sight translation experiment in eye-tracking paradigm, one computer-based working memory test and two questionnaires (pre-test background questionnaires and post-test questionnaires) were administered to first-year interpreter trainees.

Using eye-tracking to record participants' real-time response during sight translation is to examine the degree of impact by word-order asymmetry on real-time processing. Previous studies on word-order issues in interpreting mostly involve product-oriented analysis (i.e., corpus-based study) and generate little knowledge on the "black box". Eye-tracking offers a new perspective to address this issue by measuring participants' on-line behaviour pertaining to cognitive process during interpreting, thus enriching the already obtained off-line data. Moreover, eye-tracking data indicates different stages of processing, such as initial word meaning retrieval and late-stage reanalysis (Henderson & Ferreira, 1990). In the present study, eye-tracking paradigm is expected to offer a new glimpse into word-order asymmetry during interpreting. In the sight translation task, experimental sentences of the English source texts were manipulated so that they are either strikingly different from or highly similar with Chinese in word orders. The interpreting trainees were required to sight translate the pre-controlled materials into Chinese on-spot and their interpreting processes were recorded by an eye tracker.

In addition to sight translation, participants also took part in a working memory span test. Working memory has been one of the central topics among cognitive inquiries into interpreting, but its role in syntactic processing during interpreting, especially in on-line coordination under the influence of word-order asymmetry remains to be further investigated. Therefore, it is hypothesized that working memory might impact or predict participants' performance when word-order asymmetry arises. An English version of reading span test was conducted before the sight translation task. Results of the test scores were analysed in combination with eye-tracking data to identify relations between working memory capacity and syntactic processing.

To supplement the experimental data, two questionnaires were administered. The first questionnaire, completed before the experiments, was to inquire about participants' basic information, language background and interpreting experience; the second one, which was conducted immediately after the sight translation task, was designed to indicate participants' reflection on their interpreting performance and perception of difficulties triggered by word-order asymmetry.

Table 5.1 Overview of a typical experimental session

Task order	Task category	Task name	Task description
1	Survey	Background questionnaire	A survey on participants' profile
2	Working memory test	Reading span task	Test of working memory capacity
3	Eye-tracking experiment	Sight translation task	On-spot sight translation from English to Chinese
4	Survey	Post-experiment questionnaire	A survey on participants' reflection and perception

5.2 Participants

Before the experiment, information about participant recruitment was posted on social networking sites (We-chat groups and Facebook). 30 participants, who were interpreting trainees enrolled in Master program of translation and interpreting (MATI) by the Hong Kong Polytechnic University, volunteered to take part in the study. All participants, aged between 22 to 25 years old (Mean = 23, SD = 1.07), were born in Mainland China with Mandarin Chinese as their first language and began to learn English as second language after 7 years old. All had normal or corrected-to-normal vision. All participants were first-year student and were at the same stage of interpreting training, with at least three months' exposure to sight translation procedures and strategies. All claimed Mandarin Chinese as their A language and English as their B. All participants were naïve with respect to the purpose of the study.

The participants included 28 females and 2 males. No attempt was made to have equal numbers of male and female participants since MATI programs in translating and interpreting in all Hong Kong-based colleges are primarily dominated by female students. Moreover, recruiting enough participants for interpreting studies in itself has been a challenging task due to the limited pool of available professional interpreters and/or interpreting trainees. Although the female trainees notably outnumbered the male ones, the homogenous background of all participants in terms of training period and training stage can minimize the potential effect of gender imbalance.

5.3 Background questionnaires

Before the experiment, a background questionnaire (See Appendix D) was administered to each participant. The questionnaire was designed primarily to obtain the demographic and language-related information including second language proficiency, interpreting experience and self-reported proficiency in sight translation. The questionnaire comprised three sections: the first sections enquired about the interpreting trainees' basic personal information such as age, age of L2 acquisition, gender, education background, frequency of using English (with a focus on reading and speaking) in daily life; the second section focused on students' second language competence, for example, the participants need to offer scores of English standardized tests (TOEFL/ IETLS/ TEM 8 / TEM4) they had attended before being admitted by the MATI program. They were also required to self-evaluate their English proficiency in a scale ranging from 0 to 7 (0 = null, 7 = optimal). The last section was more specific, with a focus on the participants' interpreting training experience. Questions in this section concerned whether the participants had learned sight translation before and for how long, to what degree they believed they were familiar with sight translation skills, how they rated themselves regarding their English-Chinese sight translation competence, whether they had obtained interpreting certificates such as CATTI (China Accreditation Test for Translators and Interpreters) and whether they had any interpreting practice before.

In terms of education background, all participants held at least one bachelor's degree: 19 of them had obtained bachelor's degrees in English language and literature and the remaining 11 had graduated from non-English majors such as history, marketing, psychology, agricultural economy and information technology. Despite the variety of their majors, the questionnaire results showed that most participants were quite fluent English speakers and scored at least 6.5 on IELTS (*M* = 7.3, *SD* = 0.4), with 13 of them obtaining 7.5 and 3 scoring 8 or higher (all participants were required to take an IELTS test before applying the MATI program). In addition, results of self-assessed second language proficiency showed that most participants claimed to be fairly proficient English speakers (*Mean* = 5.6, *SD* = 1.2; 0: very low proficiency, 7: very high proficiency). The questions focusing on language background were supposed to ensure that each participant was highly proficient bilinguals thus excluding the potential confounding effect of second language proficiency, which facilitates the discussion of study results.

As for interpreting skills and practice, all participants had been trained in interpreting and translation (including sight translation) for at least half a year, with 8 of them receiving systematic training for one year or longer. Narrowing down to the interpreting skills of sight translation, participants self-evaluated their sight translation competence, in particular, how familiar they were with basic sight translation skills and strategies on a 5-point scale (0 = not familiar, 5 = highly familiar). Results showed that 50 % of them were quite familiar with sight translation skills and strategies (*Mean* =3.5 *SD* = 0.8) but 2 participants reported a lack of familiarity even all of them were enrolled in the same courses and received training in interpreting for at least one semester (When asked about specific reasons, these two participants explained they often encountered problems in applying the taught skills to practice). When enquired about their interpreter qualifications, one third of the participants had at least one certificate of interpreting: three participants held a CATTI certificate for interpreting (Level Two); four had obtained a level-three CATTI certificate for interpreting and three participants had passed the Shanghai Advanced-level Interpretation Accreditation Test. In regard to their interpreting experience, 40 % of the participants never had interpreting practice before the experiment and the rest only had very limited amount of experience as part-time interpreters.

5.4 Apparatus

All source materials were presented in black against light-gray background on LCD display monitor (1024 X 768 pixels). Participants were tested individually, and their eye movements were recorded by an Eyelink 1000 Plus (SR Research, Canada) eye tracker. The sampling rate adopted in this study was 1000 HZ, which enables a precise and stable recording of eye movements during sight translation. The equipment consists of a Host PC responsible for controlling and monitoring eye-tracking experiment and real-time data collection, a Display PC for presenting stimulus during the experiment and a camera mount which captures participants' eye movement. The participants were seated around 65 cm from the screen of Display PC and rested their heads on a chin rest to avoid head movements. During the experiment, only data for the right eye was recorded. The original programs (one for sight translation in single sentence context, the other for sight translation in discourse context) were created using Experiment Builder 2.1.140 and eye-tracking data were analyzed with Data Viewer 3.1.97 and SPSS 23.

5.5 Design and Procedures

5.5.1 Working Memory Test

Working memory span is defined as the mental resources available for the concurrent storage and processing of information, which is an active part of human processing system (Daneman & Carpenter, 1980; Just & Carpenter, 1987). Based upon Baddeley and Hitch's working memory model (1974), a variety of tests have been designed to measure working memory span such as listening span, digit span, reading span and operation span. These working memory tests require not only information storage but also concurrent processing of additional information, which often take the form of dual tasks: memorization of target stimuli (words or digits) and a complex, secondary task such as comprehension or calculation (Case, Kurland, & Goldberg, 1982; Turner & Engle, 1989). Methodologically, these span tests have proven to be valid and reliable measures of working memory capacity (Conway et al., 2005) and in the present study, reading span test was employed to measure participants' working memory capacity.

Reading span test is considered as a measure of general working capacity which is highly correlated with reading and listening comprehension (Daneman & Carpenter, 1980; Liu et al., 2004). It was one of the first working memory span tests tapping both the storage and processing components of working memory. In reading span tests, participants read the target sentences, judge the semantic plausibility while trying to remember certain words of the sentence (generally the last word), at some cases, letters at the end of the sentence (Kim, 2010). The target sentences are presented in groups in size ranging from two to six (Conway et al., 2005). Participants need to recall all the last words (or letters) at the end of the set in right order (Köpke & Signorelli, 2012).

In this study, all participants were required to perform an English version of Reading Span Test (Daneman & Carpenter, 1980) for two major reasons: First, interpreters during STR obtain source information via reading comprehension and source texts were written in English. Second, reading span task is the most appropriate type of measure of working memory in the case of L2 processing research (Juffs & Harrington, 2011), which caters to the need of studying English-Chinese sight translation.

The English reading span task used in the current study was developed by Kane et al. (2004) and was used in various studies (e.g., Kim, 2010; Kim, Christianson, & Packard, 2015; Kim, Packard, & Christianson, 2016). A total of 42 English sentences were presented and the length of each sentence varied from 10 to 15 words. These sentences were either semantically plausible or semantically implausible: among the 42 sentences, 19 were semantically plausible while the other 23 were implausible. There was a letter at the end of each sentence, which together constituted one single item and a set consisted of 2, 3, 4 or 5 items. The sets of different sizes were presented in randomized order to prevent participants from guessing the research purposes or strategically focusing on to-be-memorized letters. There were 12 trials in the whole task with each set size occurring three times. All the items of the reading span test are listed in Appendix F.

The reading span task was developed and operated in E-prime and self-paced by the participants. The participants were seated in front of a Windows laptop, and first read the instructions. There were several warm-up practices after the instruction to help participants familiarize themselves with the task procedures. When the real experiment started, the first item appeared on the screen. The participants were required to read aloud the sentence, answer “Yes” or “No” to judge whether the sentence is semantically plausible, then read aloud the letter at the end of the sentence while trying to remember that letter. They were not allowed to write down anything until the end of a set which was marked by three question marks (“???”). The question marks signaled the participants to write down the letters presented in the last set and the letters should be recalled in right serial order. After that, the participants pressed space bar to move to the next set and repeated the procedures introduced above until the end of the whole task. The following figure, taken from Kim (2010), illustrates basic procedures of a set size of two.

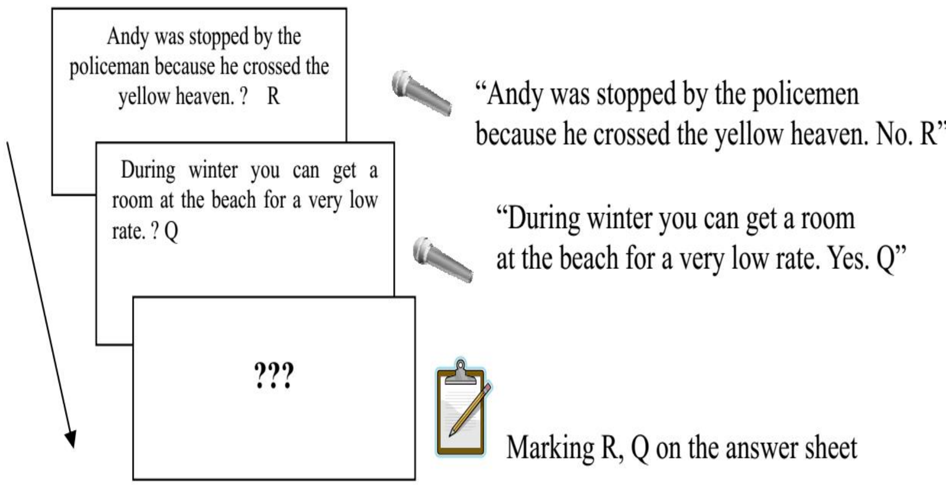

Figure 5.1 Basic steps of a set size of two in reading span test

It took the participants around 15 minutes to complete then whole task. Their responses were scored based on an "All-or-nothing" principle, one of the most widely applied scoring methods in previous studies (Conway et al., 2005). Each item of the set received one point if all items were recalled in correct serial order. No credit was given if any of the items was not recalled or items were recalled in wrong orders. The maximum score for the test was 42.

5.5.2 Sight Translation Task

a. General design and manipulation of source materials

The experiment adopted a 2 (sentence type) X 2 (task condition) within-subject design. In other words, each participant was exposed to both types of sentences under two task conditions.

Two types of sentences, namely the critical sentences and the control sentence, are adopted as experimental materials, the control of which is based upon degree of word order asymmetry. All critical sentences contain specific structures in English: either object-extracted relative clauses (ORC) or passive constructions (PC). These two types of structures are syntactically dissimilar to Chinese as typical examples of word order asymmetry and are supposed to trigger greater cognitive load during sight translation. In contrast, the control sentences are highly similar with Chinese in word orders. Syntactically speaking, the control sentences are assumed to cause little difficulty in interpreting since the participants can merely adopt a linear word-by-word approach, following the original English word orders. The two types of sentences are comparable in sentence length and word frequency and of equal numbers.

According to previous literature, readers have greater difficulty in processing English sentences that contain ORCs than sentences containing SRCs (e.g., Wanner & Maratsos, 1978); And this SRC preference in monolingual reading has been confirmed by evidence from eye-tracking (Staub, 2010; Vasishth, Chen, Li, & Guo, 2013; Wu, 2009). Therefore, processing ORCs in English requires greater cognitive load, which may become a major source of difficulty in both monolingual and bilingual condition. As for passive constructions, previous discussions have emphasized that passive sentences, in particular those with long and complex agents, occur frequently in written English but are seldom applied in Chinese (e.g., Xiao, 2006; Xiao & Dai, 2010). Therefore, this sentence structure may constitute greater relative complexity for native speakers of Chinese, and the difficulties can be intensified in interpreting due to constrained cognitive resources.

All critical sentences, if interpreted into Chinese, are supposed to trigger greater difficulty than the control sentences. These experimental sentences are subject to two task conditions: STR under single sentence context (Condition 1) and STR under discourse context (Condition 2). In the first condition, each sentence was presented separately, and the participant interpreted these randomly ordered sentences one by one; in the second condition, the participants need interpret coherent speeches in which the experimental sentences were embedded. In addition, they were also offered background information of the source speech before the task in Condition 2. Background information has been considered as an important factor that shapes interpreting quality. A series of empirical research found that background information facilitates interpreting performance: For example, background information helps improve interpreting accuracy and completeness and boost comprehension and processing efficiency of metaphors during interpreting (Zheng & Xiang, 2014).

The essential difference between the two task conditions is the amount of contextual support involved. As compared to single sentence context, discourse context involves a greater amount of contextual information. According to the interactive view of parsing, syntax and semantics interact during the comprehension process (e.g., Britt & Perfetti, 1992; Taraban & MaClelland, 1988). When initially processing a sentence, reader simultaneously used all available information including lexical, syntactic and contextual information (Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). This is also applicable in translation during which translators rely upon all types of information to facilitate language comprehension and target production. Therefore, as compared to single sentence context, a discourse context was expected to offer more contextual support for the participants' on-line processing. Processing under a wider context is supposed to encourage more sense-based interpreting thus reducing the dependence on linguistic forms of asymmetric sentences. The interpreters could draw on contextual clues in the text to establish relations between different segments, make anticipation and improve efficiency instead of dwelling on the surface language and being trapped in syntactic complexity. Moreover, more contextual support may also activate their own world knowledge in long-term memory, which further facilitate their on-line processing. In short, it was expected that discourse context in Condition 2 could to some degree offset the disruption of structural discrepancy and alleviate the cognitive load.

The source materials in Condition 1 consisted of 24 experimental sentences and several fillers. Among the 24 experimental sentences, 12 were critical sentences with 6 containing ORCs and 6 containing PCs and the remaining 12 were control sentences. To imitate a real-life interpreting condition as close as possible, all source sentences were chosen and adapted from authentic speeches at diplomatic settings. To minimize the effect of domain-specific knowledge, most sentences were related to the topic of economic development with which interpreting trainees had been quite familiar and some are of general nature. With a view to examine effect of word order asymmetry, these original sentences were rewritten so that all sentences were of the same length (21 words). Only long ORCs (containing at least six words) and PCs with long agents (containing at least six words) were adopted. This was due to the concern that the participants, who were proficient English speakers and had been trained in interpreting for one semester, would not encounter much difficulty if the original sentences were not "complex" enough. The following two examples illustrate the distance in relative clauses and different processing costs required.

Example 5.5.2-1

Long ORC

To be more efficient, we must make full use of the funds [we have received from member states and non-governmental organizations.] *RC*

Example 5.5.2-2

Short ORC

To be more efficient, we must make full use of the funds [we have received] *RC*.

It is assumed that word length of ORCs is closely related to eye movements and on-line processing effort. Eye-tracking studies by moving-window paradigm or boundary paradigm have revealed a consistent size of perceptual span for readers of alphabetical orthographies (i.e., English, Spanish and French): the span extends from the currently fixated word but no more than 3-4 letters to the left of the fixation (Rayner et al.,1980, Underwood & McConkie, 1985) and to around 14-15 letters to the right of the fixation (Rayner, 1986; Rayner & Bertera,1979; Rayner et al., 1989). Therefore, ORCs that contains only 3 or 4 words can be easily recognized by the reader within one fixation and the whole ORC can be processed as one single meaning unit during interpreting, which presumably causes fewer problems than long ORCs for the participants. And this word length issue also holds for manipulation of PCs.

As for the discourse context condition (Condition 2), two source texts of equal length (around 305 words) were used as stimulus. They should ideally be extracted from an existing corpus of real interpreting settings to ensure ecological validity. However, considering the research purpose and principles for experimental design, using fully authentic materials proved impracticable since the study required sentences constructed with clear criteria which can hardly be taken from naturalistic speech. All experimental sentences, irrespective of the task condition, should be specially designed to have comparable length, word frequency and most importantly, to contain specific structures. But there were some measures to offset the artificiality: the two source texts were selected from speeches made at international conferences written for oral purpose, which was suitable for sight translation: Text A was selected from the opening speech by H.E. Le Luong Minh, Secretary-General of ASEAN at Future of Asia Conference in June, 2017 and Text B was extracted from the President Sirisena's speech at the Plenary Session of the Boao Forum for Asia, 2015. To meet the research purpose, some sentences of the original speeches need be rewritten, and the rewriting was kept to a minimal level to retain the authenticity and coherence of the source texts. The same principles were applied to sentence manipulation in discourse context so that experimental sentences under both conditions were matched in word length (21 words) and topic. The two texts consisted of 24 experimental sentences: The final version of the source texts contained respectively 6 critical sentences (3 with ORCs and the other 3 with PCs) and 6 control sentences. Every two critical sentences were separated by at least one filler to avoid the spill-over effect. Table 5.2 displays general profiles of the manipulated experimental sentences. All source materials are listed in Appendix B.

Table 5.2 Basic information on the experimental sentences

	Critical sentences in Condition 1	Control sentences in Condition 1	Critical sentences in Condition 2	Control sentences in Condition 2
Number of sentences	12 (6 with ORCs and 6 with passives)	12	12 (6 with ORCs and 6 with passives)	12
Words per sentence	21	21	21	21

To ensure that the word frequency of the critical sentences and control sentences are comparable, words with a very low frequency (<10/per million) as measured in BNC (British National Corpus) were excluded and replaced by more common synonyms. In some cases, the low frequency words can hardly be removed or substituted due to their role in meaning construction, thus their Chinese explanations were offered before the task to facilitate comprehension during STR. All the content words of the experimental sentences were grouped based on their frequency in BNC: < 100/per million words, 100-200/per million words and > 200 per million words. In the following table, the proportion of words at different frequency levels in the symmetric sentences and the asymmetric sentences is presented:

Table 5.3 Proportion of words at different frequency levels in asymmetric and symmetric Condition

	Asymmetric sentences	Symmetric sentences
Level-1	56%	60%
Level-2	28%	23%
Level-3	16%	17%

As shown above, the distribution pattern of word frequencies are similar between the two sentence types, indicating that the word frequencies in the critical and control sentences are comparable. However, in some cases, low frequency word does not necessarily cause comprehension or translation difficulty, for example, the word "forum" has only 7 hits in per million words as measured in BNC, but is commonly used at interpreting settings. Thus, to supplement the word frequency manipulation, word familiarity of both types of sentences were examined: two first-year interpreting students from a key college in Mainland China scored on a Likert five point scale to indicate to what degree they believe that low familiarity of words in the sentence would slow down their on-line comprehension during STR (1= very low familiarity, 5= very high familiarity). All 48 experimental sentences were scored by the two students and the mean score for both types of sentences are presented as follows:

Table 5.4 The scoring result of word familiarity test

	Mean degree of familiarity	*SD value*
Student 1-critical sentences	4.3	0.6
Student 1-control sentences	4.5	0.5
Student 2-critical sentences	4.6	0.5
Student 2-control sentences	4.8	0.4

According to the table, the two types of sentences have similar degree of word familiarity as judged by the student interpreters, and there was a moderate strength of agreement between the raters (For ratings of the critical sentences: K= .551, $p < .05$; for ratings of the control sentences: K= . 44, $p < .05$).

Under Condition 1, single sentences as stimulus were presented one-by-one in randomized order. No prior topic information would be provided, and the participants should start interpreting immediately after the target sentence appears on the screen. When they completed, they moved on to the next sentence by pressing space bar. Under Condition 2, the two source texts were presented in counterbalanced order. Participants were offered the background information of the source texts before the translation. When they completed the first text, they moved on to the second text by pressing the space bar.

b. Assessing difficulty and coherence of experimental materials

To ensure that the structures of critical sentences result in greater translation difficulty whereas the controlled ones do not, two experienced interpreting teachers and another two interpreting trainees from a key college in Mainland China judged the syntactic difficulty of all experimental sentences and also the cohesion of the texts in Condition 2. None of them participated in the real experiment. Here only subjective evaluation was adopted since it may serve as a better indicator of "translation difficulty" as compared with objective evaluation. One method of objective evaluation is to measure the readability of source texts since word length and sentence length can to some degree indicate lexical and syntactic difficulty (Liu & Chiu, 2009). However, some point out that reading difficulty does not necessarily equal to translation difficulty (Jensen, 2009), and in the current study, the word frequency and sentence length of experimental materials have already been controlled. Therefore, subjective evaluation was employed to see how interpreting teachers and students perceive the structural difficulty of the source materials.

For sentence difficulty assessment, they assigned a number from 1 (very easy) to 5 (highly difficult) on a Likert 5-point scale for each of the experimental sentences according to how likely they believe the sentence structures will cause great difficulties if sight translated into Chinese by novice interpreters (first-year interpreting students). As for the cohesion evaluation, the raters made choices on another 5-point scale to indicate the degree of source text cohesion (1= not coherent at all; 5 = highly coherent) based on their intuition and experience. Results of the independent sample t-test on the mean score of the experimental sentences demonstrate that the difficulty level of the critical sentences (M= 4.6) was significantly higher than of the control sentences (M=2.6) ($t[42]=17.868$, $p < .001$). The manipulation of sentence structures does not affect the coherence of the source texts (the average coherence is 4.3 for Text A and 4.5 for Text B, suggesting a high level of textual coherence.

c. Procedures

Each participant was individually tested in a sound-proof room with artificial light. Before the experiment, the participants were asked to sign a consent form and fill out the background questionnaires. They were also briefed about the general procedures of the task and took warm-up practices under the instruction of the experimenter. The whole experiment, made up of two sessions (session one—sight translating single sentences; session two—sight translating passages with background information), lasted about 60 minutes, and there was a short break between the two sessions. The short break was expected to minimize fatigue caused by intensive cognitive load during the interpreting and also by the infrared rays illuminated on the eyes for a long period of time.

During the warm-ups and the experiment, the participants were seated 60-65 cm from the Display PC screen with the head leaning on a chin rest. In session one, participants sight translated the 24 experimental sentences along with fillers. At the beginning of the session, participants need first read the instructions on the screen, when they fully understood the experiment conditions and procedures, they pressed any button to begin a 13-point calibration and validation. The session included a warm-up task in which participants tried to sight translate a set of English sentences matched with the experimental sentences in length and word frequency but containing no complex structures. The participants went through the warm-up practice so as to get acquainted with the procedures of calibration and validation. In addition to the warm-up, there were 32 trials, each trial presenting a single English sentences. The 12 critical sentences and 12 control sentences were intermixed with 8 fillers and were presented on the screen in an individually randomized order. Each trial started with a cross at the location where the source sentence would begin. The cross disappeared until the participants fixated upon it and then the sentence to be interpreted was presented. There was a very quick fixation drift correction between every two sentences to ensure eye-tracking data stability. When participants finished interpreting, they pressed the space key immediately to proceed to the next sentence.

Session two consisted of three trials. The first trial was a warm-up practice. It consisted of two short English paragraphs which were of general nature and contained no complex structures or low-frequency words. The other two trials represented the two source texts respectively. Before each trial, participants first went through a 13-point calibration and validation. Each trial started with a small cross at the upper left corner of the screen where the source text would begin. When participants fixated upon the cross, it would disappear, and the first paragraph of the source text would be shown, and participants were required to start their translation immediately. If the eyes missed the cross trigger, another round of calibration and validation had to be performed again. The orders of the two source texts (experimental trials) were randomized. Participants pressed the space key to move to the next paragraph when they were done with the last one. There was a short drift correction between the two experimental trials in case the eyes were not landing on proper positions. To make it easier to identify which line of the text was being processed, double-spaced line was adopted for all source sentences and texts.

During both sessions, participants were required to begin their translation immediately after the source stimulus appeared. They can interpret at their own pace and there was no time limit for all the tasks. They were expected to maintain an accurate and fluent delivery and stick to the interpreting instead of giving up halfway when encountering translation difficulties. Their eye movement as well as target output were recorded synchronically by the *Eyelink* program for further analysis.

5.5.3 Post-experiment Questionnaire

Immediately after the sight translation sessions, a post-experiment questionnaire was administered. The questionnaire was designed to investigate how interpreter trainees felt about their performance and how they perceived and dealt with word asymmetry during sight translation. The participants were first required to self-evaluate their performance during the two sessions respectively on a 7 point scale (1: not satisfied at all; 7: very satisfied). Then they were asked whether they had noticed the changes in source sentence complexity as reflected by degree of word order differences between English and Chinese. There were also questions asking the participants about the primary strategy they preferred when encountering word order asymmetry and the strategies that are most frequently brought up and practiced in their daily training. The final question was about participants' perception of structure-induced difficulties, i.e. to what extent they believed that structural differences would negatively impact their interpreting performance. The questionnaire is listed in Appendix E.

In addition to self-evaluation and multiple-choice questions, participants were provided the scripts of the source materials and they were required to mark the sentence/sentences which, according to their own judgement or institution, had resulted in greater structural difficulties during the task. There was no particular instruction on the type and number of sentences they were expected to choose. If the participant believed that they had not encountered specific difficulties, they did not have to mark any sentence. The marked sentences by the participants are supposed to indicate their subjective perception of syntactic difficulty, which will be analysed in combination with the objective data, i.e., the cognitive load as measured by eye data.

5.6 Data Analysis

5.6.1 Eye-tracking Data Filtering

30 interpreting trainees took part in the study but one of them had to quit the experiment due to repeated failures in pre-task calibration and validation. Eye-tracking data of 29 participants was collected and subject to a set of filtering thresholds for final analysis. First, extreme data was excluded in case that outliers may distort the overall pattern. One of the participants, for example, spent significantly longer time than the others on tasks under both conditions and had a considerably denser distribution of fixations than the other participants. The recorded eye movement video showed that she did not start production until she finished reading the whole sentence or even several consecutive sentences and often lingered on individual words for several seconds or longer. In addition, there were also more frequent and longer pauses, self-corrections and omissions detected in her production. All these indicated that the participant had not acquired basic skills of sight translation or failed to apply what she had learnt due to nervousness or unfamiliarity with eye-tracking set ups. Her on-line processing was essentially a process of oral translation after reading instead of concurrent reading and translation as required by on-spot sight translation. Through her performance, there was no sign suggesting coordination between reading comprehension and reproduction. Therefore, her data had to be rejected.

One possible result due to absence of time constraint is that production of few participants may lag too far behind the reading, which not only slows down the whole delivery but also reduces the expected near-simultaneous mode to a consecutive one. Therefore, eye-tracking data and audio recordings of all participants were submitted to an examination of “synchronization” by comparing the onset of participants’ first fixation on the experimental stimulus and the onset when they produced the first word. For instance, if the first fixation fell upon the stimulus single sentence at

300ms and the first utterance of translation started at 1200ms, the temporal distance between these two timestamps (Eye-voice span/EVS) is therefore shorter than 1 second, which indicates that the participants managed to coordinate the input and output. Drawing upon the common practice in identifying long and short EVS in interpreting study (see Timarová , Dragsted, & Hansen., 2011) the synchronization check was conducted and data another one of the participants was removed since no evidence for concurrent reading and translation was found.

Lastly, fixations that are too short or too long are seen as outliers caused by either individual differences or technical problems during recording, which may distort the overall data pattern. Therefore, for the data of the remaining 27 participants, fixations shorter than 80 ms or longer than 1200 *ms* were eliminated from the final analysis (Drieghe, Pollatsek, Staub, & Rayner, 2008; White, 2008). The data of another participant were excluded due to abnormal frequency of small fixations (fixations shorter than 80ms).

5.6.2 Eye-tracking Data Analysis

a) Data Normality Test

Original trial reports and AOI (Area of Interest) reports were created in Data Viewer (SR research, Canada) and exported. For the global analysis, each experimental sentence was seen as one single AOI; for the local analysis, each word of the experimental sentence was set as one AOI. The original data files were imported to SPSS statistics 23 for further analysis. Operation of regular analysis including ANOVA test or t-test in SPSS requires that a given data set is normally distributed. Normal distribution of data refers to symmetric concentration of residuals around the mean value of the distribution, which resembles a bell-shaped curve (Rasinger, 2008, p.130). If data set is heavily skewed, containing random outliers, the significant effect may be caused by random effect rather than by the genuine effect due to the fixed variables.

In the present study, the value of eye-tracking metric as dependent variables were first submitted to normality test in SPSS by Shapiro-Wilk test. This is to examine the degree of data skewedness and to identify outliers which would be removed from the data set. If certain dataset was heavily skewed, with most data points concentrating around one side of distribution mean, the data would be transformed using a logarithmic function (Baayen, 2009, p.31). Then two-way repeated measures ANOVAs were administered for each dataset respectively if they conform to normality distribution and there was no significant skewedness. Otherwise, non-parametric test would be conducted instead.

b) Synchronisation of Eye-tracking Data and Audio Recordings

Representing the timing of eye movements and the target output at one single timeline is crucial for identifying or inferring cognitive processing when certain words are produced, which is also important for calculating eye-voice span (EVS) for analysis of coordination effort. Although participants' eye movements and their output were synchronically recorded by the Experiment Builder program, the timing of these two events were marked on different clocks: the timestamps of eye-tracking data were based on the Host PC while those of audio recordings were marked on the Display PC. Generally, if marked on the same timeline, the action of sound recordings is triggered later than the start of eye movement recordings and the temporal gap ranges from dozens of milliseconds to hundreds of milliseconds. To minimize the effect of this mismatch, certain variables such as the onset of voice recordings and the current time of PC were inserted during programming for calculation of the temporal distance. Eye movements and oral output could thus be synchronised when the temporal gap was identified.

5.6.3 Transcription of Audio Recordings

To assess interpreting quality and identify strategies adopted during sight translation, 26 participants' recordings for all experimental sentences were transcribed to written texts and the source sentences and target sentences were aligned manually. Schjoldager (1996) pointed out that all transcripts will miss out some details and tend to be relative subjective. To minimize the subjectivity and possible misunderstanding of original recordings, several principles were followed during transcription: First, all verbal information such as repetition, self-correction and filled pauses should be faithfully recorded; Second, serious disfluencies (such as unnatural pauses occurring within the word or the clause) should be marked with specific signs, for example, unnatural pauses in this study are indicated by the symbol "[]".

5.6.4 Error Analysis of the Target Speeches

Performance of the interpreting output was analysed based on the errors observed in the two conditions. To use an error-based analysis is to reduce potential effects of subjectivity if different evaluators were invited for quality assessment. Moreover, error detection and classification are methodologically more accessible than quality evaluation in a holistic manner or based on certain criteria.

Drawing upon the method applied by Agriofoglio (2004), errors made by the participants were first divided into meaning and expression failures. Meaning failures refer to change of original meaning, omissions and incomplete sentences. Here omissions were counted as meaning failures only when they resulted in information loss. Legitimate omissions, for example, omission of non-critical information due to strategic decision-making, were not classified as meaning errors. Expression failures include "syntax and style problems, lexical problems (such as inappropriate collocations) and grammatical mistakes (Agrifoglio, 2004, p.51)". In this study, when an error fell into both types, it would be counted as meaning failures since accuracy or faithfulness is the primary concern for interpreting quality judgement.

The output of all participants was transcribed and aligned with the source texts. One interpreting teacher, with no less than 8 years of teaching experience, identified and classified errors from the audio recordings. The teacher could check the transcription if some utterance were not clearly heard in the audio files. The results were later reviewed by the author herself who relied on the transcription. No inter-rater reliability was calculated since there were few disagreements on error detection or classification.

Chapter 6 Data Results

This chapter reports on the results of data collected during the study, including data from the pre-experimental and post-experimental questionnaires, reading span test, eye movements in sight translation tasks, strategy use and error analysis results of interpreting output.

6.1 Results of Background Questionnaires

30 participants volunteered to take part in the study and each filled out the background questionnaire before the experiment. These interpreting trainees were recruited from the MATI program of the Hong Kong Polytechnic University and had completed one semester of interpreting & translation training before the study. They had gone through similar procedures of application (such as taking English standardized test and interview), registered the same core courses and had similar amount of exposure to interpreting teaching and in-class exercise. The relatively homogeneous background helps reduce impact of uncontrolled factors such as age, gender, education experience and teaching norms varying between different institutions.

All participants were native Mandarin Chinese speakers and highly proficient in English, their second language. This was supported by the results of the background questionnaire: All participants had taken IELTS exams and the mean overall score is 7.3 ($SD = 0.5$, $Max= 8.5$; $Min =6.5$), with three of them scoring 8.0 or more. Most participants (63%) had not received sight translation training before the admission, eight participants reported that they had learned some basic sight translation skills for no shorter than one year. In terms of self-assessed familiarity to sight translation, more than 70% of the participants claimed to be very familiar in procedures and techniques of sight translation, which may be attributed to their daily training and extensive after-class practice for the upcoming final exams. As introduced by the MATI program leader, one of the focuses during the first semester was sight translation teaching, which was seen as a preluding skill for simultaneous interpreting teaching at the second semester.

6.2 Cognitive Load as Indicated by Eye Movements

This section reports on the cognitive load during sight translation as measured by global and local eye measures. The global eye measures refer to the time and number of fixations on processing the whole sentence, which are indicative of overall cognitive load. And local eye measures reflect different stages of processing and mirror efforts devoted to each individual word, which are adopted for local analysis. In translation research, fixation duration and fixation counts have been frequently used to make observation on cognitive processes underlying translation (O'brien, 2009; Hvelplund, 2014). Considerable empirical evidence demonstrate that fixations are sensitive to linguistic variables such as word frequency and word predictability (Rayner, 1998; Rayner, 2009): Generally, longer and more fixations are associated with more effortful processing, which offers evidence for task difficulty.

Dwell time (the total time spent on certain regions) and fixation counts are extensively applied to translation process research as indicators of global effort. However, they do not provide sufficient inferences on time courses of on-line processing. Thus, it is necessary to adopt local eye measures in this study to examine word-level processing by distinguishing early measures from late measures. Four local measures were used for micro-analysis: first fixation duration (FFD), first pass reading time (FRT), second pass reading time (SRT) and regression path duration (RPD).

First fixation duration is duration of the first fixation made upon a word, which is considered an indicator of early processing (Rayner, 1998). It is one of the most commonly adopted eye measures reflecting lexical assess and automatic processing (Yan et al., 2013). First pass reading time (also known as first pass fixation time/ first run dwell time) refers to the total fixations in a region from first entering the region and leaving that region (Clifton et al., 2007). Second pass reading time (also known as second pass fixation time/ second run dwell time) is the sum of all fixations made after the first pass reading. Regression path duration is the total time of all fixations made on the word and also the fixations occurring to the left of the word, from the first fixation upon the word to the first fixation to the right of the word (Rayner & Liversedge, 2004; Schaeffer et al., 2016). It includes sum of all fixations related to regressions, thus often taken as the indicator of problem detection, reanalysis and integration at later stage (Yan et al., 2013; Schaeffer et al., 2016). The following sentence from the experimental materials is presented to illustrate the above eye measures:

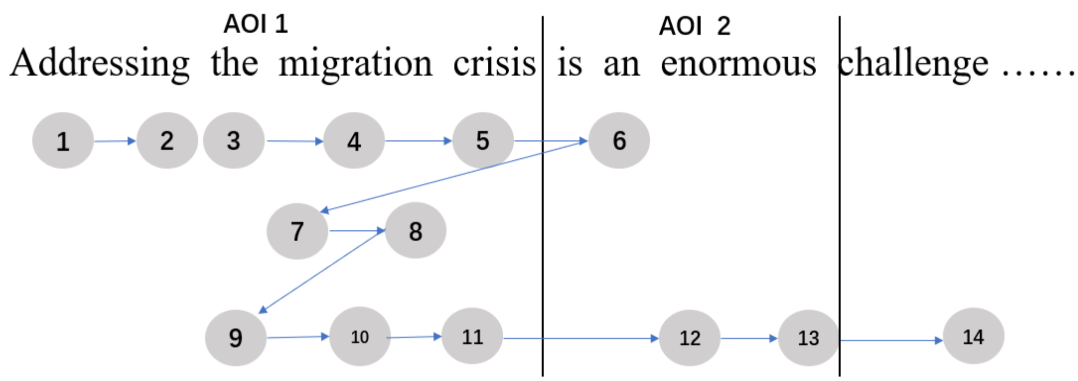

Figure 6.1 *Illustration of eye measures during on-line sentence reading*

In the example in Figure 6.1, there are two segment-based AOIs. The small circles represent the fixations made during reading and the arrows indicate the saccade direction of eyes. Fixation 1 is the first fixation made on AOI 1. Fixation 1, 2, 3, 4, 5 constitute the first pass reading time, which is the sum of fixations made between the first fixation entering AOI 1 and the first fixation to the right of AOI 1 (Fixation 6). After the sixth fixation, the eyes move backwards to AOI 1, and renters AOI 2 after Fixation 11. And the sum of Fixation 7, 8, 9, 10, 11 refers to second pass reading time. For AOI 2, the regression path duration covers both fixations within the region (Fixation 6, 12, 13) and fixations made in earlier areas that have been processed (Fixation 7—11 in this example). Thus, regression path duration of AOI 2 is the sum of Fixation 6 —13.

6.2.1 Research Questions Revisited

The first research question focuses on cognitive load induced by word-order asymmetry, with an attempt to explore whether asymmetric structures cause greater difficulties for interpreting trainees, and whether discourse context could to some degree reduce cognitive load. Mean values of the global eye measures (dwell time and fixation counts) and local eye measures (FFD, FRT, SRT and RPD) for each participant when processing critical sentences and control sentences across two task conditions will be submitted to SPSS 23 for statistical analysis. Based upon previous studies (Seeber & Kerzel, 2012; Wang & Gu, 2016; Wang & Zou, 2018), it was assumed that cognitive processes during sight translation under both conditions would be hampered by word order asymmetry, as evidenced by significantly greater cognitive load for critical sentences at both global and local levels. But participants under Condition 2 would be less susceptible to asymmetry-induced difficulties since discourse contexts and background information offered before Session Two help facilitate meaning-based interpreting and reduce dependence on surface structures.

Descriptive statistics (mean value and standard deviate value) and inferential statistics (parametric and non-parametric tests in SPSS) were combined to examine the effect of word-order asymmetry and task condition on global and local effort as well as the potential interaction between the two independent variables. Two-way repeated measures ANOVAs were conducted on each of the eye measures introduced above to analyze general cognitive load and local cognitive load for task condition (F1) and sentence type (F2).

6.2.2 Overall Cognitive Load

This section reports on the two-way repeated measures ANOVA tests on dwell time and fixation counts to examine in what way and to what extent participants' on-line processing was disrupted by word order asymmetry and how the disruption is modulated by task conditions. ANOVA test assumes that the distribution of data points in dataset conforms to normality, otherwise the test analysis might be affected by skewed pattern and random outliers. To check the normality distribution, Shapiro-Wilk test was carried out on the datasets and the results demonstrated that participants' dwell time and fixation counts were normally distributed. Two significant outliers were removed from the dataset in case they potentially skew the observed data distribution and obscure the data pattern (Hanson & Mellinger, 2016, p.181). After the normality test, the remaining 24 observations were submitted to ANOVA analysis.

The descriptive statistics was first calculated: Mean values and standard deviation values for the dwell time and fixation counts are presented in Table 6.1. It can be seen that participants always spent longer time and had more fixations for processing the critical sentences, which indicates a negative impact of word order asymmetry. But the degree of the impact and its relations to task condition need be further examined by inference statistical analysis.

Table 6.1 Mean (SD) values of eye movement indices for overall cognitive load

	Critical sentences	Control sentences
Dwell time (*ms*)		
Condition 1	18992(2775)	15809(2003)
Condition 2	14748(2655)	10727(1872)
Fixation counts		
Condition 1	51(11)	44(10)
Condition 2	58(10)	43(9)

Condition 1: interpreting under single sentence context; **Condition 2**: interpreting under discourse context

***Dwell time*:** As shown by the two-way repeated measures ANOVA, the main effect of sentence type on dwell time was significant [$F(1, 23) = 169.7$, $p < .001$]: under Condition 1, dwell time for processing critical sentences(M = 18992, SD = 2775) was significantly longer than that for control sentences (M = 15809, SD = 2003); Likewise, the same pattern was detected in Condition 2, significantly greater time was devoted to critical sentences (M = 14748, SD = 2655) than control sentences (M = 10727, SD = 1872). The main effect of task condition on dwell time was also significant [F (1, 23) =87.22, $p < .001$]: the time spent on critical sentences in Condition 1(single sentence condition) (M = 18992, SD =2775) was significantly longer than that in Condition 2 (discourse context condition) (M =14748, SD = 2655), and dwell time for control sentences in the first condition (M =15809, SD = 2003) was significantly longer than in the second condition (M =10727, SD = 1872). The interactions between sentence type and task condition was not significant [F (1, 23) = 3.26, p= .084].

The effect plot is presented below to illustrate how dwell time for processing the critical and control sentences varied across the task conditions. According to Figure 6.2, although critical sentences consistently generated longer dwell time than the control sentences, sight translation under discourse context was affected by asymmetry-induced complexity to a much lesser degree since dwell time for both types of sentences was shorter in the right side than in the left.

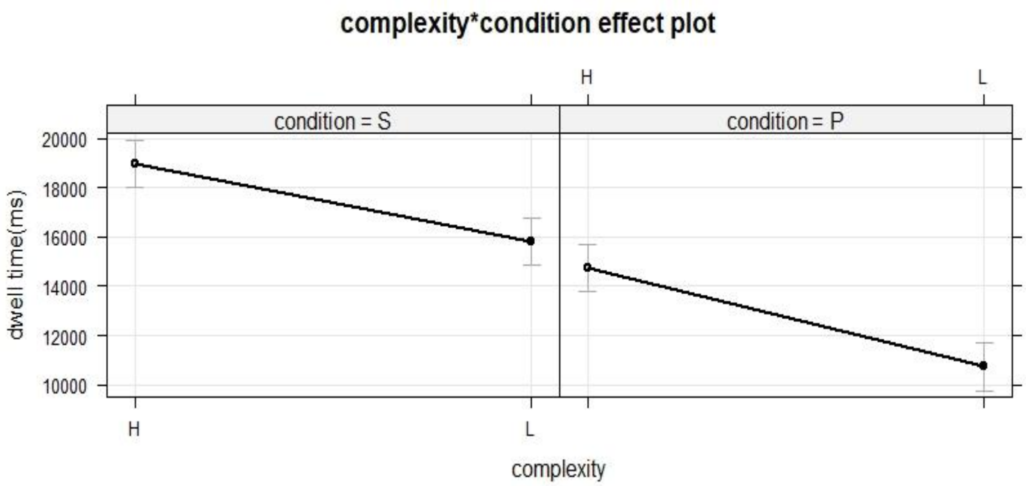

Figure 6.2 Effect plot for the dwell time

S: single sentence context; **P:** discourse context; **H:** high complexity (critical sentence); **L:** low complexity (control sentence)

Fixation count The differences of mean fixation count between critical sentences and control sentences were statistically significant, as evidenced by the strong main effect of sentence type [F (1, 23) = 217.67, $p < .001$]: under Condition 1, participants had considerably more fixations when processing critical sentences (M =51, SD = 11) rather than control ones(M = 44, SD = 10) ; similarly, fixations for critical sentences in Condition 2 (M =58, SD = 10) were also significantly more frequent than those for control sentences (M =43, SD = 9). However, there was no significant main effect of task condition: the differences of mean fixation count under the two conditions failed to reach statistical significance [F (1, 23) = 2.83, p = .106]. In addition, there was a significant cross-over interaction of sentence type and task condition [F (1,23) =37.32, $p < .001$]:

result of estimated marginal means revealed different patterns of fixation counts in the two conditions: participants had more fixations in discourse context when processing critical sentences but had more fixations in single sentence context for processing control sentences. To get the further statistics on the interaction pattern, the interaction was broke down to examine the simple effect of task condition. The simple main effect test showed that for processing the critical sentences, the fixation count in Condition 2 was significantly more frequent than in Condition 1 [$F(1,23)=12.053$, $p=.002$]; whereas for the control sentences, although the mean fixation count in Condition 1 was slightly higher than in Condition 2, differences between the two conditions failed to show significance [$F(1,23)= .155$, $p=.658$].

6.2.3 Local Cognitive Load

This section reports on two-way repeated measures ANOVAs on the four local eye measures to explore whether and how word order asymmetry and task condition affect participants' processing at word-based level. Previous reading studies demonstrate that fixations for last word of a sentence is considerably longer than the average fixations of other words in the sentence, which is known as the sentence "wrap-up effect" (Just & Carpenter, 1980). More time is devoted to the final word not because of the word itself but of the meaning integration of the entire sentence at this point (Frenck-Mestre, 2005). Therefore, the final word of a sentence is poor region as a word-based eye movement analysis. In the present study, to avoid wrap-up effect, end words of all experimental sentences were excluded from the local analysis.

The following table displays mean values and standard deviations of local eye measures.

Table 6.2 Mean (SD) values of word-based eye indices for local cognitive load

	Critical sentences	Control sentences
First fixation duration(*ms*)		
Condition 1	205(27.25)	195(25.6)
Condition 2	218(33.14)	201(30.04)
First pass reading time(*ms*)		
Condition 1	263(51.44)	252(44.32)
Condition 2	297(58.17)	272(53.5)
Second pass reading time(*ms*)		
Condition 1	360(124.39)	264(71.76)
Condition 2	468(130.13)	282(70.75)
Regression path duration(*ms*)		
Condition 1	648(132.64)	556(103.46)
Condition 2	938(281.18)	657(180.52)

Condition 1: interpreting under single sentence context; **Condition 2**: interpreting under discourse context

First fixation duration Results of two-way repeated measures ANOVA demonstrate that the main effect of sentence type on the average first fixation duration of words on experimental sentences was highly significant [F (1, 25) = 38.19, p < .001]. In Condition 1, the mean first fixation on words in critical sentences (M= 205, SD= 27.25) was significantly longer than that in control sentences (M =195, SD= 25.6). Likewise, critical sentences in Condition 2 resulted in significantly longer word-based first fixation (M=218, SD =33.14) than the control sentences did (M = 201, SD =30.04). The ANOVA test also confirms the significant main effect of task condition [F (1,25) =5.482, p= .027]: the first fixation duration for critical sentences in Condition 2(M =218, SD =33.14) was significantly longer than in Condition 1 (M =205, SD =27.25). Similarly, significantly longer first fixation duration for control sentences was found in Condition 2 (M =

201, *SD* =30.04) rather than in Condition 1 (*M* =195, *SD* =25.6). There was no significant interaction between sentence type and task condition [F (1,25) =2.45, p = .13].

First pass reading time The main effect of sentence type on first pass reading time was significant as tested by two-way repeated measures ANOVA [F (1,25) =17.7, p < 0.001]. In Condition 1, the first pass reading time for critical sentences (*M* =263, *SD* =51.44) was significantly longer than for control sentences (*M*=252, *SD*= 44.32). Likewise, in Condition 2, critical sentences induced significantly greater first pass reading time for critical sentences (*M* =297, *SD*=58.17) than for control sentences (*M* =272, *SD* =53.5). There was also a significant main effect of task condition [F(1.25) = 10.61, p = .003]. The first pass reading time for critical sentences in Condition 2(*M* =297, *SD* = 58.17) was significantly longer than in Condition 1 (*M* =263, *SD* =51.44), and for control sentences, the first pass reading in Condition 2 (*M* =272, *SD* =53.5) was significantly greater than in Condition 1(*M* =252, *SD* =44.32). The interaction between sentence type and task condition was also significant [F (1, 25) = 7.613, p= .011]. The simple effect test revealed a more significant effect of task condition on the critical sentences: the first pass reading time for processing critical sentences in Condition 2 was significantly longer than in Condition 1 [F(1,25)=18.794, p <.001]. This pattern was replicated in the control sentences but with a smaller effect: participants spent significantly longer first pass reading time to process the control sentences in Condition 2 than in Condition 1 [F(1,25)=4.268, p = .049 < .05].

Second pass reading time Shapiro-Wilk test demonstrated that the dataset for control sentences under Condition 1 violated normal distribution. As indicated by the box plot, two outliers were identified and removed from the dataset. The filtered data was then re-examined by the normality test and results showed that all data were normally distributed, which met the assumption of parametric test. The two-way repeated measure ANOVA test revealed a significant main effect of sentence type[$F(1,23) = 96.23$, $p < .001$]: In Condition 1, the second pass reading time for critical sentences(M =360, SD=124.39) was significantly longer than for control sentences(M =264, SD=71.76); in Condition 2, critical sentences also resulted in significantly longer SRT (M = 468, SD =130.13) as compared with the control sentences (M = 282, SD = 70.75). The main effect of task condition on second pass reading time was also significant [F (1, 23) = 21, p < .001]: To process critical sentences, participants spent significantly longer SRT in Condition 2 (M =468, SD=130.13) than in Condition 1(M=360, SD=124.39). And the SRT for control sentences was significantly longer in Condition 2(M=282, SD=70.75) than in Condition 1(M=264, SD =71.76). In addition, there was also significant interaction between task condition and sentence type [F(1, 23) = 34.46, p< .001]. As demonstrated by the simple main effect test, for processing the critical sentences, the second pass reading time in Condition 2 was significantly longer than in Condition 1, indicating a strong effect of task condition[F(1,23)=32.59, p < .001]. However, no significant differences were found between the two conditions in the second pass reading time for the control sentences [F(1,23)= 2.20, p=.152].

Regression path duration: According to the Shapiro-Wilk test, participants' data was positively skewed despite removal of outliers. Transformation was carried out on the original dataset and the transformed data was submitted to a two-way repeated measures ANOVA. Results demonstrated that the main effect of sentence type on regression path duration was significant [F (1, 22) = 61.98, p <.001]: In Condition 1, the regression path duration for critical sentences (M =648, SD= 132. 64) was significantly longer than for control sentences (M =556, SD =103.46). And in Condition 2, critical sentences resulted in significantly longer regression path duration (M=938, SD =281.18) than control sentences did (M=657, SD=180.52). The ANOVA test also revealed a significant main effect of task condition [F (1,22) = 23.45, p < .001]: the regression path duration for critical sentences in Condition 2 ($M = 938$, $SD = 281.18$) was significantly longer than in Condition 1($M= 648$, $SD=132.64$). Likewise, the regression path duration for control sentences in Condition 2($M=657$, $SD = 180.52$) was significantly longer than in Condition 1($M = 556$, $SD = 103.46$). Additionally, the interaction between condition and sentence type was also significant [$F (1, 22) = 12.37$, $p =.002$]. The simple effect test on task condition revealed a more considerable impact of task condition on critical sentences: for processing the critical sentences, the regression path duration in Condition 2 was significantly longer than in Condition 1[$F(1,22)= 38.00$, $p<.001$], and for processing the control sentences, the pattern was replicated but with a smaller effect [$F(1,22)= 6.10$, $p =.022$].

6.3 Relations between Working Memory Capacity and Cognitive load

6.3.1 Research Question Revisited

This section reports on participants' scores of the reading span test and statistical analysis of relations between reading span and on-line processing of critical sentences (including overall cognitive load and strategy choice). Simultaneous interpreting is a unique form of bilingual activity which requires extreme language management (e.g., Christoffels et al., 2006; Babcock & Vallessi, 2017): the concurrent activation of both source language and target language during simultaneous interpreting causes strong interference and imposes heavy burden on working memory. And this burden might be increased when the two languages involved are notably different in syntactic structures (e.g., Gile, 2002). It is well-established that working memory plays a crucial role in simultaneous interpreting: An array of studies have explored relationships between certain components of working memory (such as storage capacity and central executive) and interpreting performance. However, the effect of working memory on specific aspects of interpreting such as processing complex source structures has rarely been researched upon. Thus, one of the research questions in the present study is to examine whether and how working memory is related to on-line processing during interpreting between linguistically distant languages. It has been assumed that word-order asymmetry imposes great cognitive load on participants' mental resources. It remains to be seen whether higher working memory capacity, as indicated by the reading span, facilitates on-line processing of word-order asymmetry by reducing cognitive load. In other words, will there be significant correlations between participant's scores on the reading span test and their overall cognitive load for critical sentences? Besides, does working memory capacity affect participant's use of strategy for interpreting asymmetric sentences: will higher reading span result in less dependence on segmentation?

6.3.2 Results of Reading Span Test

The following table displays the scores on the reading span test. To ensure that all participants were reading the sentence carefully instead of merely paying attention to the alphabet to be remembered, accuracy rate of sentence plausibility judgement was calculated when summarizing the performance on the reading span test. Criteria of 80 % was adopted: any participant who failed to answer 80% of the sentences correctly would be excluded from the data analysis. Results showed that all 26 participants achieved an accuracy rate of above 80% and thus were included in further analysis.

According to the descriptive statistical analysis, the mean score on the reading span test was 18 (SD =8.45). Two participants only correctly recalled 8 items, the minimum value of the dataset, and one participant scored 38 on the test, exhibiting superior reading span than the others.

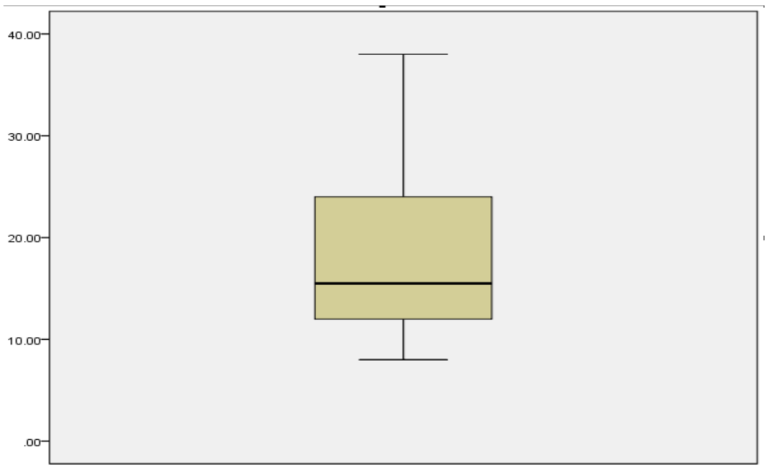

Figure 6.3 Box plot of scores on reading span test (n =26)

As shown by the above plot, most participants scored between 10 and 25, only very few of them scored above or less than that range. And the SD value indicates large variances among individuals. Shapiro-Wilk test demonstrated that the scores were not normally distributed (w =.905, p = .02), which requires a non-parametric test for the correlation analysis.

6.3.3 Relationship between Reading Span and Cognitive Load

A Spearman's rho correlation test was conducted to explore relations between reading span and global eye measures of the cognitive load (dwell time and fixation counts) in critical sentences respectively. Table 6.3 displays the test results of correlation between scores on the reading span test and the eye measures under the two conditions.

Table 6.3 Correlations between scores on the reading span test and overall cognitive load

	Condition 1 *Dwell time(ms)*	Condition 2 *Dwell time(ms)*	Condition 1 *Fixation count*	Condition 2 *Fixation count*
Reading span	r_s = .33 p = .098	r_s= .34 p = .86	r_s = .31 p = .12	r_s = .45 p = .026*

As suggested by the test result, there was no significant correlation between participants' reading span and dwell time in both conditions. And fixation count in single sentence context was not significantly correlated to the reading span. The only exception was found on the fixation count in discourse context (Condition 2): the correlation between the two variables was statistically significant, r_s = .45, p =.026, N =26. The test confirmed that there was a strong positive correlation between reading span and the total number of fixations in Condition 2: The higher the score on the reading span test, the more fixations were made for interpreting critical sentences in discourses.

6.3.4 Relationship between Reading Span and Strategies for Word-order Asymmetry

To examine whether participants' working memory capacity plays a role in on-line decision of strategy choice, in other words, whether scores on the reading span test was significantly correlated with numbers of sentences that were processed with segmentation, a Spearman's rho correlation test was run to determine the relationship between reading span and frequency of segmentation in Condition 1 and Condition 2 respectively. Table 6.4 demonstrates results of the correlation test.

Table 6.4 Correlations between scores on the reading span test and frequency of segmentation

	Condition 1 *Frequency of segmentation*	Condition 2 *Frequency of segmentation*
Reading span	r_s =.38 p = .05 *	r_s= .16 p = .42

According to the table, there was no significant correlation between reading span and frequency of segmentation under Condition 2. But the test revealed a strong positive correlation between reading span scores and frequency of segmentation in single sentence condition, r_s =.38, p =.05, N=26: Larger reading span indicates more frequent use of segmentation for interpreting critical sentences in Condition 1.

6.4 Strategy Choice and Cognitive Load in Sight Translation

6.4.1 Research Question Revisited

One of the research questions is to explore how interpreting trainees address word order asymmetry during English-Chinese sight translation, in other words, what strategies did the participants adopt to deal with sentences containing asymmetric structures? And what are the frequencies and distribution of the strategies used? As introduced in Chapter Three, strategies for processing word order differences can be generally categorized into two types: segmentation, also known as chunking, and restructuring. Segmentation is seen as a particularly useful technique when source sentences are long and complex, with one clause being embedded in another (Jones, 2014, Qin & He, 2009). By segmentation, interpreters chunk the source sentences into several independent "units of meaning (Lederer & Seleskovitch as cited in Jones 2002, p.73)" and translate according to the original syntactic order by linking the units in a flexible and coherent way. In contrast, restructuring refers to making change of original word order, for example, putting the source relative clause before the relative pronoun in target language when translating from English to Chinese. Both strategies are commonly used during interpreting, in particular, segmentation has been recommended and emphasized in interpreting training, as reported in participants' post-experimental questionnaires. However, relations between strategy choice and cognitive load when encountering word order asymmetry remain to be further explored.

In the present study, it is assumed that segmentation would be used more frequently than restructuring for interpreting critical sentences, which is consistent across the two task conditions. And frequencies of segmentation in discourse context (Condition 2) would increase. In addition, cognitive load would be significantly lower in sentences interpreted by segmentation than in those interpreted through restructuring, as evidenced by significantly shorter dwell time and fewer fixations.

6.4.2 Frequencies and Distribution of Sentences Interpreted by Segmentation and by Restructuring

With a view to explore which strategy was used more frequently, it is necessary to first listen to all audio recordings in the critical sentences, the judgement was then made based on analysis of oral delivery in combination with the transcribed target text. Recordings of the 26 participants were transcribed: each participant interpreted 12 critical sentences in Condition 1 and 12 critical sentences in Condition 2 and the asymmetric structures in each critical sentence was addressed either by segmentation or by restructuring.

The following table displays frequencies of the two strategies in single sentence context

(Condition1) and discourse context (Condition 2). As seen from Figure 6.4, segmentation was the primary strategy in both conditions for processing asymmetric sentences. In Condition 1, 223 critical sentences were interpreted by segmentation, accounting for over 70 % of the total (312) and only 89 critical sentences were rendered by restructuring. This gap in raw frequency was enlarged in discourse context at which 242 critical sentences were segmented, taking up almost 80% of the total.

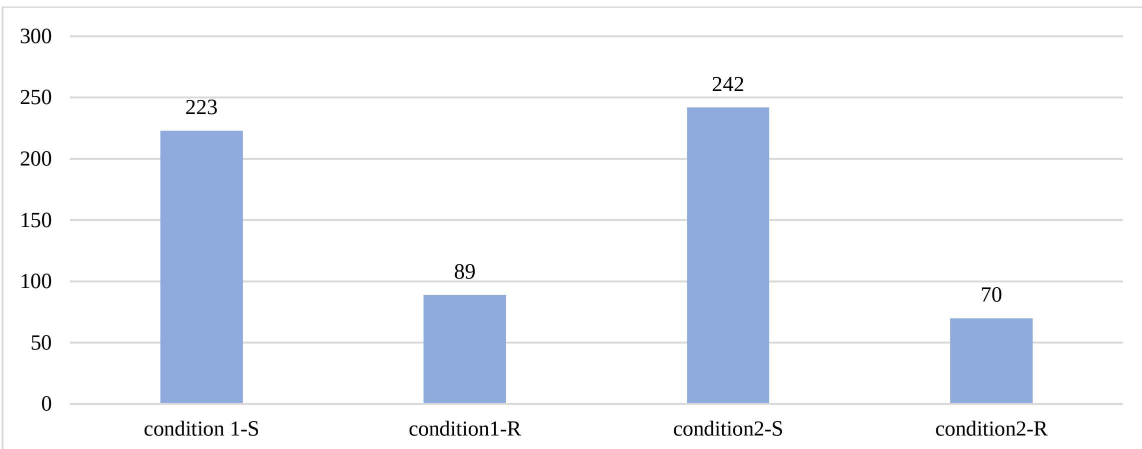

Figure 6.4 Frequencies of segmentation(S) and restructuring(R) in the two task conditions

Figure 6.5 exhibits individual data on frequency of segmentation in the two conditions in order to check whether strategy choice would be affected by task condition. Among 26 participants, 16 participants chunked more critical sentences in Condition 2 than in Condition 1. The segmentation and restructuring were equally distributed between the two conditions on five participants (P9, P12, P18, P19, P20). Only 5 participants (P7, P11, P14, P21, P22) employed restructuring more frequently than segmentation in Condition 2. The results suggested the impact of task condition on participants' strategy for processing asymmetric sentences: more than half of the participants increased the use of segmentation to deal with asymmetric sentences in Condition 2. And it appeared that sight translation in discourse context increased participants' reliance on segmentation.

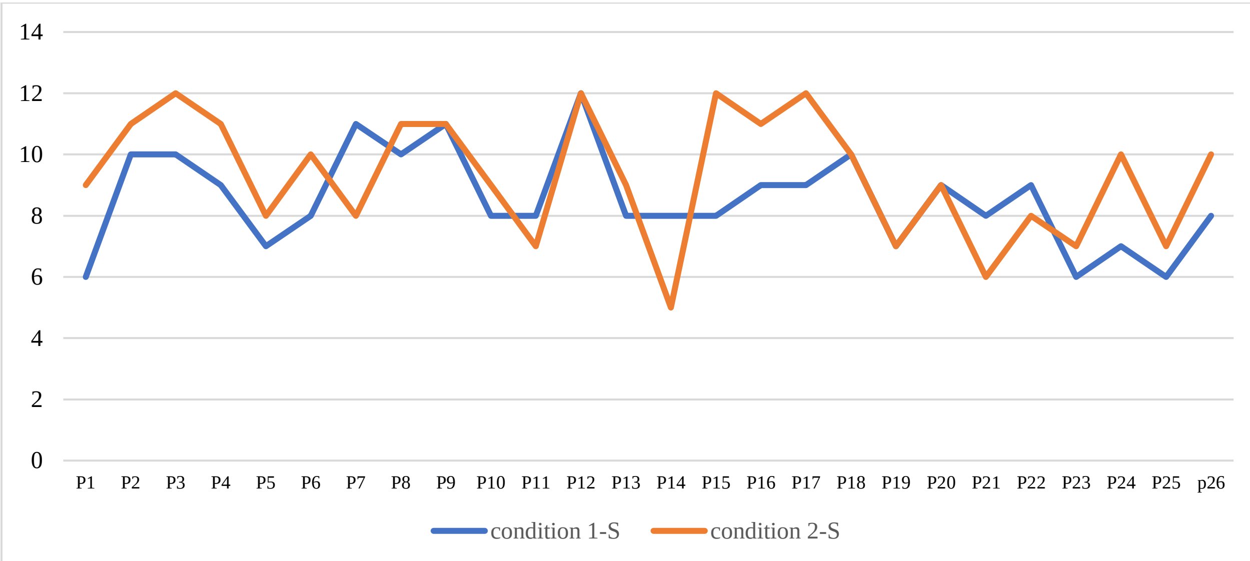

Figure 6.5 Frequencies of segmentation(S) for individuals in the two task conditions

To examine whether the differences across strategies and conditions achieve statistical significance, all 26 observations were submitted to SPSS for further analysis. One pre-assumption for t-test is that the sample data are normally distributed, thus a Shapiro-Wilk test was first carried out on each group of data respectively. The test results confirmed the normal distribution of the dataset. Then paired t-tests were conducted to measure frequency differences between segmentation and restructuring and the differences of segmentation counts across the two conditions.

According to the paired t-test, in Condition 1, the observed frequency of segmentation in Condition 1 (M= 8.5, SD =1.6) was greater than that of restructuring (M = 3.5, SD= 1.6). And the difference was statistically significant (t [25] =8.19, p < .001, 95% CI [3.86, 6.45]). The pattern was replicated in Condition 2 under which segmentation (M = 9.3, SD = 2) also occurred more frequently than restructuring (*M* =2.7, *SD* = 2) and the significance of difference was supported by the t-test ($t[25]=8.37$, $p< .001$, 95%CI [4.98,8.24]). The results of paired t-tests indicated that segmentation was always preferred over restructuring for critical sentences in both conditions and its frequency was significantly greater than that of restructuring. To examine whether use of segmentation differs across the two conditions, another paired t-test was carried out on measures of segmentation counts in Condition 1 and in Condition 2. The test revealed a significant difference: $t\ [25] =-2.07$, $p = .049 < .05$, 95% CI [0.003, 1.46]. Notably more sentences in Condition 2 were segmented (*M* = 9.3, *SD* =2) than in Condition 1(*M*= 8.5, *SD*= 1.6).

6.4.3 Strategy Choice and Cognitive Load for Processing Word Order Asymmetry

This section examines whether and how use of different strategies affect overall cognitive load for processing word order asymmetry during sight translation. Paired t-tests were conducted for dwell time and fixation counts under the two conditions respectively to examine the impact of strategy choice on participants' overall cognitive load. To ensure that the potential significance is caused by authentic differences between groups of data instead of by random cases, several principles were followed for data filtering: 1) Data of the participants who did not apply restructuring in either condition was excluded from analysis. 2) In Condition 1 or Condition 2, data of the participants who applied restructuring only once was removed from analysis.

In Condition 1, 18 observations were included for statistical analysis. Considering the uneven distribution of segmentation and restructuring for most participants, mean dwell time and mean fixation count associated with the segmentation or restructuring was calculated for each participant. T-test assumes that residuals of variables should be normally distributed, thus pre-test of normality was carried out: according to the Shapiro-Wilk test, all data groups in Condition 1 conformed to normal distribution, however, the dwell time associated with both strategies was positively skewed. Rochon and Kieser (2011) pointed out that heavily skewed distribution may reduce the statistical power of normality pre-tests. Thus, for comparison of dwell time, Wilcoxon signed rank test was applied to dwell time analysis and paired t-test was conducted for comparison of fixation counts which were normally distributed without significant skewedness. The results of descriptive statistics showed that to process the critical sentences, participants' mean dwell time (*ms*) by restructuring (M = 20465, SD = 3931) was longer than by segmentation (M =18719, SD = 3950) and differences were significant as evidenced by Wilcoxon signed rank test: T = 23, z = -2.72, p = .006. Similarly, number of fixations made for critical sentences translated by restructuring (M = 55, SD = 13.28) was greater than that for critical sentences processed by restructuring (M = 50, SD= 13.61). And the result of paired-test supported the significant difference: t[17] = 2.72, p = .015, 95% CI [1.05,8.28].

In Condition 2, 13 observations were retained for comparison. Considering the uneven distribution of segmentation and restructuring at most cases, mean dwell time and mean fixation count associated with the segmentation or restructuring was calculated for each participant. Although the sample data was normally distributed as confirmed by the Shapiro-Wilk test, positive skewedness was also detected among the data groups. Thus, the Wilcoxon signed rank test was adopted for further comparisons. The results of descriptive statistics demonstrated that dwell time associated with restructuring (M = 15963, SD = 3861) was longer than those associated with segmentation (M =14485, SD = 3058). And the difference was significant as evidenced by the Wilcoxon signed rank test: T = 6, z =-2.76, p= .006. Fixation counts associated with segmentation (M = 61, SD =18) was larger than that associated with restructuring (M = 58, SD = 14), but the difference failed to achieve significance level (T = 28, z = -1.23, p = .22).

As indicated by the comparisons, cognitive load for segmentation was consistently lower than for restructuring. To further explore whether on-line reading behaviour would be affected by the strategy choice, separate analysis was conducted on the rereading rate between critical sentences processed through restructuring and critical sentences processed through segmentation in the two conditions. Here, rereading rate refers to the probability of rereading the source word, which was calculated as the proportion of second-pass fixations to total fixations. Fixations in second pass are generally related to later-stage processing for correction of miscomprehension or semantic/syntactic integration. The higher proportion of second-pass fixations, the greater difficulties may be involved. 18 observations in Condition 1 and 13 in Condition 2 were obtained for computation of the mean proportion for each participant and the data results were submitted for parametric/non-parametric pairwise comparisons.

The Wilcoxon signed rank test on observations in Condition 1 revealed significant differences in terms of rereading rate between segmented sentences and restructured sentences：

$T = 6$, $z = -3.34$, $p = .001$. The rereading rate for restructured sentences ($M = .57$, $SD = .09$) was significantly greater than for segmented sentences ($M = .49$, $SD = .12$). Similarly, in Condition 2, restructured sentences ($M = .59$, $SD = .12$) also elicited higher rereading rate than the segmented ones ($M = .57$, $SD = .13$), but the difference was not supported by the paired t-test (t [12] = 1.36, $p = .199$).

6.5 Error Analysis of Interpreting Output

This section is primarily a product-based analysis with a focus on interpreting output in critical sentences. Firstly, research questions concerned in this section are reviewed by introducing corresponding data analysis methods. Second, I will report the frequencies and distribution pattern of meaning errors and expression errors made in critical sentences and control sentences under the two conditions. Both average value and individual data will be considered. Additionally, comparisons between error types and between task conditions would be carried out to examine whether and how word order asymmetry affects interpreting performance.

6.5.1 Research Question Revisited

One of the research questions of the present study is to examine the effect of word order asymmetry on participants' interpreting output as measured by meaning errors and expression errors and to explore the correlations between participants' cognitive load and interpreting performance.

Specifically, the data analysis concentrates on two aspects:

1) Are there significant differences in frequencies of meaning and expression errors between critical sentences and control sentences? And how are meaning errors and expression errors distributed across sentence types and task conditions?
2) How do the participants perceive the structural difficulty during sight translation? Is their self-perception of syntactic difficulty related to actual cognitive load involved?

6.5.2 Error Frequencies under the Two Conditions

This section reports on the frequency of meaning errors and expression errors in critical sentences under both conditions. All errors were counted and classified based on transcripts of participants' output and the audio recordings when some details needed be specified. And the results were discussed between one experienced interpreting teacher and the author until agreement was achieved on all judgement.

Meaning errors refer to major changes of semantic meaning or distortion of the logical relations between clauses and phrases. For example, one participants rendered “All European countries(所有歐洲國家)” into “所有歐盟國家(All EU countries)”, which obviously betrayed the original meaning. In another example, the source sentence “The United Nations during the past decades has been motivated by our commitment to a multilateral, open and tolerant international system.(聯合國過去幾十年來一直被我們的承诺所驅動，這個承诺就是要建立一個多變的，開放的，包容的國際體系)” was misinterpreted by one participant as “在過去幾十年間，通過我們的承诺，已經變成了一個多變開放并包容的國際體系(During the past decades, it has been our commitment that make the United Nations a multilateral, open and tolerant international system)”,which changed the original logical relations between the subject and the agent. As for expression errors, more attention was paid to grammatical mistakes, wrong collocations and inappropriate styles. Expression errors do not alter or distort the original meaning but impede the acceptability of the output. For example, one participants interpreted “these terrible impact (這些糟糕的影響)” as “這些恐怖的影響(These horrible impact)”. The adjective “恐怖的 (horrible)” conveys the original negative meaning but increases the seriousness of the “impact”. Another participant rendered “climate change (氣候變化)” into “氣候改變(changing climate)”, which can still be understood by target audience but was not accurate.

It was noteworthy that there were very few omissions in the output. It can be accounted for by the visible source information in sight translation which greatly reduces memory burden and information loss. However, the visual accessibility of source language does not lower frequency of errors in critical sentences. Figure 6.6 presents the total of meaning errors and of expression errors in critical sentences and control sentences under both conditions.

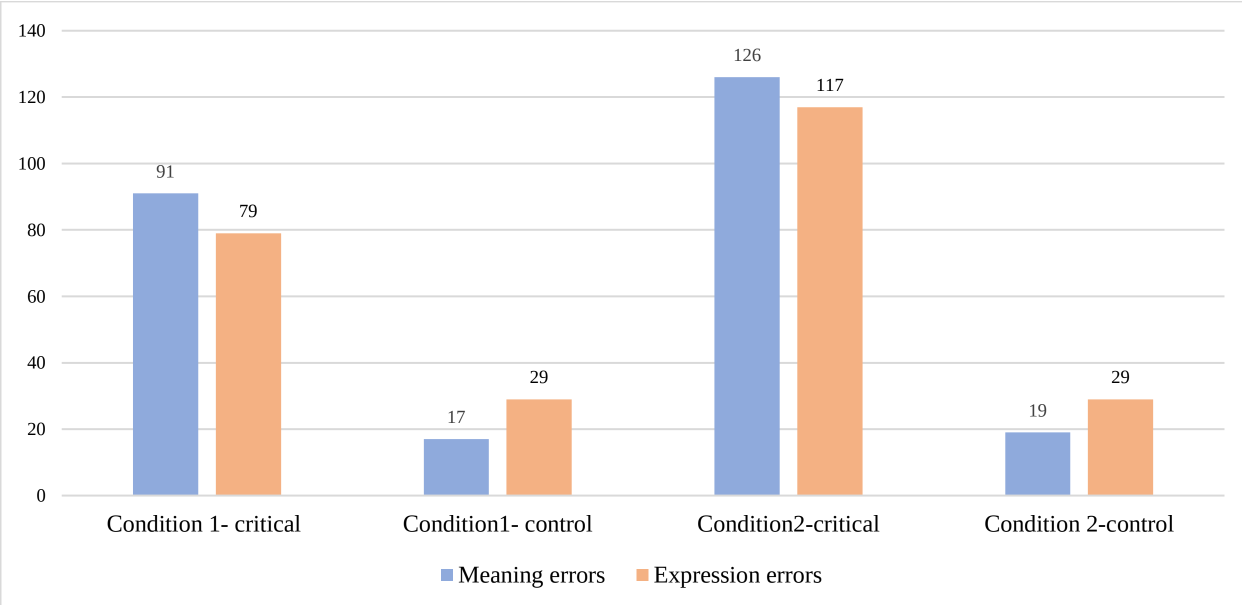

Figure 6.6 Frequencies of meaning errors and expression errors

Here the sums are intended to mainly serve as the indictor of general distribution pattern: according to the figure, there were always more errors made in critical sentences than in the control sentences, irrespective of task conditions or error types. In Condition 1, 170 errors were detected in output for critical sentences, which was far more frequent than the total error found in the control sentences (Sum = 46). In Condition 2, participants made 243 errors when dealing with the critical sentences, in contrast, only 48 errors were made in the control sentences. The breakdown of errors in sentence types and conditions sheds more light on cognitive constraints induced by word order asymmetry: in both conditions, participants made more meaning errors than expression errors in critical sentences, but the pattern was reversed when they processed the control sentences: more expression errors were found in control sentences under both conditions.

To conduct statistical analysis, all original data should had been submitted to a two-way repeated measures ANOVA test, however, as demonstrated by the Shapiro-Wilk test, distribution normality was violated in most data sets. Therefore, Wilcoxon-signed-rank tests, the non-parametric version of paired comparisons were conducted instead to test whether the mean values of meaning errors and expression errors differ to a statistically significant degree. A set of paired Wilcoxon signed-rank tests were carried out to test: 1) whether participants under both conditions made significantly more total errors in critical sentences than in control sentences; 2) whether task condition affects the distribution of total errors, in other words, whether there are significantly greater number of errors in Condition 2 than in Condition 1 irrespective of sentence types; 3) whether meaning error and expression error displayed different patterns of distribution.

In terms of the general error pattern (meaning errors and expression errors combined), the test results indicated a serious disruption of word-order asymmetry on participants' interpreting performance as measured by significantly more errors made in critical sentences than in control sentences irrespective of task conditions. In Condition 1, more total errors were spotted in critical sentences ($M = 6.5$, $SD = 2.8$) than in control sentences ($M = 1.8$, $SD = 1.6$), and the differences in frequency achieved statistical significance: $T = 1.5$, $z = -4.44$, $p < .001$. Likewise, in Condition 2, the total errors in critical sentences ($M= 9.3$, $SD =4.5$) were significantly more frequent than in control sentences ($M =1.8$, $SD =2.1$), and the difference was statistically significant: $T = .00$, $z = -4.47$, $p < .001$. The statistical analysis also found the significant effect of task condition on errors in critical sentences: $T =193$, $z = -2.7$, $p =.007$; when processing the critical sentences, the participants made significantly more errors in Condition 2 ($M = 9.3$, $SD=4.5$) than in Condition 1 ($M= 6.5$, $SD= 2.8$). But there was no significant effect of task condition on error frequency in control sentences: $T =139$, $z =-.03$, $p =.975$. As for the proportion of both types of errors, error distribution exhibited similar patterns in critical sentences across the two conditions: In Condition 1, although there were more meaning errors ($M = 4$, $SD=2.2$) than expression errors ($M= 3$, *SD*=1.63), the difference was not statistically different: T = 75.5, z = -1.11, p=.27. Similarly, in Condition 2, meaning errors (*M*= 5, *SD*= 3.1) outnumbered expression errors (*M*= 4.5, *SD*= 2.5) but the difference was not significant: T = 140 , z = -.61 , p=.543. In contrast, error distribution in control sentences was reversed, with significant differences in mean values: In Condition 1, there were more expression errors (*M*= 0.85, SD =.85) than meaning errors (*M* =1.11, *SD*= 1.07) and the difference achieved significance level: T = 95, z =-2, p=.041<.05. And in Condition 2, participants made significantly more expression errors than meaning errors: T =106, z =-2.1, p=.033.

As for the respective effect of task condition on distribution of meaning errors and expression errors, only significant differences were found for the critical sentences: significantly more meaning errors were made in Condition 2(*M*=4.8, *SD*=3.1) than in Condition 1(*M*=3.5, *SD*=2.2), T = 192, z =-2.1, p=.032. Similarly, significantly more expression errors were found in Condition 2(*M*= 4.5, *SD*=2.5) than in Condition 1(M=3, SD=1.6), T = 199, z =-2.4, p=.018.

6.6 Results of Post-experimental Questionnaires

Immediately after the sight translation tasks, a post-experimental questionnaire was administered to the participants. The questionnaire was designated primarily to investigate how the interpreting trainees felt about their own performance, and more importantly how they perceived and dealt with the translation difficulties induced by word order asymmetry.

This section reports the main results of the post experimental questionnaires. The first section focused on the self-assessed scores by the participants on their sight translation performance. The second section moves onto the participants' perception of asymmetry-induced difficulties.

In addition to the questionnaires, scripts of the source texts were offered immediately after the second session and participants were required to mark any sentences which they felt had caused great structural difficulties during the translation. Only scripts of the two source texts in Condition 2 were provided in that participants were expected to make their decisions based on fresh memory of the on-line performance. They may have to reread all source materials very carefully and judge the sentence difficulty based on the offline analysis if scripts in Condition 1 was offered since their initial memory of the single sentence translation may had faded away after the break and the passage sight translation. There were no specific instructions on their judgement so as to avoid hinting on selecting only asymmetric sentences.

6.6.1 Self Assessed Scores on Interpreting Performance and the Strategies for Processing Asymmetric Sentences

26 valid post-experimental questionnaires were collected. According to results of self-assessment based on the 7-point scale, participants were not very satisfied with their performance under both conditions. The average self-assessed score on sight translation was only 4.7 (*SD* = 0.89) for Condition 1 and 4.35(*SD*= 0.94) for Condition 2. And the Wilcoxon signed rank test revealed no significant differences in scores across the two conditions: $T = 22$, z =-1.73, p= .083. Only four participants believed they performed better in Condition 2, which suggested that more contextual and background information did not necessarily improve interpreters' self-evaluation of output quality.

Almost all participants reported that they had been aware of the increasing difficulties of some sentences as compared with the others. 14 participants noticed the varying degrees of word order asymmetry across all source sentences and 11 participants believed they did perceive the slight inter-sentence differences in syntactic structures. Only one participant did not notice any particular difficulties, which may be caused by faded memory since she can hardly remember any details during the task, as explained by the participant.

In terms of the primary response when asymmetric sentences occurred, although all participants claimed that segmentation was the most frequently recommended strategy in daily training, the choice of the response preferred varied between individuals. 11 participants chose “scanning through the source sentence before interpreting”, 14 participants considered “going straight ahead with interpreting by segmentation” as their first option and one participant preferred to anticipate sentence meaning based on the contexts. It appeared that the on-line response to word order asymmetry was not highly consistent among the participants.

As for the subjective perception of asymmetry-induced difficulties, the participants were required to score on a 7-point scale to indicate to what extent they felt like being negatively impacted by asymmetric structures during sight translation (7 = very significant impact; 1= no impact at all). As measured by the scale, most participants considered word order asymmetry as one major problem trigger during on-line processing (*M* =5.23, *SD*=1.03).

6.6.2 Sentences Considered Structurally Difficult by the Participants

This section reports the sentences that resulted in great structural difficulties as perceived by the participants. Figure 6.7 displayed how many times the 12 critical sentences were marked as structurally difficult by the participants (RC: relative clause, P: passive construction):

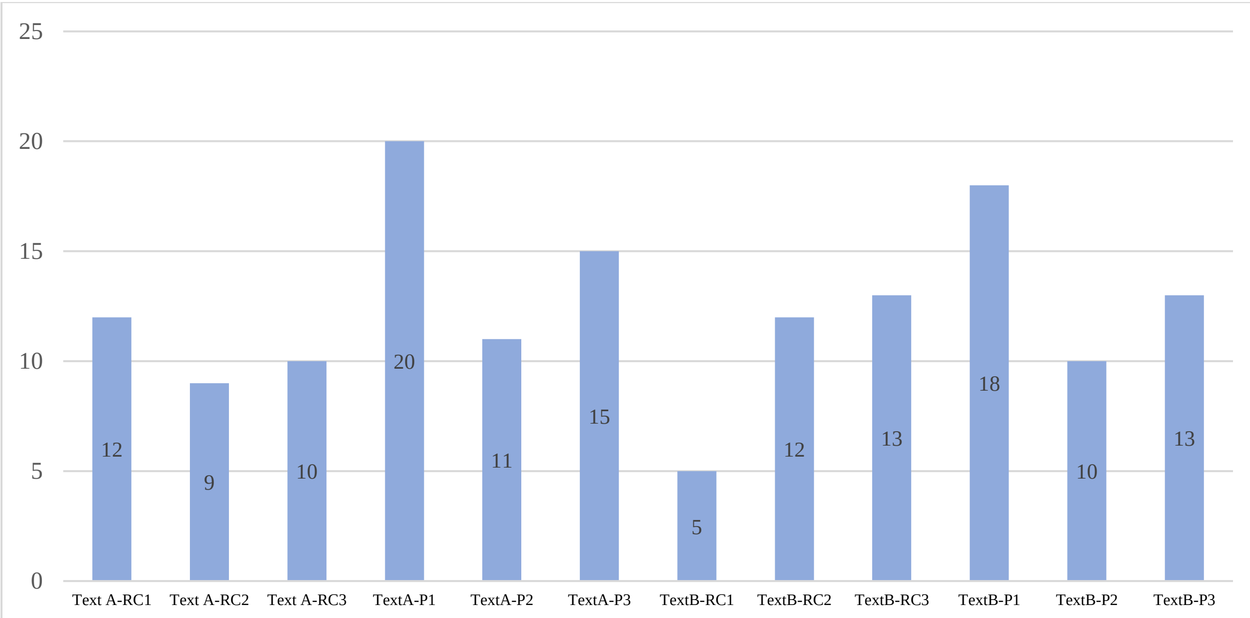

Figure 6.7 Frequencies of each critical sentence of being considered as structurally difficult

As demonstrated by Figure 6.7, all the critical sentences of the two source texts in Condition 2 were considered by at least five participants as syntactically difficult. Five critical sentences (P1 and P3 in Text A; RC 3, P1 and P3 in Text B) were chosen by more than half of the participants as structurally difficult.

To explore whether the participants' self-perception of structural difficulty is related to the cognitive load involved, in other words, whether a higher degree of perceived difficulty leads to higher actual cognitive load, statistical comparisons were carried out on both overall cognitive load and local cognitive load between those who selected the more critical sentences and of those who selected the fewer. Based on the individual data on sentence selection, those who marked less than 1/3 of the total critical sentences constituted Group A and those who selected more than half of the total were assigned to Group B. Here, the dwell time and the second pass reading time in passage sight translation were employed as indicators of general and local cognitive load respectively. As mentioned before, second pass reading time was associated with reanalysis due to comprehension difficulty or failure. If there were strong connections between participants' self-perception and their on-line processing, significant differences in dwell time and second run reading time should be found between the two groups. Considering the relatively small and unequal sample size (Group A: 8 observations, Group B: 10 observations), Mann-Whitney U-test was adopted for the inter-group comparison.

The Mann-Whitney U-test on participants' dwell time indicated that there were no significant differences between Group A and Group B: U (N_{GroupA} =8, N_{GroupB} =10) =29.5, z = -.933, p =.351. Contrary to previous assumption, the average dwell time*(ms)* of Group A (M =15476, SD=2108) was slightly higher than Group B (M =15056, SD =4712). The result suggested that a lower degree of self-perceived difficulty as measured by number of marked critical sentences did not necessarily result in shorter task time. As for the local eye measures, the descriptive statistics showed that the average second run reading time*(ms)* of group B (M = 494, SD=60.95) was longer than that of group A (M = 463 , SD =54.18), which suggested that participants who noticed more frequent disruption by asymmetric sentences tended to have greater efforts in sentence rereading and reanalysis. However, the Mann-Whitney U-test revealed that the differences between the two groups in second run reading time were not statistically significant: U (N_{GroupA} =8, N_{GroupB} =10) =32.50, z =-.67, p =.505.

The above analysis indicated no significant differences in cognitive load between the group that marked more critical sentences and the group that marked fewer. It appeared that there was no obvious evidence for strong connections between one's self-perceived degree of structural difficulty in passage sight translation and actual effort for processing the difficulty. The participants who noticed little syntactic difficulty turned out to devote longer time for processing the asymmetric sentences.

Chapter 7 Discussion

This chapter discusses the data analysis results so as to address the research questions proposed previously. The chapter is divided into three sections: in Section 1, findings obtained from the eye-tracking data was reviewed to explore the impact of word-order asymmetry on cognitive load during sight translation. In addition, this section discusses the roles of contextual information under different task conditions and of working memory in participants' cognitive load. Section 2 focuses on discussion of participants' response to asymmetric sentences to examine the relations between word-order asymmetry and on-line strategy choice. Section 3 concentrates on the effect of word-order asymmetry on interpreting performance and the relationship between cognitive load and participants' subjective feeling. The discussion of this section is primarily based upon error analysis of the interpreting output and the post-experimental questionnaires.

7.1 Effect of Word Order Asymmetry on Cognitive Load in Sight Translation

Whether language-specific factors such as word order asymmetry constitute difficulty during interpreting has been at the centre of interpreting research. Information processing models assume a significant impact of word order divergences such as verb-final/verb-initial structures, or right/left branching structures, while the Interpretive School claims no special difficulty caused by language-specific factors in that interpreting is fundamentally a manifestation of ordinary language comprehension and production (See Setton, 1999).

This study sets out to address this controversial issue in the scenario of English-Chinese sight translation from a cognitive perspective. The primary question to be resolved is in what way and to what extent that on-line processing by the interpreting trainees is impacted by word-order asymmetry. To explore this issue, eye measures associated with processing at different levels and stages were adopted to indicate participants' cognitive load when interpreting symmetric and asymmetric sentences under two task conditions.

7.1.1 Overall Cognitive Load in Both Conditions

a). The main effect of sentence type: cognitive processing disrupted by word order asymmetry to a significant magnitude

Table 7.1 displays the data results for overall cognitive load as measured by dwell time and fixation counts. Here *p*-values are considered significant if they are below or equals to .05.

Table 7.1 Eye-tracking data results for overall cognitive load

Overall cognitive load	**Main effect of word order asymmetry**	**Main effect of task condition**	**Interaction**
Dwell time(*ms*)	$p< .001$*** A1 > B1 A2 > B2	$p< .001$*** A1 > A2 B1> B2	$p= .084$
Fixation counts	$p< .001$*** A1 > B1 A2 > B2	$p = .106$	$p< .001$*** A1 < A2 ** B1 > B2

A= critical/asymmetric sentences; B = control/symmetric sentences; 1= Condition1; 2= Condition 2; ***= very high degree of significance; ** = high degree of significance)

As reported in the table, there was a highly significant main effect of word order asymmetry on the overall cognitive load: significantly longer time was devoted to processing sentences with asymmetric structures irrespective of task conditions, suggesting that the participants failed to free themselves from word-order asymmetry even when more contextual cues were available in the second condition. Likewise, the negative effect of word order asymmetry was also observed on fixation counts: in both conditions, the participants made significantly more frequent fixations for syntactically different sentences than for syntactically similar ones. The highly significant main effect of word order asymmetry supports a considerable impact of language-pair specific factors, which offers a reasonable basis for refuting language-independent view of interpreting. To illustrate how cognitive load was shaped by input word orders, the fixation patterns of one participant in single sentence context was visualized: Figure 7.1 depicts fixation distributions during on-line processing of a control sentence and Figure 7.2 offers visualisation of fixations for processing a critical sentence. The two figures were generated from the original data by the same participant. Each blue circle represents one fixation. The size and density of these circles are closely related to the participants' processing load. As illustrated by the gaze plots, fixations are more densely distributed in Figure 7.2, indicating a more effortful processing mode in the critical sentence. Majority of words in the critical sentence, particularly the content words, were fixated repeatedly, as seen by clustered overlapping circles, while words in the control sentences were generally fixated by fewer times, receiving sparsely distributed fixations.

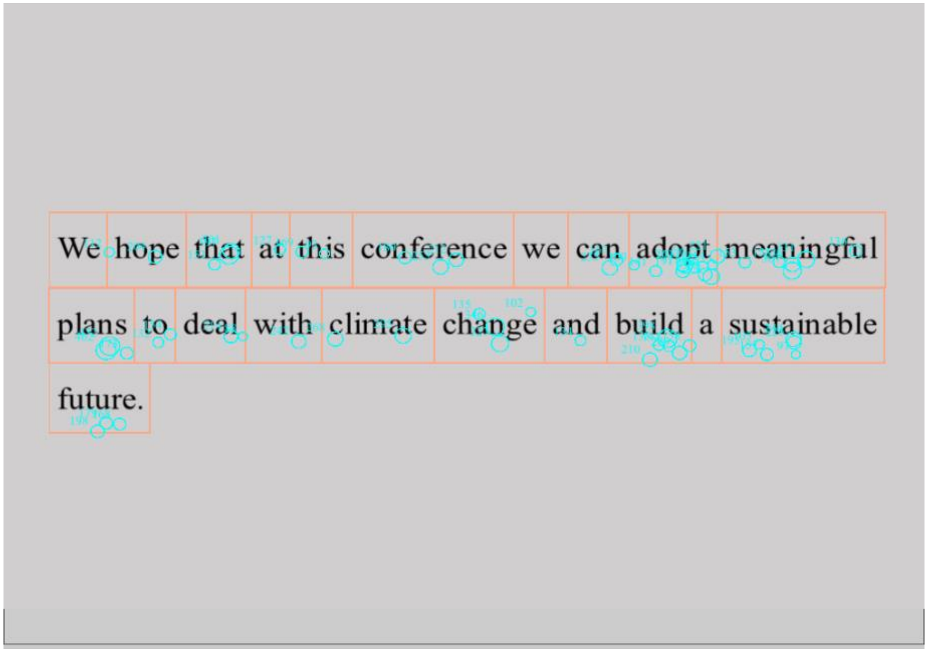

Figure 7.1 Gaze plots for processing the control/symmetric sentence

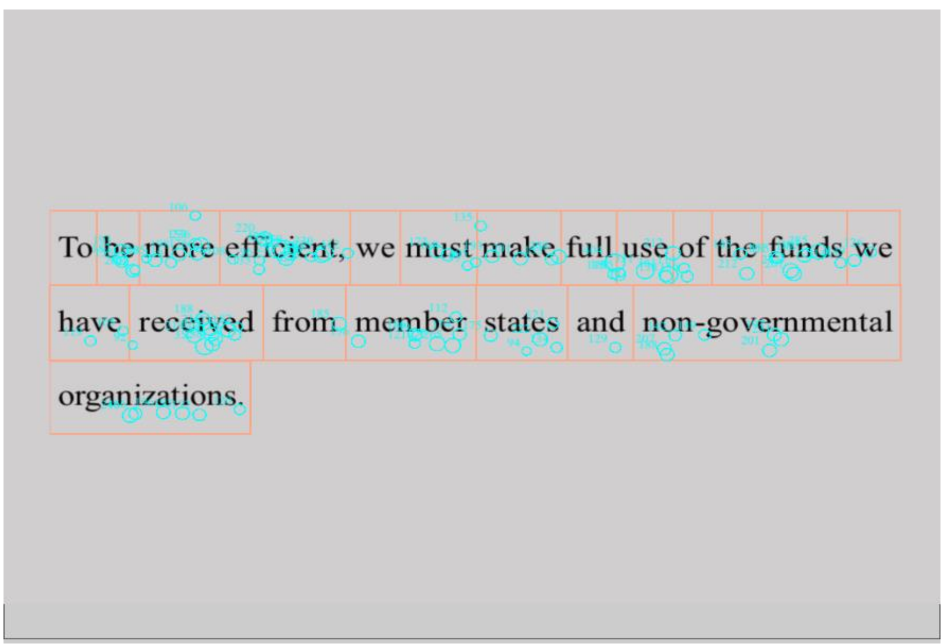

Figure 7.2 Gaze plots for processing the critical/asymmetric sentence

Fixation-based measures are closely related to the on-line processing load in language tasks: generally, longer and more frequent fixations indicate greater cognitive load while shorter and less frequent fixations index lower cognitive load. Thus, the eye measures in the present study reveal a significantly increased cognitive load as a result of word order asymmetry.

The strong effect of asymmetry could be understood from a psycholinguistic account: “structural priming” is a frequently mentioned concept in psycholinguistic study. It refers to the tendency to reuse the similar structural pattern that was previously comprehended or produced (Bock, 1986; Bock, Chang, Dell, & Onishi, 2007). Priming describes the effect of earlier processed items on the subsequent processing (Schaeffer et al., 2017). A substantial body of studies have demonstrated that the priming exists between languages and the effect can be similar to within-language priming (e.g., Kantola & Van Gompel, 2011; Schoonbaert et al., 2007). In a cross-linguistic priming experiment, primes are presented in one language to elicit the target in another language. Thus, the process of sight translation can be understood as a process of priming: the syntactic features pertaining to the source language tend to be transferred to the target language. It is expected that the participants were affected by structure in the source sentences: when word orders were shared between the languages, the participant were primed by the source structure and produce translation with the similar sentence structure. This priming effect would be positive since the participants could adopt a syntactically linear translation instead of searching for different structures, which helped reduce mental load. However, if the source structures, such as relative clauses and passives in the present study, were dissimilar to the target structures, the benefit of priming would disappear. Instead, the participants were disrupted by the asymmetry-induced interference that tended to be stronger in sight translation due to visual accessibility. They had to make extra efforts to resist the natural tendency of being primed and resolve structural differences through certain strategies. Consequently, this added up to the already strained cognitive resources.

The increasing cognitive load as a result of word order asymmetry corroborates findings in a recent eye-tracking study: Ho (2017) compared processing load for PBD (principal branching direction) units and non-PBD units during English-Chinese sight translation by groups with different levels of interpreting experience. Eye-tracking analysis demonstrated that all three groups (professional interpreters, interpreting students and untrained bilinguals) had longer mean fixation duration on PBD units that manifested structural asymmetry between English and Chinese, as compared with non-PBD units. However, significant differences in eye measures were only observed on the untrained bilinguals as shown by statistical analysis. It came as no surprise that untrained bilinguals were seriously disrupted by structural differences since they had never been trained to interpret, let alone strategies to deal with syntactically difficult parts. Ho (2017)'s finding confirms greater cognitive constraints imposed by structural asymmetry in English-Chinese sight translation, which is in line with the general pattern found in the present study. One plausible account for absence of significant effect on professional and novice interpreters in Ho's research is the degree of source language manipulation and the size of items under examination: As claimed by the author, there were no specially designed Areas of Interest (AOI) in the source materials. Only modifiers such as adverbials and phrases located at different positions in English and Chinese were marked as indicators of structural asymmetry (PBD units) and those counterparts that took similar positions in both languages were studied as baseline condition (non-PBD units). It was noticed that the size of most PBD/non-PBD units were quite small, often limited to several words or phrases. There was thus a strong possibility that disruptive effect induced by asymmetry showed up not only on the units under scrutiny but also on words to the right of the units due to "spill over" effect. Moreover, participants may also notice the structural difficulty before fixating exactly upon the PBD unit since it might had been recognized via parafoveal view (Rayner, 2009; Conklin & Pellicer-Sánchez, 2016). Thus, the effect of PBD unit may take place on both the unit itself and words preceding or following the unit. As Clifton and Staub (2011) pointed out, syntactic difficulties can show up at different points in eye-tracking records. If wider regions surrounding the target units were inspected, there might be more significant effect of word order asymmetry as indexed by eye metric.

The general pattern observed in this study also echoes the findings from an eye-tracking study by Seeber and Kerzel (2012). Using pupil dilation as measure of the processing load, they found that the cognitive load indeed tended to be higher in syntactically asymmetric structures than in symmetric structures during simultaneously interpretation by expert interpreters. But the difference in pupil change was only marginal: no significant main effect of syntax was found. This may be attributed to the expertise of the participants: participants recruited in Seeber and Kerzel (2012)'s experiment were well-experienced interpreters. It is possible that they were less susceptible to interference caused by asymmetric structures since they were more adept in certain strategies or became more concentrated on semantic meaning rather than syntactic forms. Another potential factor is the eye measure adopted. Considering the lack of stable visual stimulus in simultaneous interpreting, Seeber and Kerzel (2012) only used pupil dilation as the eye measure. However, interpretation of pupil-based measures should be exercised with caution since pupil size can be very sensitive to extra-linguistic factors such as light intensity and emotional events (Holmqvist et al., 2011). As discussed in previous sections, change of pupil dilation sometimes failed to display the expected patterns in language processing tasks.

In addition, findings from this empirical study were consonant with data from product-oriented studies on language-specific factors in interpreting: Wang and Gu (2016) found that when addressing right-branching source structures (such as attributive clauses) in English-Chinese interpreting, interpreters' performance was seriously affected by syntactic differences between the two languages: longer and more frequent pauses were observed, along with more omissions and errors, which confirms the negative impact of language-specific factors on interpreting. In another study with similar approach, Wang and Zou (2018) found evidence for cognitive-taxing effect of structural differences based on a parallel corpus of Chinese - English interpretation: extra cognitive load was required to restructure long and complex attributive modifying structures that are front-loaded in Chinese but back-loaded in English. Therefore, findings of the present experimental studies were consistent with those generated from natural observation on interpreting performance in authentic settings.

To sum up, the significant differences between the critical and control sentences offer experimental evidence for the negative impact of language pair specificity during interpreting. The dramatic increase in task time and fixation counts points to relevance of word order asymmetry as one major source of difficulty in English-Chinese sight translation. Although school of sense-based interpreting argues that interpreting can be independent of linguistic forms and "deverbalization" has been widely taught to cope with language-related difficulties, the impact of source structures cannot be eliminated. In language pairs such as English and Chinese that involve wide discrepancies in linguistic structures and cultural concepts, structural differences can exert very prominent effect on cognitive processing during interpreting. Eye-tracking data offered a wealth of evidence for the disruption of word order asymmetry in English/Chinese interpreting, as demonstrated in this study, which complements the similar results observed in relevant studies using a product-oriented approach.

b). The main effect of task condition: modulating role of context when addressing word order asymmetry

In addition to main effect of word order asymmetry, task condition as the other independent variable also played a role in modulating participants' on-line processing load. It was assumed that more contextual information would facilitate interpreting of asymmetric structures, as indicated by less cognitive load in discourse context irrespective of sentence type. A wider context was supposed to facilitate more inference processing, enabling the participants to set up links between different parts of the discourse and to activate their world knowledge. Besides, contextual effect is also relevant to reading speed: How fast a word is accessed is strongly shaped by the degree of contextual constraints: expected words in highly constraining context are generally read faster than those in non-constraining context (Rayner & Well, 1996). According to previous reading researches, word predictability in contexts is one of the most critical factors that influence word recognition and processing (Ehrlich & Rayner, 1981). Word predictability is improved in a highly constraining context, thus facilitating word meaning retrieval and reducing total reading time. It was thus expected that negative effect of word order asymmetry can to some degree be offset by more contextual information in Condition 2: overall cognitive load for critical sentences in discourse context would be significantly lower than in single sentence context.

However, inconsistent patterns regarding the role of task condition in dwell time and fixation count were found: There was a significant main effect of task condition on dwell time. Dwell time for both types of sentences was considerably shorter in discourse context than in single sentence context, which was consistent with the previous expectation. This was perhaps due to the context benefit in sight translation of discourses, as well as the background information offered before the task, which enabled the participants to grasp the main idea of the source text. Highly predictable words were more likely to be skipped or retrieved faster in coherent discourses as a result of wider contexts, thus reducing the total fixation duration. Similar role of context was also expected for the number of fixations. However, no significant main effect of task condition was found on fixation count and a considerable cross-over interaction was reported between task condition and sentence type. A closer look into the interaction pattern revealed different roles of task condition in determining the fixation frequency. Discourse context was only conductive to processing of the control sentences as evidenced by the simple effect test: fixation count for processing control sentences in single sentence context was longer than that in discourse context, indicating an effect of context in modulating the disruption of syntactic asymmetry. However, the pattern was reversed in the critical sentences: significantly more fixations were made in discourse context than in single sentence context. Thus, in terms of fixation counts, the assumed context-induced facilitation was not confirmed on critical sentences and the function of context varied across sentences with different degrees of syntactic complexity. This may be accounted for by an increasing need to seek contextual information in discourse condition by frequently shifting the attention between words or lines. Disrupted by the asymmetric structure, participants may attempt to concentrate on a meaning-based interpreting which forced them to collect more contextual clues for semantic analysis or anticipation. The more supporting information obtained from the context, the easier for the participants to resist the asymmetry-induced interference and to interpret the critical sentences based on “sense” rather than surface structures. And it was this process of seeking contextual information that contributed to a significant increase in fixation counts under discourse condition: participants tended to have more regressive fixations on prior regions or to have a quick glance at the region following the asymmetric part.

The amount of contextual information in different task conditions was also one of the variables examined by Seeber and Kerzel (2012) who found that the pupil size was slightly smaller in the discourse context than in the sentence context and the difference approached significance, besides, no significant interaction between context and syntax was observed in their study. One possible reason for the variance might be the research design: three variables including syntactic asymmetry, context in different task conditions and temporal period of interest were examined in Seeber and Kerzel's study while only two variables were included in the present study. Multiple variables under study may complicate the data pattern, particularly the interaction across different variables. Another reason might be the differences in level of interpreting proficiency: well-trained professional interpreters in Seeber and Kerzel (2012) made more efficient use of discourse context and also enjoyed a higher degree of automaticity. In contrast, the interpreting trainees recruited in this study were less adept in applying contextual information to on-line comprehension and prediction. They had to devote extra efforts, for example, making frequent regressions or reading ahead to obtain contextual support. In addition, eye indices and the interpreting mode under study may also account for the different results: only pupil dilation was examined in Seeber and Kerzel (2012) due to a lack of stable visual stimulus in simultaneous interpreting, the interpreting mode under study. The differences in methodologies may lead to the variances in study results.

7.1.2 Local Cognitive Load in Both Conditions

a) The main effect of sentence type

To distinguish initial processing and subsequent processing in language task, eye movement was generally broken down into different measures. Namely, as regard to local processing through different stages, eye tracking indices can be divided into "early" and "late" measures (e.g., Altaribba et al., 1996; Clifton, Staub, & Rayner, 2007). With an attempt to further understand the timing of processing, four word-based eye measures (two early measures and two late measures) were adopted as indicators of participants' cognitive load at local level. As introduced in Chapter Four, investigation of early and late eye measures is helpful in providing more informative knowledge on different dimensions of moment-to-moment processing. First fixation duration and first pass reading time are often used as early measures to probe into initial stages of processing and automatic processing (Conklin & Pellicer-Sánchez, 2016). They are generally associated with cognitive activities at lower levels such as word recognition during reading. Second pass reading time and regression path duration in this study are taken as late measures that reflect more conscious or strategic processing such as reanalysis due to miscomprehension or ambiguity. Hence, they are indicative of difficulty in lexical or syntactic integration at later stage during reading. It was assumed that with all other aspects being matched (word frequency/familiarity, word length, genre and topics of source materials), there were no considerable differences in terms of lower-level processing as measured by first fixation duration and first pass reading time. The disruptive effect only showed up during later stages when participants, after recognizing syntactic difficulties during the first pass, had to regress to prior words for reanalysis, self-repairs or structural integration. Therefore, the main effect of sentence type would only be significant for the second pass reading time and regression path duration. Similarly, the main effect of task condition was also expected in only later stages. Thus, no significant effect of word order or task condition would be detected in first fixation duration and first pass reading time. The results for local cognitive load in both conditions are summarized in Table 7.2.

Table 7.2 Eye-tracking data results for local cognitive load

Overall cognitive load	**Main effect of word order asymmetry**	**Main effect of task condition**	**Interaction**
First fixation duration (*ms*)	$p< .001$*** A1 > B1 A2 > B2	$p= .027$ * A1 <A2 B1< B2	$p= .13$
First pass reading time (*ms*)	$p< .001$*** A1 > B1 A2 > B2	$p = .003$ ** A1 < A2 B1 < B2	$p= .011$ *
Second pass reading time (*ms*)	$p< .001$*** A1 > B1 A2 > B2	$p< .001$*** A1 < A2 B1< B2	$p< .001$***
Regression path duration (*ms*)	$p< .001$*** A1 > B1 A2 > B2	$p< .001$*** A1 < A2 B1< B2	$p =.002$ **

A= critical/asymmetric sentences; B = control/symmetric sentences; 1= Condition1; 2= Condition 2; ***= very high degree of significance; ** = high degree of significance; *=significance)

The repeated-measures ANOVA test revealed significant main effects of both sentence type and task conditions on all four eye measures. In terms of the main effect of sentence type, all local eye measures, irrespective of "early" or "late", were affected by word order asymmetry to a significant degree, which was at the variance with the prior assumption. In both conditions, first fixation duration for the critical sentences was significantly longer than for the control sentences. According to reading researches, first fixation duration signals lexical retrieval, thus being very sensitive to lexical information such as word frequency (Dussias, 2010; Rayner, 1998). It was hypothesized that no significant results would be reported as concerns the effect of word order asymmetry on first fixation duration since word frequency in both types of sentences had been comparable. The considerably longer FFD in critical sentences could be accounted for by activities more than word meaning retrieval during the initial stage such as analysis of syntactic relations or planning for target reformulation. When making the first fixation upon a certain word, the participants not only activated its semantic meaning but also activated some syntactic information: for example, they may attempt to assign a grammatical role to the word and set up an initial local phrase structure. As tested in relevant studies, source sentences that have parallel syntax with target language were easier to process. Therefore, if syntactic information was activated during word identification, significant discrepancies between asymmetric structures and symmetric structures in FFD would be observed, which indicated that word order asymmetry had begun take its toll at a very initial stage of sight translation.

Similarly, the critical sentences in both conditions also elicited significantly longer first pass reading time than the control sentences. First pass reading time has been adopted as indicator of detecting syntactic anomalies (Dussias, 2010). Hence, the participants in this stage had noticed the structural difficulty of the critical sentences: it took them more time for syntactic analysis when encountering marker of word order asymmetry such as relative pronouns. They may check whether the initially built structures can be incorporated into the words being fixated upon or make anticipation of the ensuing structures. If on-line planning of target structure was involved during this stage, participants' first pass eye indices will be closely linked to syntactic complexity: parallel word orders between the languages can greatly reduce the first pass reading time while syntactic dissimilarity would consume more time and effort in the first run. The significant differences in early eye measures suggest that the syntactic processing are influencing interpreting from very early on, thus the participants were affected by word order asymmetry during the initial stage of processing. This corroborated the results from Bangalore et al. (2016) who found considerable effect of source syntactic structures on early eye measure. They used eye-tracking to investigate the relationship between syntactic variation and priming effects during translation. The assumption was that when source language and target language share a common syntactic representation, this shared network can facilitate translators' on-line processing, leading to a priming effect. The syntactic structures of source texts were classified into two types: PRIME (every TL segment that preserves the structure of the corresponding SL segment) and DIFFERENT(all segment that show a structural change in the TL as compared to its corresponding SL segment) (Bangalore et al., 2016, p.222). Data results demonstrated a significant effect of syntax on the average first fixation duration: the first fixation duration for processing the DIFFEREENT was significantly longer than for processing the PRIME. A possible explanation for this very early effect of source structures may be that both SL and TL were activated. That means that the participants had engaged in exploring and selecting the potential target text elements as soon as they encountered the source words. As introduced in the research design, all other linguistic properties such as word frequency and sentence length had been matched across conditions, it was thus inferred that the considerable differences in early measures were to a larger degree caused by the syntactic processing activated in this stage: the participants started syntactic planning from the moment they first fixated upon the word.

Significant word order effect on the early eye measures may offer some valuable insights into understanding two major cognitive approaches to translation: a sequential/vertical approach or a parallel/horizontal approach (de Groot & Christoffels, 2007; Macizo & Bajo 2006). The sequential view holds that translation is essentially a concept-driven process during which the source language is first abstracted into non-linguistic concept and then is reorganized in the target language (Seleskotvitch, 1978; Schaeffer & Carl, 2013). By sequential approach, the translator/interpreter decodes and deverbalizes the source context before reformulating it in the target language, which to some degree echoes the meaning-based approach advocated by the Paris School. By contrast, the parallel view believes that source comprehension and target production occur in parallel: there is a co-activation of both source and target linguistic systems (Schaeffer & Carl, 2013). When certain source words, phrases or structures are encountered, their cognitive representations in the target language are activated concurrently. The significant effect of word order asymmetry on early measures may be interpreted as the evidence of a parallel approach to interpreting: If interpreting was primarily sequential or meaning-based, there would be no considerable differences between the critical sentences and the control sentences at initial stage of processing. Given that all other aspects such as word frequency, word familiarity and sentence length had been controlled and all participants were proficient English speakers, early encounter with the source word, if sequential view was supported, was not fundamentally different from normal reading since no target representation was activated at this stage. Mere comprehension of the source sentence, irrespective of structural asymmetry, would not elicit significant differences at initial stage unless extra activity, for instance, target encoding took place at the same time. The possible explanation is that both source and target language systems were activated at the early stage and the asymmetric structures required extra mental effort for target reformulation. Hence, participants were imposed upon higher cognitive load at very early stage in which the on-line planning for target expression were already activated. This parallel/horizontal approach may be attributed to the extreme cognitive constraint during interpreting: participants do not have the time for sequential processing otherwise they may lag far behind the source input.

However, the data should be interpreted with caution since the significant differences in early eye measures may also be a result of inherent difficulty of syntactically complex sentence in monolingual reading. To distinguish normal reading and cross-linguistic transfer is beyond the scope of the current study, but a baseline condition (reading comprehension task) is necessary to identify the exact source of significant effect: Similar attempts were made by Balling et al. (2014) who investigated the effect of word order (the canonical SV order and non-canonical VS order in source language) on translation from Danish to English. They found a significant effect of congruence: The gaze time on incongruent VS segments in the source text was significantly longer than the congruent SV segment. To rule out the possibility that this effect was actually caused by the inherent difficulty of the VS segment, the same source texts were also used for a L1 reading and L2 reading task: a group of native speaker of Danish and native English speakers who acquired high proficiency of Danish read the source materials for comprehension. No significant effect of congruence was observed in the reading tasks. Thus the author concluded that the congruence effect in translation task was not an artefact of the VS segments being inherently more difficult to process but due to the activation of target syntactic structure during the stage of source language comprehension. Although this result cannot be directly applied to the findings in this study, it suggested that effect of syntax in normal reading was far from significant and the syntax of source language was not activated to a measurable extent. Thus, it is speculated that syntactic processing during sight translation such as anticipation of syntactic structure or assigning syntactic roles occurs at the very initial stage of processing in parallel to semantic processing such as lexical retrieval or lexical transfer. Although meaning-based approach or deverbalization has been emphasized in interpreting training, the effect of syntax seems to prevail throughout the interpreting process and can have a very strong effect on processing. More empirical data with baseline reading task are expected to identify the stage during which syntactic effect shows up and to confirm the exact source of word order effect on early eye measures.

As for the late eye measures, it came as no surprise that the main effect of sentence type was highly significant on second pass reading time and regression path duration. It is tempting to draw on views from psycholinguistics to account for increasing cognitive load at later stage of processing: difficulty for syntactic processing is related to the degree to which the initially anticipated structures and its target forms accord with the actual sentence structures (Levy, 2008). As suggested by the local eye measures, both semantic and syntactic knowledge were activated at the very early encounter with the source word, which suggested that the target expression or the expectation for the upcoming meaning/ structures were being constructed incrementally as reading continued. When the two language systems have parallel syntactic structures, the on-line parsing would be facilitated with no or little need for reprocessing. However, the initial expectations were more likely to be violated by the asymmetric structures which do not conform to conventional syntactic rules in the target language. As introduced in Chapter Three, relative clauses as post modifiers are grammatically unaccepted in modern Chinese and there is a much lower frequency of passives in Chinese. In other words, RCs and passives in English tend to be more "unexpected" in the eyes of native Chinese speaker since they do not conform to the syntactic expectation of the participants. It was thereby highly possible that the participant only noticed their initial anticipation was incorrect when they fixated on certain word that signals the asymmetric structures (such as the relative pronoun in relative clauses and the past particle in passives) and had to revisit the word and sometimes the regions to the left to reconstruct their target formulation. This expectation violation and correction process resulted in a significant increase in values of the late eye measures. Additionally, the need for establishing syntactic links between different segments or syntactically incorporating certain parts into earlier words may also contribute to the increase in value of late measures. Figure 7.3 is an actual recording of one participant's eye movement and the transcribed output for a critical sentence containing passive constructions:

Figure 7.3 Gaze plot for processing a critical/asymmetric sentence

Source sentence: *The economic development has been further fostered by the region's enhanced cooperation and efforts in promoting comprehensive trade and economic partnerships.*

Target sentence: 經濟發展進一步得到培養 通過的方式就是 地區之間要加強合作加強努力 要促進全面的貿易和經濟合作夥伴關係。

To illustrate how later-stage eye movements were relevant to syntactic reanalysis and structural integration, the onset of first fixation on key words constituting the passive structure and the onset of producing the corresponding target output was presented as follows. Time points for each fixation were exported from the eye-tracking data file and the timing of the corresponding oral delivery was identified through Pratt, professional sound analysis and editing software.

Table 7.3 Onset of reading certain words and of producing the corresponding target word

Word	Onset of first fixation	Onset of second pass reading	Onset of producing the target expression
further	1849ms	2405ms	2670ms
fostered	2261ms	4150ms	5226ms
by	3201ms	6972ms	8449ms
region's	7273ms	8775ms	10010ms

According to Table 7.3, after reading the word "fostered" for the first time at 2261 *ms*, the participants did not start translation immediately but continued with reading by fixating upon the "by" to the right. "By" in this sentence was a marker of passive construction. It was the encounter with this word at 3201*ms* that prompted the participant to make a regressive saccade to the prior word "fostered", which indicated an attempt of syntactic reanalysis since the occurrence of passive marker might had disrupted the participants' initially expected syntactic structure. Therefore, she had to reread the word(s) to the left to check the earlier syntactic expectation and consider how to incorporate these words. Between the time when "by" was first fixated upon and the time its target expression was uttered, very frequent attention shifts were observed across "fostered" and "by", as seen by clusters of fixations on these regions in the figure above. After this long string of fixations, the participant finally came up with the target expression and completed the syntactic incorporation. It seemed that extra efforts were spent on identifying syntactic relations between these words and also searching for appropriate target words to connect them, which resulted in a surge in second pass reading time and regression path duration. Noteworthy, all the target equivalents to the above four words were produced during the second pass (the onset of uttering the corresponding expression was later than the beginning time of second pass reading), suggesting that most efforts for meaning integration and reformulation were involved in a later-stage.

b) The main effect of task condition

The data results presented in the table above were generally consistent with the assumption that word-based cognitive load was also modulated by the task condition. The ANOVA comparisons revealed a significant main effect of task condition on all four eye measures. A closer examination showed that the pattern was in contrast to the previous prediction. Given that word predictability is higher in discourse context, it was hypothesized that sight translation in Condition 2 was always less effortful than in Condition 1 as indexed by both early and late measures. However, it turned out to be the opposite: the values of all local eye measures were greater in Condition 2 than in Condition 1 irrespective of sentence type, thus no benefit of discourse context was found. Additionally, there were significant interactions between task condition and sentence type on the eye measures excerpt for first fixation duration, which further complicated the data pattern.

Several factors may account for the non-expected data results: First, as compared to single sentence context, sight translation in discourse context involved larger amount of information including but not limited to the text itself, which imposed greater memory load. As introduced in the methodological section, background information including the interpretation setting, brief introductions on core words such as “ASEAN” in Text A and “Siri Lanka” in Text B, and the main topics were offered before the task. All these need to be kept in mind during the on-line processing, which partly accounts for the increasing efforts. Moreover, the critical sentences in Condition 2 were intermingled with the control sentences and fillers, which led to higher memory load as compared with single sentences: according to Slevc and Novick (2013), prediction in reading are often made through integration of information encountered in the ongoing sentence and the information stored in readers' memory. In discourse condition, the already processed sentences and words had to be maintained in short-term storage as basis for comprehending and predicting the upcoming message, which may contribute to greater working memory load as reflected by the eye measures.

Second, the increase of cognitive load in condition may be related to an extra updating cost in wider contexts: A precondition for text comprehension or further processing is the establishment of a coherent mental model (Kintsch, 2004). The coherent mental model is constructed by constantly updating the current model built on earlier words (Van den Broek, Young, Tzeng, & Linderholm, 1999). In this case, as more contextual information was accumulated as the task progressed, participants had to constantly update or revise the previous mental model during sight translation by constant rereading and reanalysis. Considering the limited amount of contextual information in Condition 1, little efforts in updating were required. However, to process in discourse context, more frequent updating was required as a wider context unfolded in front of eyes, which contributed to the increased value of late eye measures.

In addition, this phenomenon can also be accounted for by the stronger visual interference in discourse sight translation. According to Agrifoglio (2004), processing during sight translation is constrained by the visual interference induced by constant presence of textual information. In an eye-tracking study of sight translation, Shreve et al. (2011) found that all second paragraphs in source texts were apparently more effortful than the first paragraphs to process, which pointed to the incremental cognitive load in discourse context. This study suggests that cognitive load in sight translation is temporally related, in other words, the effect of visual interference appears to increase as the sight translation progresses, which partly accounts for the significant increase in mean value of all local measures in Condition 2.

Lastly, the higher regression path duration in discourse context might be attributed to participants' frequent search for contextual cues between words for semantic or syntactic integration. Previous eye-tracking experiments showed that readers tend to make use of earlier textual information to direct their eye movements when processing new or difficult message (e.g., Ito et al., 2018). Therefore, participants were more likely to reread the prior words or sentences when asymmetric structures were encountered. Only when enough contextual support was obtained from the surrounding regions, the participants could concentrate more on the conceptual meaning of source language instead of the linguistic forms.

In addition to the main effects, significant interactions between sentence type and task condition were also found on three local measures: first pass reading time, second pass reading time and regression path duration. Separate analysis of condition effect indicated that processing of critical sentences was influenced by contextual information to a greater degree, which means that the condition-induced differences in terms of the eye measures were more significant for the critical sentences than for the control sentences. This was expected: the more complex the source structure became, the greater need for contextual support, in other words, as compared to the simple sentence, processing of syntactically difficult sentences is more closely related to contexts. When addressing the critical sentences, the participants relied on contextual information for better comprehension, and more importantly, to free themselves from the interference of language forms. And this heavier dependence on contexts during critical sentence translation may explain the greater effect of task condition on the eye measures.

7.2 Relations between Working Memory and Processing of Word-order Asymmetry

7.2.1 Relations between Reading Span and Cognitive Load

Simultaneous interpreting is an extremely demanding task which involves many subtasks competing for the limited cognitive resources. Therefore, efficient management of attention, in particular, the coordination between source input and target output is of paramount importance. In this study, working memory capacity as measured by English reading span test was introduced as a variable that may impact processing of asymmetric sentences. It was hypothesized that higher working memory could help relive the cognitive burden induced by word order asymmetry: participants with better performance in the reading span test would be less affected by word order asymmetry. To explore the relations, Spearman's rho correlation tests were administered on scores on reading span test and the overall cognitive load. But correlations between the two were not statistically supported: significant correlations were only found for fixation count in Condition 2 (discourse context), as for the dwell time, it turned out that total processing time for the critical sentences in both conditions was not related to working memory span.

Even for the significant correlations between the score and the fixation count, the pattern was quite unexpected since the data result revealed a positive correlation: the higher the score was, the more fixations were made in discourse context, which seemed quite insensible. It thus appeared that a higher reading span played a counterproductive role. One possible explanation is that for participants who has been trained in basic interpreting skills, working memory capacity was no longer the most crucial factors in shaping the cognitive load. Some structure-induced problems can be resolved through specific strategies rather than relying solely on larger working memory span. If another group of participants, for example, untrained bilinguals or interpreting students at the beginning of training, took part in the study, relations between WMC and cognitive load might be stronger since these participants can hardly address syntactic difficulties through interpreting strategies and had rely on larger information storage. Secondly, the unexpected result suggested that reading span test in L2 may not reflect the genuine WMC of the participants, even though it has been one of the most widely applied measurement of working memory span. Language mode of the reading span task may play a role: As claimed by some, working memory measured in L2 may interact with L2 proficiency (e.g., Coughlin & Tremblay, 2012; Omaki, 2005), thus, WMC in L2 span test and language proficiency may be confounded. But this need be further tested by other types of working memory test such as the operational span task (Turner & Engle, 1989) which taps domain-general and language-independent WMC. Besides, reading span may be less relevant to the working memory capacity involved in asymmetry processing since it is primarily a measure of maintenance & interference also known as "processing as storage". It was possible that other aspects of working memory such as coordination, updating and switching (Macnamara & Conway, 2016) played a greater part in asymmetry processing, which however cannot be reflected by the reading span task.

Despite the reasons speculated, one point confirmed by the data analysis was that WMC measured by English reading span test failed to show any expected correlations with the overall cognitive load for critical sentences. Better performance in the reading span test will not offset the structural disruption, thus having a very limited role in on-line processing of sight translation. Although this result need be interpreted with caution, it was quite possible that working memory is not one of the most determinant factors in sight translation.

7.2.2 Relations between Reading Span and Interpreting Strategies

It was assumed that working memory capacity affects strategy choice when dealing with the critical sentences: for those with a smaller working memory span, segmentation which involves shorter EVS and storage of smaller chunks would be used more frequently than restructuring in both conditions. However, this was not supported by the data analysis. According to the Spearman's rho correlation test, no significant correlations were found between reading span and frequency of segmentation in Condition 2. And there were only marginally significant correlations between the scores on reading span test and the segmentation frequency in Condition 1 and the correlations were positive, which indicated that larger reading span was related to more frequent use of segmentation.

As previously assumed in Chapter Three, larger working memory span would be conductive to on-line coordination between message storage and later integration, thus when asymmetric sentences occurred, participants with higher working memory would adopt restructuring more frequently since it was easier for them to memorize source units, delay the output and integrate the stored parts with later information. However, the statistical analysis presented the reversed pattern. It seemed that the role of reading span was quite limited in processing critical sentences. One possibility was that one semester of STR training had altered students' interpreting habits during sight translation: as shown by the post-experimental questionnaires, segmentation was the most frequently emphasized and practiced strategy in daily training. Although restructuring could produce the target language which is in line with the canonical word order in Chinese and sounds more natural, it also involved higher risk of cognitive overload as characterized by more pauses, omissions and errors. Therefore, despite the individual differences in working memory span, the majority of participants would prefer segmentation for coping with asymmetric sentences and conquer any memory-related difficulties through some interpreting techniques such as addition or transformation. It may be concluded that the effect of reading span on sight translation was outweighed by impact of interpreting training. But given the relatively small sample, it need be further supported by larger-scale empirical data.

As for the positive correlations between reading span and the frequency of segmentation in Condition 1, the results may be quite strange at the first sight. It was previously supposed that participants with larger working memory span could wait for longer thus being less burdened by restructuring since they could better manage the trade-off between storage and processing. However, the analysis showed that higher-span participants tended to use more segmentation for critical structures. The possible explanation may reside in the way that source sentences were chunked: segmentation skills such as number of segments the sentence is split into, location of the cutting points and the size of chunked units (See Davidson, 1992) may be more closely linked to one's cognitive ability as compared to general consideration of strategy choice. For example, lower-span participants may have to chunk the sentence into more segments than their higher-span counterparts in that lower-span people can hardly wait for more information to form longer segments due to limited memory capacity. In other words, lower reading span may predict a pattern of over-segmentation. To probe into detailed techniques of segmentation was not the focus of the present study, however, it may offer a new perspective to examine the relations between working memory and interpreting strategy.

7.3 Strategy Choice and Cognitive load

7.3.1 Segmentation as the Primary Strategy Adopted for Word Order Asymmetry

English and Chinese are inarguably two syntactically different languages. As stressed by Setton (1999), English favours right-branching structures while Chinese is a left-branching language, which constitutes one major source of word order differences between the two languages.

In addition, as for certain sentence structures, such as passives in the present study, although they exist in both languages but follow different syntactic orders and imply different semantic meanings. As a result, special strategies are required when word order asymmetry occurs.

This study categorizes the strategies for processing critical sentences into two major types: segmentation (chunking) and restructuring. The criteria for identifying these two was quite straightforward: if segmentation was applied, the target word order of the structure under study would be parallel with the source word order, otherwise, restructuring was adopted, characterized by a reversion of word order for example, putting the relative clause before the relative pronoun. The recordings showed that few participants changed their strategy during the on-line processing: for example, one of them attempted to re-order the original sentence but soon decided to chunk the sentence instead. In this case, the strategy labelling was based upon the final production. The following example illustrated how a critical sentence containing a PC was rendered through segmentation (Target text A) and restructuring (Target text B) respectively by two participants. The examples were transcribed based on the audio recordings in single sentence condition.

Example 7.3.1-1

Source text: *The economic development has been further fostered by the region's enhanced cooperation and efforts in promoting comprehensive trade and economic partnerships.*

Target text A: 經濟發展已經得到了加快, 這是因為地區共同合作共同努力, 來促進全面貿易和經濟合作夥伴關係。

Target text B: 經濟發展在區域合作的加強以及推動全面的貿易和經濟夥伴這些努力下有了進一步的發展。

The first target version was a typical example of segmentation by which the original word order was retained in target output. The participant divided the source sentence into several shorter segments, then interpreted them in sequence by adding logical links between the segments. For example, "这是因為 (it is because)"was added to connect the subject and the predicate, constructing a cause-and-effect relations, otherwise the target language would be unnatural and incoherent. As shown by Target text 2, the participant adopted a non-linear approach through restructuring: reformulation of the segment "*has been further fostered*" was delayed and temporally stored in memory to be integrated with the agent "*the region's ...partnership*", which was supposed to increase the short-memory load and coordination effort. In real practice, both strategies can be used for coping word order asymmetry, but they may differ in the amount of cognitive resources involved, which is one of the concerns in the present study.

In Chapter Six, frequencies of segmentation and restructuring for critical sentences in both conditions were counted and compared. Segmentation was used far more frequently than restructuring under both conditions: In single sentence context, segmentation accounted for more than 70 % of the total, and the difference expanded in discourse context under which segmentation took up almost 80 % of the total. It turned out that the participants always preferred segmentation over restructuring as the primary strategy for word order asymmetry and the differences in terms of frequency were statistically significant. An inter-condition comparison showed that frequencies of segmentation use also differed significantly across conditions: segmentation was adopted more frequently in discourse context than in single sentence context, which corroborated the findings on cognitive load: sight translation in discourse context involved greater efforts as reflected by local eye measures. As discussed in Section 7.1.1, sight translation in discourse context involved higher memory load and stronger visual interference, which constrained the already insufficient processing capacity. Therefore, segmentation under this circumstance was relied upon to ease the memory burden and avoid saturation of mental resources.

This significantly higher frequency of segmentation among the interpreting trainees could be accounted for by both the need for relieving cognitive burden and the norm based on training and professional experience. Shlesinger (2003) pointed out that norm-driven strategies may play a more important role in shaping interpreters' on-line decision making than was previously assumed. Wang and Gu (2016) listed four major factors which influence the interpreting performances, namely, interpreting competence, cognitive conditions on site, norms of interpreting and language-pair specificity. In descriptive translation studies, norms can be understood as the common rules or expectations accepted by certain community (Toury, 2012). In this study, the norms of interpreting include the shared views on certain "what the generally accepted interpreting methods and strategies are" (Wang, 2012, p.1999). As reported in the questionnaires, segmentation was the most frequently recommended strategies for dealing with syntactically difficult sentences by the interpreting instructors. Thus, to chunk the difficult structures in simultaneous interpreting had been accepted as a norm which guided or governed the participants' on-line choice of strategy. And this wide application and pedagogical status of segmentation raises another question: will adoption of segmentation significantly reduce the cognitive load for addressing structural asymmetry?

7.3.2 Relations between the Strategy and Cognitive Load

Segmentation has been considered a fundamental skill in interpreting training to deal with syntactic complexity such as long sentences, or sentences with embedded structures (e.g. Qin & He, 2009; Yang, 2005). It is taught as a crucial strategy for successful English/Chinese interpreting in light of the prevailing word-order differences involved in this language pair (Dawrant, 1996). By segmenting source sentences into smaller fragments, interpreters could reformulate without waiting for the entire sentence to unfold or changing the basic sentence structure. Thus, segmentation was used as the primary strategy for addressing word order asymmetry, as evidenced by its frequency analysis and the questionnaires. Despite the pedagogical value of segmentation, most relevant studies merely focus on its techniques such as identifying meaning units and the cutting points, and little has been known about how much cognitive load is involved for chunking an asymmetric sentence and whether segmentation, as recommended by interpreting trainers, is cognitively more efficient. Seeber and Kerzel (2012) listed segmentation as one of the strategies for syntactically asymmetric sentences in an eye-tracking study on simultaneous interpretation of speeches containing asymmetric structures, but they did not identify which of the strategies listed accounted for the change in cognitive load. It remains to be seen whether cognitive load involved differ across strategies and how reading behaviour measured in eye indices is related to specific strategy.

This section focused on the relations between strategy choice and the cognitive load involved with an attempt to depict the underlying mechanism of on-line response to word order asymmetry and also to offer cognitive evidence in favour of using segmentation during sight translation. To cope with the asymmetric sentences, the participants either adopted syntactic linearity through segmentation or changed word orders of original structures. It was assumed that restructuring involved much greater cognitive load in terms of global eye measures as compared with segmentation, and this pattern applied to both task conditions.

The prediction was partly supported by the data analysis: For addressing critical sentences in single sentence context, restructuring elicited significantly longer dwell time and more frequent fixations than segmentation. Thus, changing the word order was more effortful when interpreting single sentences. Similarly, in discourse context, there was significantly longer dwell time involved in restructuring than in segmentation. Restructuring also elicited more fixations than segmentation under discourse context, but the differences failed to reach significance.

According to the data results, segmentation did help relieve the cognitive load in single sentence context as hypothesized: processing the critical sentences was quicker and less effortful through segmentation. It may be attributed to the approach of "syntactic linearity" when chopping the sentence: following the original word order, most parts of the sentence can be processed at local word or phrase level, which reduced the frequency of backward fixations for rereading and syntactic integration. In contrast, restructuring was more cognitive-taxing: it involved long-distance integration which was more effortful due to memory decay over distance.

This pattern was replicated on the sentence dwell time in discourse context. It can thus be summarized that as compared with segmentation, restructuring was more time-consuming for dealing with asymmetric sentences. Although in discourse context, the participants spent considerably shorter time through segmentation, there was only marginal difference in terms of fixation count: the mean fixation count for segmentation was slightly more than for restructuring. Considering that the dwell time associated with segmentation was significantly shorter, it can thus be inferred that segmentation in discourse context exhibited a quite special reading pattern characterized by frequent but very short fixations during chunking. This pattern suggested that when segmenting the critical sentences, the participants tended to quickly switch their attention between the words to seek contextual clues and identify inter-word/clause relationship for coherence construction or they preferred to have denser but very short fixations within the word for meaning retrieval and integration.

7.3.3 On-line Reading Behaviour for Segmentation and Restructuring

In this section, I turned to discuss reading behaviour associated with specific strategy choice. Previous approaches to reading behaviour during translation/interpreting include examining reading across difference tasks to see whether and how task purpose shapes reading pattern (e.g., Ho, 2017; Jakobsen & Jensen, 2008) or examining reading across different groups to see whether and how training experience affects reading pattern (e.g., Dragsted & Hansen, 2009; Ho, 2017). However, far fewer studies investigated the relations between reading behaviour and on-line strategies in processing certain structures.

It was assumed that segmentation and restructuring would result in different reading behaviour as measured by the rereading rate. Segmentation, as the most frequently practiced strategy in daily training, would change the reading behaviour in sight translation as indicated by fewer re-fixations since a segment-by-segment approach allowed the interpreters to address asymmetric structures in a linear manner and they did not have to read back and forth for reordering. Therefore, under both conditions, the rereading rate in critical sentences processed through segmentation would be significantly lower than those processed with restructuring.

In Condition 1, the assumption was statistically supported: for critical sentence processing, restructuring involved significantly higher rereading rate than segmentation, which indicated that a considerably greater proportion of fixations were made during the second pass; The similar pattern was also observed in Condition 2: but the numerical differences failed to achieve statistical significance: the mean rereading rate in restructured sentences was only slightly higher than in segmented sentences. Thus, the prediction was partly confirmed.

According to the data results, effect of strategy choice on reading behaviour was observed under both conditions but appeared to be stronger in single sentence context and became less visible in discourse context. In Condition 1, participants' mean rereading rate was significantly lower in chunked sentences than in restructured sentences, revealing an apparent influence of training: these interpreting trainees, who had been learning and practicing interpreting for at least one semester, were quite familiar with basic techniques of segmentation. For a successful execution of segmentation, interpreters were expected to complete meaning retrieval and construction at local level instead of moving their eyes back and forth in a larger scale. As compared to restructuring, eye movements during segmentation tended to be more smooth and successive, with few disruptions such as frequent rereading or long-distance regressions.

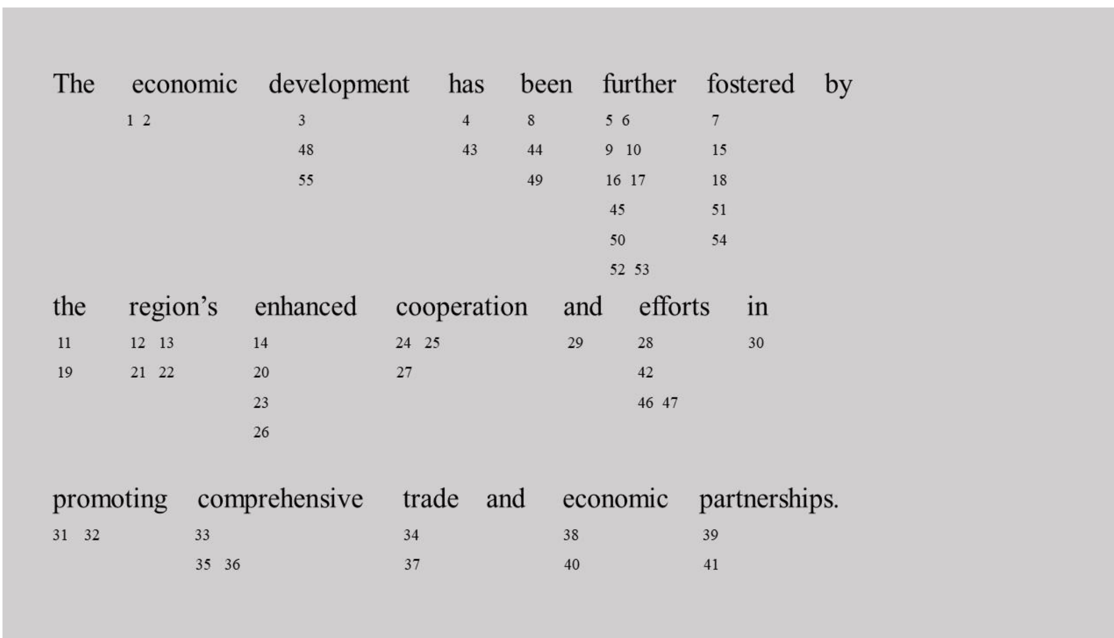

Figure 7.4 Fixation sequence for asymmetric structure processed through restructuring

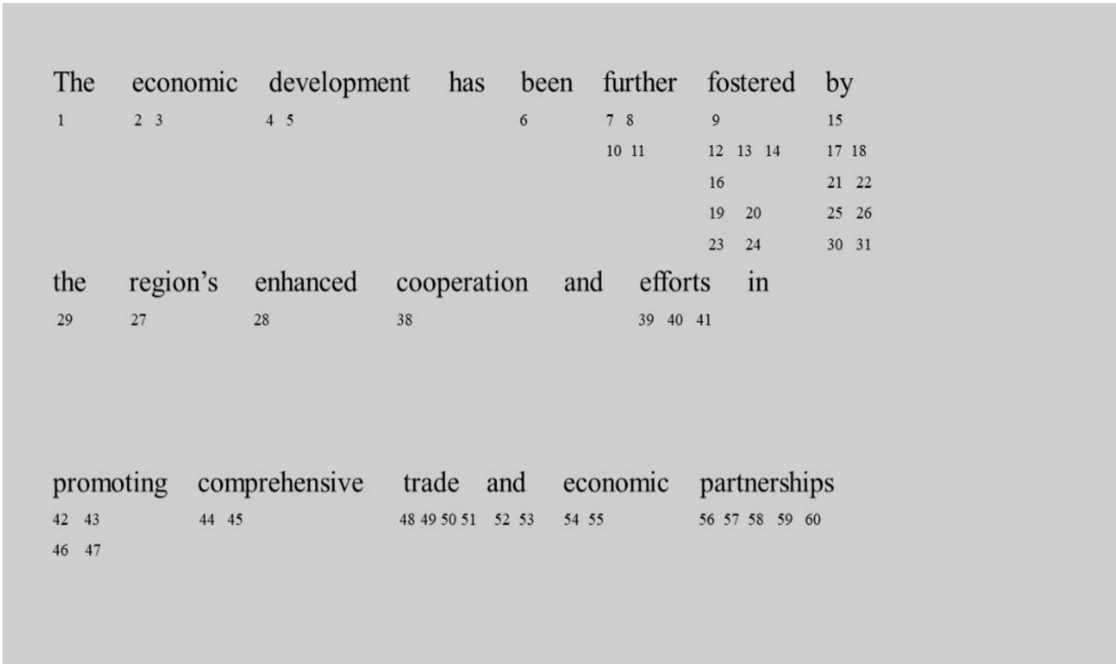

Figure 7.5 Fixation sequence for asymmetric structure processed through segmentation

The above two figures displayed the fixation sequence of the same critical sentence processed through restructuring and segmentation respectively. The fixation sequence plots were drawn based on the original eye-tracking data by two of the participants. The number in the plots represents the order of fixations made through the translation, for example, "1" refers to the first fixation and "27" represents the 27th fixation made since the beginning of the trial. The number of lines of fixations under each word reflects the number of reading passes, for example, there are three lines of consecutive fixations under the word "efforts", it means that "efforts" was passed by three times (The first line represents first run, and the second and third line combined refer to the second pass reading in eye-tracking researches).

According to Figure 7.4, the on-line processing for a reordered sentence was characterized by a more "disruptive" reading pattern as indicated by frequent rereading. The majority of words in the sentence was passed by at least twice, and words as markers of the relative structure were even passed by five or six times. In addition to the overall frequency of rereading, the sequence of fixations also suggested a quite long eye-voice span, in particular for words related to the critical structure. For example, the participant regressed to the area “has been further fostered” (Fixation No.43, 44, 45) after she had read the word “efforts” for the second time (Fixation No. 42), then she shifted the attention again to “efforts” for a third run (Fixation No. 46, 47). After that, the fixations were once again moved to the distant earlier region (Fixation No. 48-55). The fixation sequence revealed a frequent long-distance attention shift between earlier region and later region of a sentence, which indicated the participant’ conscious effort in restructuring: after first encountering the critical structure, she decided to continue with source reading until more information was collected for reordering and then that later parts stored in short memory could be integrated to the previous markers of PC. As demonstrated in Chapter Six, restructuring in single sentence context elicited considerably greater mental load. It might be attributed to the higher memory load during the frequent attention shifts, in particular shifts between very earlier parts and later parts.

In contrast, Figure 7.5 exhibited a strikingly different reading mode: the rereading was far less frequent with most words being passed only once or twice. In addition, there were almost no long-distance attention shifts detected: most fixation shifts occurred between neighbouring words. Only words related to the critical structure such as “fostered” and “by” were reread by five times. The five passes of fixations contained altogether 18 fixations and above 80% of the fixations were actually due to attention shifts between these two words or between them and “further”, the first word to the left, which indicated a more local processing. The focus of on-line analysis was actually narrowed down due to segmentation. As for the repeated reading of some words, it may be attributed to the increasing difficulty in determining detailed chunking method, say, where to cut the original structure and how to link the chunked elements.

It was expected that significantly lower rereading rate in segmented sentences would be replicated in Condition 2. However, the divide between the two strategies was blurred: when processing the critical sentences in discourse context, the participants tended to frequently reread the earlier regions irrespective of the strategy they adopted.

One possible reason was that the participants were imposed by higher memory load and stronger visual interference when dealing with critical sentences in discourses. As the sight translation progressed, more contextual information of the prior sections need be stored in short-term memory for later use such as predicting the meaning of yet-to-come segments. Meanwhile, an increasing visual interference due to task progression may force the participants to increase their dependence on contextual information.

In consequence, the participants tended to reread the earlier words to check whether the contextual information had been maintained and whether their context-based prediction or analysis was correct. Therefore, in discourse condition, a universal tendency of increased re-fixations was observed irrespective of the strategy type. Another possibility was that performing segmentation in discourses involved reanalysis effort that was not necessarily lower than performing restructuring. Using cohesive conjuncts to link the split segments is a crucial technique for successful segmentation, which suggested that enough information need be collected before connecting two neighbouring meaning units. It was this information searching process at wider scale, as characterized by frequent re-fixations that contributed to a comparable rereading rate in segmented sentences.

Inconsistent patterns between conditions may also be attributed to unrelated samples in the two conditions. Some participants observed in Condition 1 were not included for analysis in Condition 2 since they did not apply restructuring for any of the critical sentences or used it only once. Therefore, the observations in the two conditions were not related, which only allowed for separate within-group comparisons and may increase the confounding impact of individual differences.

7.4 Effect of Word Order Asymmetry on Interpreting Performance

An error-based analysis of the interpreting output was conducted to see whether target delivery was negatively impacted by word order asymmetry. As shown by the data result in Section 6.5, there was a very strong effect of word order asymmetry on the error frequency in target output: Under both conditions, the participants made significantly more overall errors during critical sentence processing than during control sentence processing. In addition, there was also a significant effect of task condition: processing the critical sentences in discourse context elicited significantly more errors than in single sentence context. Although the Paris School denies the existence of language-pair specific factors and meaning-based approach has often been emphasized in daily training, there is still a strong effect of word order asymmetry in terms of both cognitive process and end product. Interpreting, according to the Paris School, is essentially an activity of meaning comprehension and reformulation, which underlying mechanism is similar to that in normal language tasks, thus language-pair specificity would not impact the final product (Seleskovitch, 1978). However, data from this study offered both on-line and off-line evidence in disfavour of this language-interdependent view. A dramatic increase of cognitive load for critical sentences indicated greater attention, more frequent reanalysis, and active thinking for on-line solutions, but these more intensive efforts were not transferred to a better performance as shown by the error analysis.

The results were aligned with previous studies through product-oriented approach: for example, Gile (2011) compared the errors and omissions among renditions of the same English speech into different target versions (French, German and Japanese) during simultaneous interpreting with text and found that although the Japanese interpreters were highly proficient with at least 15 years of experience and had more time for preparation, they still had considerably more micro-units affected by EOs("different unites of the source speech affected in each interpreter's output") (Gile, 2011, p.206).

As compared to Japanese, French and German can be considered closer to English in terms of linguistic distance, which partly accounted for more difficulties experienced by the Japanese interpreters. And these data seemed to support the impact of language-pair specific difficulties on interpreting performance. Similar to Japanese, Chinese is also typologically very different from English at both grammatical and conceptual level. Robust evidence from descriptive study of English-Chinese interpreting had proved the negative effect of structural differences on target production. Wang and Gu (2016) reported very long pauses in interpreters' delivery when they dealt with the right-branching structures in English-Chinese simultaneous interpreting. Despite different methodologies adopted, these studies all point to the fact that target production will be negatively affected by word order differences, highlighting the role of language-specific factors in interpreting.

Results of error analysis in the present study further confirmed that word order asymmetry in sight translation not only increased on-line cognitive load but also had disruptive impact on interpreting quality. The interpreting trainees, who had been trained for at least one semester, were still not able to get rid of the asymmetry-induced difficulty as evidenced by the fluctuation in their performance.

As for the distribution of error types, participants consistently made more meaning errors than expression errors for the critical sentences, but the differences did not achieve significance. However, there were significantly more expression errors reported in control sentence irrespective of task conditions. Hartsuiker et al.(2004) predicted that during translation or interpreting, the target production would be greatly facilitated if the two languages have similar syntactic structures since processing the source structure will act as a syntactic priming which leaves the target structure with residual activation. When dealing with the symmetric sentences, participants would be primed by the original word order and transferred the structure in the target language with ease, which reduced the efforts for parsing and the potential reordering. However, in the face of syntactic asymmetry, the original word orders that differed strikingly with the target language would become a source of interference, imposing greater cognitive burden on the limited processing capacity.

Greater number of meaning errors observed in the critical sentences suggested that a failure sequence might had been triggered by word order asymmetry. As emphasized in Section 5.5.2, linguistic properties of all experimental sentences such as word frequency and word familiarity had been controlled to minimize the confounding effect of comprehension problem. And the background questionnaires showed that the participants were very proficient speakers of English. Therefore, failure of word meaning retrieval should not be the major factor that caused large amounts of meaning errors. A more plausible account may be cognitive overload. Shlesinger (1995) noted that interpreting entailed a trade-off between sub-components of the task. For instance, if syntactic processing became highly burdensome, then cognitive resources for other sub-tasks, say, lexical searching and self-repairs would be reduced. It was inferred that syntactic analysis had consumed large amounts of attention which prevented the interpreters from self-correction of misunderstood or misinterpreted elements. As Gile (2002) pointed out, sometimes frequent errors in interpreting are not associated with lack of linguistic or extra-linguistic knowledge but with cognitive load: if the cognitive load for processing earlier segments was too high, it may lead to heavier burden on processing the next segments and ultimately to a failure sequence (p.166). Thus, the participants in this study, overstressed by asymmetry-induced difficulty, did not have extra attention for accurate reformulation. They might encounter no or few problems in word meaning retrieval, but sometimes word production had to be delayed since the participants were waiting for more meaning units so as to decide the interpreting strategy (segmentation or restructuring), and this delayed rendition may contribute to greater mental load on the final production: it was highly possible that even all words had been correctly perceived, the participants were still not able to reformulate them accurately due to cognitive overload. Moreover, they sometimes might had been aware of the miscomprehension but had to continue with processing later parts so as not to lag behind.

And the error type detected in target output was impacted by the degree of cognitive overload: the higher the load, the more likely that a major error (e.g., misinterpretation of a key word) rather than a minor error (e.g., wrong collocations) took place. The error analysis showed that participants always made more meaning errors when interpreting the critical sentences, implying a stronger degree of cognitive overload. If too much attention was distracted to the syntactical differences and on-line planning of target word order, there would be higher likelihood of misunderstanding and more frequent reanalysis, which was corroborated by greater value of late eye measures.

It was expected that the use of segmentation can lessen the syntactic interference and improve interpreting efficiency. However, as indicated by output analysis, although segmentation was the primary strategy used for addressing word order asymmetry, significantly more errors were still reported in critical sentences. The following figure illustrated the sequence and location of each fixation made for processing a critical sentence through segmentation. It can be seen that there was a high frequency of rereading, for example, the word "peace" and "maintained" were fixated three times and "increasing" was read four times. One possible reason was difficulties in later-stage meaning integration. After one semester of training, most participants were quite adept in dividing a long sentence into several shorter segments, but how to explicate the logical links and connect these segments in coherent manner was constrained by not only cognitive resources but also level of interpreting proficiency. To identify which factor exactly contributed to frequent rereading in the segmented sentence was out of the scope in the present study, but it could be inferred that the participant in this example had suffered increasing cognitive load when searching for appropriate links. Thus, she had to go back to the prior word "maintain" after the first fixation on word "increasing". The underlying motivation might be the need to set up logical links between different units and to reformulate them in an acceptable way.

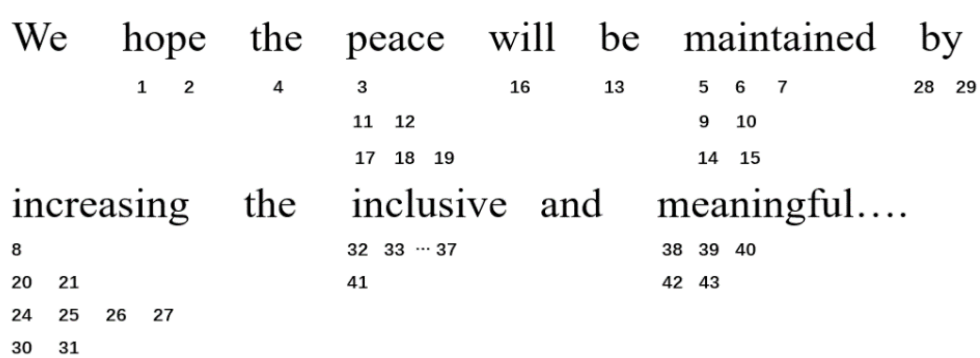

Figure 7.6 Fixation sequence for critical sentence by one of the participants

This frequent attention shift between words indicated great difficulties in segmentation, which was supported by results in the output analysis. Some participants only chunked the original sentence mechanically but failed to set up logical links between the segments. The following example showed an illogical segmentation of a relative structure in single sentence context:

Example 7.4-1

Source text: *For the past seven decades, the choices that we have made as a responsible major power has outlined a better future*.

Target text: 過去 70 年*(For the past 70 years)* 這個選擇*(this choice)* 我們所做的 *(we made)* 一個非常有責任感的大國 *(a very responsible major nation)* 可以導致一個更美好的未來 *(can result in a better future)*.

As shown by Example 7.4-1, the participant adhered strictly to a linear approach, revealing a strong trace of training. The whole sentence was chunked into at least 5 units of meaning and the participants rendered them sequentially. However, no effective linking devices were observed in her rendition. Additionally, translation of some words was not accurate, for instance, "导致 (result in)"implied undesirable results, which was not in line with the positive tone of the source sentence. It seemed that different segments were merely piled up incrementally to follow the original word order. The participant might had spent too much time on word retrieval and identifying the proper cutting points for chunking, which strained the limited mental resources and prevented her from establishing coherence. This cognitive-taxing effect was exacerbated in discourse context as evidenced by a significant increase of total errors. As discussed in Section 7.1.1, this could be accounted by greater memory load and stronger visual interference in passage sight translation. And in this sense, the offline end product was to some degree related to on-line processing since cognitive load measured in discourse context was also significantly higher than in single sentence context.

It thus appeared that for some participants, a frequent use of segmentation did not make up for the negative effect of syntactic differences on interpreting quality. The following was another example indicating an insufficient chunking technique. As a matter of fact, frequent segmentation also entails a risk of incoherence or inappropriate cutting points:

Example 7.4-2

Source text: *We gather here to honour the remarkable success ASEAN have achieved against all difficulties and challenges since its founding in 1967.*

Target text: 我們聚集在這裡(*We gather here*)，去將這個東盟的成功(*to BA this ASEAN success*)，在面對著各個困難和挑戰(*when encountering all difficulties and challenges*)，自從它 1967 年成立以來 (*since its 1967 founding*)。

Example 7.4-2 is the rendition of a critical sentence in discourse context by one of the participants. In view of the structural differences between Chinese and English, Wu (1994, p.92-93) stressed that simultaneous interpreter need “use his judgement to divide the sentence into operative units by virtue of sense”. For successful segmentation, to identify the operative segments by splitting at the appropriate location and construct logical links between the segments has a direct bearing on quality of interpreting. As shown in the example, although the participant attempted to avoid restructuring by chunking the original sentence, the delivery was still problematic: the target sentence was a mere sum of segments without any logical links. There were almost no cohesive devices added to connect different segments, resulting in very awkward expression. It is inferred that the participant was still not very adept in segmentation skill or she had already been overloaded by asymmetry-induced difficulty and had no extra attention resources for coherence establishment.

Example 7.4-3 illustrates a very effective segmentation adopted by one of the participant when rendering a critical sentence containing passive construction:

Example 7.4-3

Source text: *Negative effects of globalization can be minimized by China restructuring and strengthening its financial systems before opening up the financial market*.

Target text: 全球化的負面影響*(The negative impact of globalization)* 可以被最大程度減少 *(can be minimized)* 方法就是*(The method is)* 通過中國的改革和加強其金融體系*(through China's reform and strengthening its financial system)* 這是在開放金融市場之前就要完成 *(This should be completed before opening up the financial market)* 。

The original sentence was divided into 5 segments and were linked up with each other by addition of cohesive devices such as "方法就是" and "這是"。In the case of simultaneous interpreting, the overall structures are revealed piecemeal and can only be accessed at local levels. Thus Hatim & Manson (2005, p.37) argued that simultaneous interpreting was "characterized by contexts and structures being less readily usable than texture". Requirement for immediacy of response denies the possibility of a top-down processing during interpreting, structure of original sentence can only be inferred from textual signals and a successful execution of segmentation relies heavily on identifying texture in source speech and reconstructing textural signals in target output. It can be inferred that the participant in the above example identified the passive marker "be minimized" and quickly chunked the sentence at this point: the agent following "by" was not incorporated to the previous structure but used as the starting point of a new clause by adding "方法就是" which related the emerging long agent to "minimized" and also logically propelled the sentence forward. Thus, segmentation was not simply mechanically adding up segments but involved a process of texture establishment to ensure the target sentence was organized in a meaningful and coherent way. The example above demonstrates an effective way of breaking up structurally asymmetric sentence. The translation was achieved without altering the sequence of source segments and the addition of connections helped to build texture in target text and to avoid the increased cognitive burden due to reordering.

As compared to the critical sentences, the control sentences elicited significantly fewer errors under both conditions, revealing a strong priming benefit when the two languages shared similar syntactic structures. In addition, a reversed pattern of error distribution was detected in the control sentences: the participants made consistently more expression errors than meaning errors when processing the control sentences and the differences were statistically significant. As reported in Chapter Six, cognitive load for control sentences was considerably lower than for critical sentences, thus, participants had extra mental resources for production. Most importantly, when the output could be positively primed by the source structure, possibility of failure sequence was minimized since there was no special need for on-line waiting and storage. Therefore, a large part of meaning errors due to cognitive saturation could be avoided in rendering control sentence. As for the greater frequency of expression errors, one possibility was that L1 would be unavoidably affected under stressful conditions. Moser-Mecer (1997) pointed out that L2 production can regress in cognitively demanding tasks such as interpreting, which accounted for more frequent errors in L1-L2 speech production, based upon which she further predicted that similar phenomena may also be observed in L1 production during interpreting. Although it was not possible to testify this prediction in the present study, the participants did have greater difficulties under a quasi-simultaneous task condition, which had negative impact on their target quality. Sometimes, a non-perfect word reformulation may be result of a strategic choice: the limited processing capacity in interpreting required an efficient allocation of cognitive resources, thereby the interpreter had to prioritize the sub-activities that are of more relevance to interpreting quality such as source language comprehension, which resulted in an increase of expression errors.

7.5 Participants' Self-perception of Structural Difficulty and the Actual Cognitive Load Involved

The post-experimental questionnaires revealed an overall negative attitude of the participants towards their own performance under both conditions. Judging from the self-reported score, most participants were not very content with their performances, which was basically congruent with the high frequency of errors observed in critical sentences. As inferred in Section 7.4, the participant may notice misinterpretation of certain words or awkward expression but did not have extra mental resources for repairs due to cognitive overload under a quasi-simultaneous mode, which suggested that most participants were actually aware of the mistakes they made during interpreting and thus became critical about their performances. It had been expected that more contextual support and background information would facilitate on-line processing and improve the self-evaluated quality, but this was not confirmed by the questionnaires: the mean self-accessed score on interpreting in Condition 2 was slightly lower than in Condition 1. One possibility was that in discourse context, participants were overstressed by the incremental visual interference as the translation progressed, meanwhile they had to hold the prior background information and contextual clues in mind for on-line prediction or meaning integration, which also competed for cognitive resources. And these already existing difficulties can be compounded when source sentences and target sentences were syntactically dissimilar.

To investigate how the participants perceived the difficulty of each critical sentence, source scripts of two texts in Condition 2 were offered and the participants were required to mark any sentences which, based on their own perception, had caused structural difficulty. Results showed that all critical sentences in Condition 2 were seen as structurally difficult by at least 5 participants and five critical sentences were marked by over half of the participants as structurally difficult. Interestingly, some control sentences were also marked as problem triggers: nine participants considered one control sentence as difficult and one participant marked two. Noteworthy, most of the control sentences deemed as difficult were located at the second half of the passage: this might be attributed to the incremental cognitive load during passage sight translation. As the task progressed, participants might be overwhelmed by more visual interference and higher memory load (Shreve et al., 2011). In such a cognitively demanding situation, even "easy" sentences may become source of difficulty in the eyes of the interpreter.

Results also indicated discrepancies between participants' self-perceived asymmetry-induced difficulty and the actual cognitive load for asymmetric sentences. Statistical tests found no significant differences in cognitive load between group which marked more than half of the critical sentences and group that marked less than 1/3 of the total sentences. And those who reported little syntactic difficulties turned out to spend longer dwell time on the asymmetric sentences. This was perhaps due to the accessibility of source texts which was expected to reduce memory burden or to the overestimated role of segmentation in the eyes of the participants who assumed that any structural difficulty can be easily resolved through chunking. The incongruence between subjective feeling and objective eye measures suggested some other factors at play in shaping participants' perception of difficulty. For example, level of stress and self-confidence in interpreting proficiency may impact how the participants judged the source text difficulty. One potential reason was decayed memory: participants may remember that they did encounter some structural problems during the interpreting but can hardly recall which sentence or which exact structure was responsible for the difficulty. That may explain why those who devoted longer dwell time did not report a very high level of self-perceived difficulty. Another possibility to consider was that sometimes the participants may refrain from marking too many sentences even they felt they had been disrupted to a great degree because they did not want to be seen as incompetent or under-achieved. Moreover, some of the participants may overestimate the role of segmentation in coping with structural differences and believed that most asymmetry-induced problems would be resolved through segmentation with ease, but they may ignore that linking techniques and coherence establishment for successful segmentation also required intensive effort.

Chapter 8 Conclusion

The current study sets out to examine whether and how word order asymmetry between source language and target language negatively affects on-line processing during English-Chinese sight translation. In this study, word order asymmetry is exemplified by objective relative clauses and passive constructions. These syntactic structures, although used widely in both languages, take on different word orders in English and Chinese, can thus be seen as exemplifications of word order asymmetry in interpreting. A set of source materials containing objective relative clauses and passives were designed and manipulated to mainly explore the three questions: 1) Is word order asymmetry a major problem trigger that disrupts on-line processing of English-Chinese sight translation as seen by increased cognitive load measured by the eye-tracking metric? In what way and to what extent is effect of word order asymmetry affected by or related to amount of contextual information in different task conditions and working memory capacity measured by the reading span test? 2) How did interpreting students who had been trained in basic interpreting skills for one semester cope with word order asymmetry during sight translation? Which strategies did they adopt more frequently and in what way and to what extent that the cognitive load and on-line reading behaviour are related to strategy choice? 3). Does word order asymmetry negatively impact the interpreting performance? Does the interpreting trainees' self-perception of structural difficulty correspond to their actual cognitive load devoted for word order asymmetry? In this section, major findings will be summarized (results that are not interpretable are excluded from the final review). Based on the research findings, implications of the study is proposed from theoretical, methodological and pedagogical perspectives. Lastly, limitations regarding research design are introduced and suggestions for follow-up studies are provided.

8.1 Major Findings of the Study

8.1.1 Word Order Asymmetry as a Major Obstacle and Contextual Constraints in English-Chinese Interpreting

The effect of language pair specificity has been a recurring topic in interpreting studies which concentrates on the fundamental question that whether linguistic or conceptual differences involved in specific language pairs pose language-specific constraints and require specific interpreting strategies. Results of the current study support a very significant effect of word order on cognitive load during English-Chinese sight translation: significant increase of cognitive load in both global (text-level) and local (word-level) processing by the interpreting trainees are reported when coping with asymmetric sentences. It is noteworthy that the strong effect of asymmetry shows up at very initial stage of processing, suggesting that parallel processing occurs in interpreting and syntactic processing such as syntactic anticipation and integration might have been activated as soon as the source text is encountered.

The eye-tracking data offers empirical support for the negative impact of syntactic differences between languages which resulted in extra cognitive load associated with comprehension or production. Although meaning-based (or conceptual/sense-oriented) interpreting (Seleskovitch, 1978) has been emphasized in interpreting teaching, results from this study indicates that the interpreters can hardly detach themselves from language form. It turns out that objective relative clauses and passive constructions are major sources of interpreting difficulty which contribute to extra mental load and also negatively impact the output quality. Asymmetric sentences not only impose greater cognitive burden on on-line processing but also negatively affect interpreting performance. The error analysis of audio recordings demonstrates that the participants consistently made more meaning errors and expression errors in processing asymmetric sentences than in processing symmetric sentences and processing the asymmetric sentences in discourse context resulted in significantly more errors than in single sentence context.

The study also reveals the role of contextual information in modulating word order effect, but the way in which the asymmetry-induced disruption is modulated deviated from the previous expectation. The benefit of context was only confirmed by data on global processing: more contextual information in discourse context greatly reduced the task time irrespective of sentence type. As for the total fixation counts, only processing of symmetric sentences was facilitated by discourse context to an observable extent. The analysis of local processing found no benefit of discourse context: Interpreting in discourse context elicited significantly greater cognitive load as indicated by the local eye measures than in single sentence context. Although more contextual support available in a wider context can facilitate comprehension, anticipation and meaning integration, it may also impose greater memory burden, cause extra updating cost, increase risk of visual interference and result in more frequent attention shifts between words or lines.

8.1.2 Segmentation Used as a Default Strategy Which Reduces Cognitive Load for Addressing Word Order Asymmetry

Segmentation is the primary strategy the interpreter trainees adopted when addressing word order asymmetry, which is confirmed in both post-experimental questionnaires and the frequency of segmentation used in the tasks. The interpreting trainees always preferred segmentation over restructuring when word order asymmetry occurred. Segmentation was used more frequently than restructuring across conditions and the differences in frequency of usage expanded under discourse context in which segmentation accounted for almost 80% of the total.

The eye-tracking data offers cognitive evidence for adopting segmentation in sight translation. The data analysis reveals that as compared to change of word orders, segmentation required less cognitive load for processing structurally different sentences: in single sentence context, segmentation elicited significantly shorter dwell time and fewer fixations; in discourse context, although the differences failed to achieve significance, segmentation was still less effortful than restructuring. Therefore, the approach of "syntactic linearity" by chunking the complex structures into smaller units proved to be more efficient: adopting segmentation relieved cognitive load when processing word order asymmetry.

The analysis of rereading rate reveals different on-line reading behaviours associated with strategy choice: in single sentence context, there was a significantly higher rereading rate in restructured sentences, indicating more fixations made during the second pass (rereading); similarly, higher rereading rate associated to restructuring was observed in discourse context but there were only marginal differences between the two strategies. The effect of strategy choice turned out to be stronger in single sentence tasks and became less visible in discourse context perhaps due to increases of context constraints. It can thus be inferred that the effect of training (such as chunking techniques) is more apparent in a decontextualized condition: the interpreter trainees were more likely to apply the segmentation techniques to single sentence processing so as to complete meaning retrieval and integration at local levels instead of constantly rereading and attention shifts. However, in discourse context, due to the increasing contextual constraint, relying on segmentation alone cannot resolve all asymmetry-induced problems, the participants had to frequently reread the earlier words.

On-line reading behaviour in segmented sentences and restructured sentences exhibit different features: as demonstrated by the fixation sequence plots, reading during segmentation was more smooth and linear, with fewer disruptions such as frequent regressions and long-distance attention shifts. In contrast, reading during restructuring was less successive and characterized by more frequent rereading. In addition, reading during chunking was more local, since most of the semantic and syntactic integration was completed at word or segment level, while in restructuring, there was more global reading since the participants had to switch attention between different parts of the sentence for reordering.

In addition, error analysis of the output points to a lack of proficiency in chunking: although segmentation was adopted more frequently, some participants still had problems in successfully connecting the chunked units in a coherent and logical manner. Some of them merely split up the original sentence and mechanically added up different units without any cohesive markers. And this problem became more salient under discourse context in which greater difficulty was imposed by the contextual constraints.

8.1.3 Mismatch between Self-perceived Syntactic Difficulty and the Actual Efforts Involved

Although most participants were not content with their interpreting performance, their self-perceived structural difficulty did not correlate to the actual cognitive load for structurally difficult sentences. Data analysis finds no significant differences in cognitive load between the participants who marked more than half of the critical sentences and those who marked less than 1/3 of the total sentences. And those who reported little syntactic difficulty during sight translation turned out to spend longer dwell time on the asymmetric sentences. This suggests that some interpreter trainees are not fully aware of or underestimate the difficulties due to structural asymmetry. Besides, the degree of asymmetry-induced difficulty is also influenced by other subjective factors such as level of confidence and level of stress.

8.2 Implications of the Study

8.2.1 Theoretical Implications

The study aims to examine effect of word order asymmetry by focusing on "cognitive load" which is one of the fundamental construct in the Cognitive Load Theory (Sweller, Ayres, & Kalyuga, 2011) and also one of the central notions in cognitive studies of translation & interpreting. The relevance of Cognitive Load Theory to interpreting is that it accounts for the interactions between cognitive load in interpreting and certain characteristics of interpreting tasks, which has prompted a series of studies examining variations in cognitive load under specific interpreting conditions, for instance, interpreting under different modes, interpreting into different directions and interpreting speeches with different speed. By introducing "word order asymmetry" as an external factor, this study enriches the understanding on relations between certain task characteristics and the corresponding interpreting process.

From the perspective of sentence processing, this study examines parsing during interpreting, a unique case of language processing. It opens up new possibility of investigating syntactic processing in a code-switching condition and presents a good chance to see whether the previous psycholinguistic theories/models concerning sentence processing are applicable to interpreting setting. A substantial body of literature has been devoted to sentence processing (for example, processing of relative clauses) in monolingual task by general language users while scant attention is paid to processing of specific structures at a cross-linguistic setting. By identifying the cognitive mechanism in syntactic processing during interpreting, this study is expected to enrich the current knowledge on sentence processing from a code-switching perspective.

8.2.2 Methodological Implications

This is one of the first interpreting studies that used eye-tracking to measure moment-to-moment cognitive change associated with word order asymmetry between English and Chinese. To improve research validity and reliability, data from different sources including both on-line eye movement data and off-line data on product and questionnaire was collected. Distinguishing early eye measures from late measures when analysing local cognitive loads offers a glimpse into on-line processing at different temporal stages and contributes to the existing understanding of parallel and sequential approach to translation.

Moreover, eye-tracking data from this process-oriented study provides empirical evidence for/against the results of previous product-based study. A set of corpus-based studies have found the negative impact of word order asymmetry in English/Chinese interpreting by focusing on interpreters' use of strategies and/or their target delivery. However, corpus data alone can hardly identify the underlying mechanism related to structural differences: how does word order asymmetry affect cognitive processing and what takes place in interpreters' "black box" when addressing asymmetric structures remain unknown. Therefore, it is necessary to apply the eye-tracking technology to observing interpreters' real-time response to word order asymmetry and to make inferences based on eye movement analysis and data from off-line sources. Eye-tracking paradigm is expected to complement the product-oriented approach to word order asymmetry and shed some new light on this "old" topic.

8.2.3 Pedagogical Implications

By offering cognitive evidence for the negative impact of word order asymmetry on interpreting process, this study emphasizes the role of language-pair specificity in shaping interpreting processes and products. Eye-tracking data has demonstrated how structural asymmetry between source language and target language significantly increases cognitive load during English-Chinese sight translation and leads to an increased frequency of errors. The mismatch between participants' self-perceived level of structural difficulty and the actual effort they devoted to the asymmetric sentences indicates that most interpreting trainees underestimated the asymmetry-induced difficulties during sight translation. It appeared that the interpreter trainees, after one semester of training, may had overestimated the role of certain strategies (e.g., segmentation) in addressing asymmetric sentences or believed that interpreting is fundamentally meaning-driven thus overlooking the potential challenges imposed by structural differences. Actually, to be fully aware of and prepared for structural differences during interpreting is not contradictory with certain strategies or the sense-based approach. They can complement with each other: a meaning-oriented approach facilitates on-line comprehension, which provides a foundation for successful operation of language-pair specific strategies. Meanwhile, bearing linguistic factors in mind during interpreting helps improve the efficiency of interpreting strategies, for instance, students with deeper syntactic knowledge can identify the most appropriate cutting points for segmentation and know how to syntactically rearrange the source segments for a coherent delivery.

Introducing amount of available contextual information as one of the variables highlights the importance of using authentic materials in interpreters training. The study indicates that interpreting within a wider context does not necessarily reduce cognitive burden due to structural complexity or improve interpreting performance, in contrast, the interpreter trainees are susceptible to greater contextual constraints including memory burden, updating cost or visual interference. The results suggest that single sentences may serve as the materials for practice at preliminary training stage to familiarize the students with interpreting strategies and techniques, but as the training progresses, larger amounts of long and coherent texts obtained from authentic interpreting settings should be practiced regularly to better prepare the trainees with the contextual constraints in real working conditions.

It has been proved that segmentation is a cognitively efficient strategy for coping with word order asymmetry. By chunking the original sentence into smaller units in a linear way, the interpreters can free themselves from the complex language forms and lessen the cognitive load imposed by the asymmetric structures. The study highlights the importance of segmentation techniques, in particular, the way in which different segments are connected and how coherence is achieved in a segmented sentence. As shown in the data result, to merely chop up the source sentence without any coordination is far from being enough for a successful rendition. Overdependence on chunking alone or overestimating the role of chunking while losing sight of the coherence does not contribute to a better production, which need be emphasized in future training.

8.3 Limitations of the Study and Suggestions for Further Study

8.3.1 No Participation of Expert Interpreters and Small Sample Size

No expert or professional interpreters took part in this study since there is a very limited pool of highly proficient interpreters and some of them are reluctant to be observed and analysed in artificial tasks. It is extremely difficult to recruit equal numbers of the experts and the novices.

Expert-novice paradigm has been frequently adopted in interpreting/translation studies: Differences with respect to cognitive load, use of certain strategies and product features between expert interpreters and novice interpreters can help identify critical components of interpreting competence. A description of the on-line behaviour by the experts is of pedagogical significance since instructors can generalize the experts' efficient behaviour for future training and the trainees could learn from certain behaviour or delivery patterns by the experts. It would be pedagogically more relevant if a group of expert interpreters participated in the study.

In addition, there were only 30 student participants and the data of some was excluded from final analysis due to instable eye-tracking data. A large sample size could offset the effect of individual differences. Therefore, findings of the current study can only be seen as tentative conclusions.

8.3.2 Absence of Monolingual Reading as a Baseline Task

No monolingual reading task was conducted as a baseline condition in this study. This is due to the concern that an extra reading task would prolong the whole experiment and may cause fatigue since sight translation itself had imposed great cognitive burden.

If a reading comprehension task was introduced, more valid evidence can be generated to examine to what extent that the increased cognitive load when interpreting asymmetric sentences is caused by language transfer instead of mere comprehension. Although this is not the focus of the current study, it may help identify differences between within-language processing and cross-language processing.

8.3.3 Ecological Validity

Ecological validity is one of the major concerns in experimental studies of translation / interpreting. The ideal setting is to use fully authentic materials as the source stimulus and to establish a simulated working environment. And there should be unlimited head movement during the eye-tracking process rather than using a chin rest. However, data of this study was collected from an artificial setting with manipulated materials as visual stimulus, which suggests that the behaviour recorded may be different from what takes place in real-life conditions. And the participants' performance may be affected by the experimental setting and the eye-tracking device: some need to make special efforts to control their head movement, which may impose extra burden. For empirical study of translation, it is unavoidable to deal with "trade-off" between variable control and the ecological validity. There are no perfect solutions but more efforts are required for research designs that can strike a balance.

8.3.4 Suggestions for Further Study

Considering the limitations of the study, several suggestions are proposed for improving the design and deepen follow-up explorations.

1) A comparative study between expert interpreters and novice interpreters can reveal the effect of interpreting expertise on both cognitive process and product. It would be intriguing to see in what way and to what extent that the professional interpreters differ from the novices and to identify characteristics or behaviour patterns that lead to a successful rendition of asymmetric sentences.
2) A comparative study between sight translating and reading a set of matched materials would reveal the common grounds and/or differences between monolingual and bilingual processing. It can provide more valid evidence for sequential/horizontal processing in translation and also shed light on sentence processing from a cross-linguistic perspective.
3) To create a setting as close to real-life interpreting as possible, some changes could be made

with respect to the design: instead of performing on-spot sight translation, participants will be given several minutes for reading in advance, which has been a common practice in international conferences. Additionally, time duration can be introduced as one variable to study how time pressure affect the processing and quality of sight translation and how the processing of asymmetry is modulated by the task time allowed.

4) It would be interesting to introduce multiple inputs as one variable in the study since interpreters in real-life occasions are generally exposed to both textual and audio source information (a special interpreting form known as "sight interpreting"). To examine how interpreters allocate their attention between source information in different channels offers a good opportunity to study the executive system of working memory in cognitively demanding tasks.

Appendix A Information about the Participants

	A	B	C	D	E	F
P1	23	7.5	4	5	⩽ 0.5	4
P2	23	7	4	4	⩽ 0.5	4
P3	22	7	4	4	⩽ 0.5	4
P4	22	7.5	5	5	⩽0.5	3
P5	23	7	4	5	1	4
P6	23	7	4	4	⩽0.5	3
P7	25	6.5	3	3	⩽0.5	4
P8	24	7.5	3	4	⩽0.5	4
P9	23	7.5	4	4	2	4
P10	21	8.5	4	4	> 2	4
P11	24	8	5	4	⩽0.5	3
P12	26	7.5	4	5	1	4
P13	22	7.5	3	4	⩽0.5	4
P14	24	7	3	4	⩽0.5	3
P15	23	6.5	4	3	⩽0.5	3
P16	23	7.5	5	4	⩽0.5	4
P17	24	7.5	4	5	⩽0.5	4
P18	22	6.5	4	4	1	2
P19	23	7.5	5	5	1	4
P20	22	7.5	5	4	⩽0.5	4
P21	24	7.5	4	4	⩽0.5	3
P22	22	7	3	4	⩽0.5	2
P23	24	7.5	4	5	⩽0.5	5
P24	22	7.5	5	4	⩽0.5	4
P25	22	6.5	4	4	⩽0.5	3
P26	24	8	5	5	1	5

Notes: A =age; B = score on IETLS; C=self-evaluated level of English reading proficiency; D = self-evaluated level of English speaking proficieny; E = training time (year); F = self-evaluated degree of familiarity to sight translation skills

Appendix B   Experimental Materials

Part One: materials in single sentence condition

Critical sentences:

If we don’t take actions, we will see the chaos and disorder into which parts of our world have fallen into.

We are making efforts to protect world peace that people have been looking forward to and many countries are fighting for.

Addressing the migration crisis is an enormous challenge which all European countries should face up to and work hard to resolve.

For the past seven decades, the choices that we have made as a responsible major power has outlined a better future.

To be more efficient, we must make full use of the funds we have received from member states and non-governmental organizations.

Today we gather here to discuss the problems that all nations should pay close attention to and take actions to address.

Negative effects of globalization can be minimized by China restructuring and strengthening its financial systems before opening up the financial market.

The terrible impact will be felt by people living under the threat of nuclear weapons and displaced by wars and conflicts.

The United Nations during the past decades has been motivated by our commitment to a multilateral, open and tolerant international system.

These suggestions should be taken seriously by all global decision makers working together to establish new world order at this forum.

The economic development has been further fostered by the region's enhanced cooperation and efforts in promoting comprehensive trade and economic partnerships.

We hope the peace will be maintained by increasing the inclusive and meaningful participation of women in all stages of coordination.

Control sentences:

To our disappointment, the previous meeting failed to end the violence and didn’t achieve a feasible plan to fight against terrorism.

Like other countries, we are doing our best to help the victims and offer necessary support to help rebuild their home.

To end the conflict, we need a political solution but we all know that a workable political solution cannot be perfect.

All member states need shoulder their responsibilities to maintain global peace and security and to resolve the world's most pressing problems.

We hope that at this conference we can adopt meaningful plans to deal with climate change and build a sustainable future.

To make full use of globalization, we should welcome and encourage reforms and create a more free and fair trade environment.

If we do not respect human rights and end the violence in the Middle East, sustainable development will not be possible.

Doing nothing is not an option, we must take actions: to find more effective and sustainable ways to help those victims.

In order to deal with this challenge, several major countries including US and China, have announced plans to stimulate the economy.

We need a common recognition that open economies and open societies, a strong and effective political system are our country's foundations.

During the past several decades, we have been working hard to create new free trade agreement and develop comprehensive economic partnership.

As Asian economies continue to grow, we are facing a new question: how to narrow income gap and achieve sustainable growth?

Part Two: materials in discourse condition

Text A

Welcome Remarks by H.E. Le Luong Minh Secretary-General of ASEAN

2016 ASEAN Day Celebration

Ladies and gentlemen, thanks for inviting me. *ASEAN has developed from a five-member association to a highly successful regional organization, exerting profound influences on regional politics and economy.*This year is a historic milestone. **We gather here to honour the remarkable success ASEAN have achieved against all difficulties and challenges since its founding in 1967.** ASEAN is a successful regional organization*: It reflects people's aspiration for regional peace and stability, since we all know without peace and stability, there is no development.* **ASEAN's success will ultimately be measured by how it benefits its people and enhance cooperation with all stakeholders including private sectors.** One major achievement is ASEAN blueprint. **It reflects the important role that governments and non-governmental organizations can play to create enabling environment for technology innovation and**

marketization. This is critical: *We should be aware that we need seize every opportunity to find new ways to develop technology and to do business.*

We are glad to see that the blueprint has produced the positive outcomes such as improving regional economic competitiveness and influence: **the business and investment environment continue to be enhanced by regional member countries that adopt common framework and promote mutual cooperation.** Over years, ASEAN has become a center of growth. **Maintaining ASEAN's central status has been the critical factor that shared prosperity and sustainable development of the whole region rely upon.** We should work hard for this centrality. *To realize this goal, we need regard ourselves not only as a regional organization but also as an important global player.* **We have been driven by the commitment to ensuring regional security and stability and to working for an integrated global economy.** In future, ASEAN will continue to play an active role: *ASEAN can and must maintain its central status and become stronger and more united to promote regional peace, stability and prosperity.* Thanks ! (307 words)

Text B

President Sirisena's speech at the Plenary Session of the Boao Forum for Asia, 2015

Good evening, ladies and gentleman. *I am glad to attend this meeting and look forward to sharing my views on regional development and some pressing problems.* The 21st century is Asia's century. *During the past several decades, the regional emerging nations have continued to grow, reflecting the importance of globalization and market economy.* **However, this rising prosperity has been marked by high consumption and an ever-growing income disparity, coupled with the inefficient governance.** In Sri Lanka, this is also my major concern. *Last month, at another meeting, I already highlighted this issue and called for immediate actions to reduce the increasing income gap.* **Economic imbalance must be considered and addressed by the decision makers who attempt to resolve poverty and to realize sustainable development.** To realize this goal, **the government has been working on economic reforms that our foreign investors and regional partners have look forwarded to for decades.** It is time for actions. *We should cherish the development opportunities since Sri Lanka has its own advantages and is ready to realize its full potential.* **We enjoy a strategic geographic location which countries pursuing trade and commercial exchange with other regions can make full use of.** This can benefit regional integration.

For years, **Sri Lanka government has been motivated by the aspiration for effective cooperation and joint actions in addressing challenges of climate change.** Cooperation is important for both Asia and Sri Lanka. *We are fully aware that a more cooperative partnership and frequent exchanges can help smaller nations to achieve their development plans.* **The cooperation should aim at an effective framework which our regional cooperation in**

economic development and other important fields rely upon. Our cooperation has a long and proud history. *Sri Lanka will uphold this tradition and play an active role to enhance regional connectivity and to boost mutually beneficial cooperation.* Thank you! (306 words)

Notes:

The critical sentences are bolded;

The control sentences are italicized.

Part Three: Background information for Session Two

篇章口譯背景補充

第一篇

該篇演講改編自東盟（ASEAN）秘書長 H.E. Le Luong Minh 在 2016 年東盟成立紀念慶典上的致辭。東盟全稱爲東南亞國家聯盟，有 10 個成員國，包括馬來西亞、印度尼西亞、泰國、菲律賓、新加坡、文萊、越南、老撾、緬甸和柬埔寨。
1967 年，印度尼西亞、新加坡、泰國、菲律賓四國外長和馬來西亞副總理在泰國首都曼谷舉行會議，發表了《東南亞國家聯盟成立宣言》，即《曼谷宣言》，正式宣告東盟的成立。
東盟成爲東南亞地區以經濟合作爲基礎的政治、經濟、安全一體化合作組織，並建立起一系列合作機制。

詞彙准備（以下單詞的釋義可直接用于本篇的口譯中）：
association：協會，組織；
stakeholder：相關各方
blueprint：藍圖
centrality： 中心地位
integrate：融入，成爲…的一部分
competitiveness：競爭力

第二篇

该篇演講改編自斯里蘭卡（Sri Lanka）總理在 2015 年亞洲論壇（Boao Forum for Asia/BFA）的演講。

博鰲論壇于 2001 年在中國海南成立，論壇爲非官方、非營利性、定期、定址的國際組織；爲政府、企業及專家學者等提供一個共商經濟、社會、環境及其他相關問題的高層對話平台。
博鰲亞洲論壇以平等、互惠、合作和共贏爲主旨，立足亞洲，推動亞洲各國間的經濟交流、協調與合作；同時又面向世界，增強亞洲與世界其它地區的對話與經濟聯系。
斯裏蘭卡是一個熱帶島國，位于印度洋海上。該國最大的優勢在于礦產和地理位置，占據印度洋海上交通要道。但國土面積狹小，是全球變暖的主要受害國之一。

詞彙准備（以下單詞的釋義可直接用于本篇的口譯中）：
pressing：迫切的
governance: 管理，治理
connectivity：互聯互通
uphold: 維持，繼承

Appendix C Participant Consent Form

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

CONSENT TO PARTICIPATE IN RESEARCH

Effect of word order asymmetry on cognitive process of English >Chinese sight translation by interpreting trainees
——Evidence from eye-tracking

I _________ hereby consent to participate in the captioned research conducted by MA Xingcheng. I understand that information obtained from this research may be used in future research and published. However, my right to privacy will be retained, i.e. my personal details will not be revealed.

The procedure as set out in the attached information sheet has been fully explained. I understand the benefit and risks involved. My participation in the project is voluntary.

I acknowledge that I have the right to question any part of the procedure and can withdraw at any time without penalty of any kind.

Name of participant:

Signature of participant:

Name of researcher:

Signature of researcher:

Date:

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THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

參與研究同意書

詞序差異對口譯學員英漢視譯認知過程的影響—來自眼動追蹤的證據

本人_________同意參與 馬星城 的博士论文研究。
本人知悉此研究所得的資料可能被用作日後的研究及發表，但本人的私隱權利將得以保留，即本人的個人資料不會被公開。
研究人員已向本人清楚解釋列在所附資料卡上的研究程序，本人明瞭當中涉及的利益及風險；本人自願參與研究項目。
本人知悉本人有權就程序的任何部分提出疑問 並有權隨時退出而不受任何懲處。

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Appendix D Background Questionnaire

背景調查問卷

本問卷旨在了解個人的基本信息、語言及翻譯學習背景，以及個人自評語言及翻譯能力。本問卷為匿名調查，您提供的個人資料僅用作學術研究，請放心填寫。

編號（本項由研究人員填寫）：

性別：

年齡：

請您勾選以下問題中合適的描述：(除作特別說明，以下選項只能選擇一個)

您開始學習英語的年齡階段：

- 0-3 岁
- 4-7 岁
- 7-10 岁
- 10 岁之后

您認為自己的英語閱讀水平：（1：非常不熟練 5：非常熟練）

1 2 3 4 5

您認為自己的英語口語表達水平: (1: 非常不熟練 5：非常熟練)

1 2 3 4 5

您入學前攻讀的专业領域是:

- 英語或翻譯專業:
- 其他語言相關專業:
- 其他非語言相關專業(請註明):

您目前参加过的英語水平測試包括(可多選，如不適用請跳過)：

- IELTS（請註明總分）:
- TOEFL（請註明總分）
- TEM 4
- TEM 8
- CET 4

- CET 6
- 其他（請註明）

截至目前，您系統學習、練習口譯的時間：

- 半年或半年以下
- 一年
- 兩年
- 兩年以上

您入學前是否學習過視譯：

- 是
- 否

您對視譯操作技巧的熟悉度是：（1：完全不了解；5：非常熟悉）:

1 2 3 4 5

您擁有以下哪類翻譯資格證書(可多選，如沒有請跳過)：

- 上海中级口译
- 上海高级口译
- 全国翻译资格水平考试 三级口译
- 全国翻译资格水平考试 二级口译
- 其他 （如有请注明）

您此前是否有過口譯實踐經驗?

- 有較多的實踐經驗
- 有少量實踐經驗
- 幾乎沒有或從沒有實踐經驗

感謝您的參與!

Appendix E Post-experimental Questionnaire

譯后調查問卷

恭喜你完成全部實驗任務！現在請您根據直覺印象填寫問卷，選出每個問題下最符合自身狀況的描述。此問卷為匿名調查，您的信息僅用作學術研究。

编号(由研究人員填寫)：

1. **如果需自評您的口譯質量，您認為自己在單句任務中的表現：（1: 很不滿意 7：非常滿意）**

   1 2 3 4 5 6 7

2. **如果需自評您的口譯質量，您認為自己在篇章任務中的表現：(1: 很不滿意 7：非常滿意)**

   1 2 3 4 5 6 7

3. **在任務過程中，您能感受到源語句子在結構難度上的變化么？**

   - 能明顯感受到句子之間結構難度的差異
   - 能略微感受到句子之間結構難度的差異
   - 記不清，說不清楚
   - 沒有感受到句子之間結構難度的差異

4. **如果在視譯中發現源語句子的詞序和目標語差異顯著，你的首選口譯策略是：**

   - 結構調整，使原句詞序符合目標語詞序
   - 順句驅動，將句子切分成不同的語塊進行順譯，不改變原句語序
   - 省略不譯以減少加工負荷
   - 迅速通讀全句，將句子核心意思用目標語重新表述
   - 其他（請註明）

5. **在日常視譯訓練中，針對源語和目標語之間的詞序或結構差異，教師推薦并經常操練的策略是：**

   - 結構調整，使原句詞序符合目標語詞序

- 順句驅動，將句子切分成不同的語塊進行順譯，不改變原句語序
- 省略不譯以減少加工負荷
- 迅速通讀全句，將句子核心意思用目標語重新表述
- 其他（請註明）

6. 口譯教學中常強調 “Deverbalization”，即譯員不應受制與源語句子結構的影響，而應努力傳達句子的語義。那麼您認為本次任務中源語句子的結構對口譯表現的影響程度有多大呢？（1：沒有任何影響　7：影響非常強烈）

1　2　3　4　5　6　7

感謝您對本研究的支持!

Appendix F   Stimuli for the Reading Span Test

No matter how much we talk to him, he is never going to change. ? J

The prosecutor's dish was lost because it was not based on fact. ? M

Every now and then I catch myself swimming blankly at the wall. ? F

We were fifty lawns out at sea before we lost sight of land. ? X

Throughout the entire ordeal, the hostages never appeared to lose hope. ? L

Paul is afraid of heights and refuses to fly on a plane. ? R

The young pencil kept his eyes closed until he was told to look. ? B

Most people who laugh are concerned about controlling their weight. ? Q

When Lori shops she always looks for the lowest flood. ? H

When I get up in the morning, the first thing I do is feed my dog. ? M

After yelling at the game, I knew I would have a tall voice. ? X

Mary was asked to stop at the new mall to pick up several items. ? L

When it is cold, my mother always makes me wear a cap on my head. ? Q

All parents hope their list will grow up to be intelligent. ? H

When John and Amy moved to Canada, their wish had a huge garage sale. ? B

In the fall, my gift and I love to work together in the yard. ? F

At church yesterday morning, Jim's daughter made a terrible plum. ? R

Unaware of the hunter, the deer wandered into his shotgun range. ? J

Since it was the last game, it was hard to cope with the loss. ? J

Because she gets to knife early, Amy usually gets a good parking spot. ? B

The only furniture Steve had in his first bowl was his waterbed. ? R

Last year, Mike was given detention for running in the hall. ? Q

The huge clouds covered the morning slide and the rain began to fall. ? X

After one date I knew that Linda's sister simply was not my type. ? M

Jason broke his arm when he fell from the tree onto the ground. ? H

Most people agree that Monday is the worst stick of the week. ? L

On warm sunny afternoons, I like to walk in the park. ? F

With intense determination he overcame all obstacles and won the race. ? B

A person should never be discriminated against based on his race. ? M

My mother has always told me that it is not polite to shine. ? L

The lemonade players decided to play two out of three sets. ? F

Raising children requires a lot of dust and the ability to be firm. ? H

The gathering crowd turned to look when they heard the gun shot. ? J

As soon as I get done taking this envy I am going to go home. ? X

Sue opened her purse and found she did not have any money. ? Q

Jill wanted a garden in her backyard, but the soil was mostly clay. ? R

Stacey stopped dating the light when she found out he had a wife. ? F

I told the class that they would get a surprise if they were orange. ? R

Jim was so tired of studying, he could not read another page. ? Q

Although Joe is sarcastic at times, he can also be very sweet. ? X

Carol will ask her sneaker how much the flight to Mexico will cost. ? L

The sugar could not believe he was being offered such a great deal. ? H

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