Consultation behaviours with online resources in English-Chinese translation: an eye-tracking, screen-recording, and retrospective study

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Consultation Behaviours with Online Resources in English-Chinese Translation: An Eye-tracking, Screen-recording, and Retrospective Study

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Declaration

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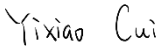
(Signature) 

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Abstract

Online resources which support translators in their workplace in the digital age have undergone rapid development in both their variety and efficiency. Most existing studies focus on describing the characteristics of consultation, leaving two critical issues unexplored: the factors influencing consultation and the impact of consultation on translation products.

To fill this gap, the present study intends to answer the following three questions: (1) What is the effect of information needs on consultation behaviour? (2) What is the effect of translation experience on consultation behaviour? (3) What is the effect of consultation behaviour on translation quality? 68 participants (22 language learners, 23 translation students, and 23 professional translators) were recruited to translate three 100-word texts from English (L2) into Chinese (L1). Their translation (using the Translog II interface) and consultation processes were recorded using a Tobii eye-tracker with a built-in screen-recording function. Retrospective interviews and post-translation questionnaires were used to categorise the translation problems that were encountered and to collect the participants' background information.

The main findings are as follows: (1) as the perceived translation difficulty increases, the amount and proportion of attention on consultation, the number of online resource types, and the number of transitions show an upward trend, but cognitive load on consultation is not affected; (2) consultation for production problems involves a greater amount of attention and a higher complexity than for comprehension translation problems; (3) consultation behaviour is generally target-oriented, and information relevance evaluation is consistent with the information required by the types of translation problem; (4) the reliance on consultation shows an inverted U-shape relationship with translation experience; and (5) longer consultation only benefits the production of individual solutions but not holistic target texts.

Keywords: consultation, English-Chinese translation, eye-tracking, screen-recording, retrospective interview, allocation of cognitive resources, translation quality

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List of Abbreviations

AOI	Area of Interest
GFP	Gaze sample to Fixation Percentage
GTS	Gaze Time on the Screen
L1	First Language
L2	Second Language
LSP	Language for Special Purposes
LT	Literal Translation
MFD	Mean Fixation Duration
SD	Standard Deviation
SERP	Search Engine Result Page
ST	Source Text
TAP	Think-aloud Protocol
TFD	Total Fixation Duration
TOI	Time of Interest
TT	Target Text

Chapter 1: Introduction

1.1 Background

Hansen (2003) defined *translation process* as "everything that happens from the moment the translator starts working on the source text until he finishes the target text" (p. 26) and summarised three types of interactions within the process: interactions with the texts, with internal resources, and with external resources. In today's society, information and communication skills are at the very core of any professional activities. Translation is one activity that is knowledge-based (Austermuhl, 2001) and "constantly requires information" (Pinto & Sales, 2007, p. 532). Given the fact that translators often have to deal with texts from various domains, it is unlikely that they will always have sufficient internal knowledge. In this case, translators would need to seek help by interacting with external information resources, which is a type of *information behaviour*. Information behaviour is a term commonly used within the disciplines of Library and Information Science, Information Studies, and Documentation Studies. It refers to "those activities a person may engage in when identifying his or her own needs for information, searching for such information in a way, and using or transferring that information" (Wilson, 1999, p. 249). Similarly, Pettigrew et al. (2001) conceptualised information behaviour as "involving how people need, seek, manage, give, and use information in different contexts" (p. 44). Information behaviour can be carried out using a wide range of information resources (in various formats) and formal channels, such as traditional libraries, interpersonal communications, and the Internet.

Initially, the external resources used by translators were mainly in nondigital formats, such as printed dictionaries. Although the nondigital external resources have been an important aid for translators and are still widely used, the consultation of these resources can be time-consuming and tedious. A member of ProZ[1] described the experience of consulting external resources prior to using the Internet:

> I had a ton of paper dictionaries (over 300) and I would sit at a table with all of the

1 ProZ is a membership-based website founded in 1999 targeting freelance translators (http://www.proz.com).

> appropriate dictionaries open (business, legal, etc.). If the word or phrase wasn't in any of your paper dictionaries, you were in big trouble. You had to spend hours and hours looking things up. […] I also had a book full of paper glossaries, clippings of word lists from magazines, the ATA Chronicle, terms on index cards. […] I would also have to make frequent trips to the university library and make telephone calls to experts in order to ask questions. (ProZ, 2015)

Nowadays, with the development of information technology, online resources have become increasingly important for professional translators in their workplaces. Technologies that support translators in their work are evolving rapidly, with an increase in both quantity and quality (Fulford & Zafra, 2004; O'Hagan, 2012). The Internet, as "a goldmine of knowledge and information contained in its web pages and the biggest source of tools and specialised resources for translators to help them access this knowledge at the click of a mouse" (Gough, 2016, p. 14), has a unique advantage of being convenient and is probably the most widely used resource by translators. However, unlike dictionaries, which are specially designed for linguistic purposes, the Internet provides a large amount of information that can be both helpful and challenging for translators. Enríquez Raído (2014) highlighted the advantages of translators using the Internet as well as the potential challenges they may face:

> The impact and penetration of the Internet have indeed dramatically transformed the way translators carry out their documentary research and address their information needs. Among other benefits it has eliminated previous constraints of time and space regarding the acquisition of information. However, its ubiquity and structure, along with the dispersed and dynamic nature of the information available on the web, pose a set of challenges for the critical evaluation, selection, and use of credible sources of information. (p. 2)

With the help from the Internet, it is much easier to access external information, but the searching process may require more effort from translators to decide whether to trust the consulted information or not. According to the Optimal Foraging Theory (Pirolli & Card, 1999;

Sandstrom, 1994), the heuristics of information foraging is based on the principle that the cost of obtaining information cannot be higher than the benefit derived from the information. When translators consult online resources in the translation process, if they find using the Internet too effortful, they need to evaluate the necessity of using it and the potential benefits for improving the consultation efficiency. Therefore, the increasing demand and the accompanying challenges for translators using the Internet call for further research into the consultation of online resources in translation.

This standpoint has been widely recognised in Translation Studies, as various studies have taken translators' ability to use external resources as a part of the translation competence. For instance, PACTE (2003) developed a competence model that includes five sub-competencies and a series of components: bilingual sub-competence, extra-linguistic sub-competence, knowledge about translation sub-competence, instrumental sub-competence, strategic sub-competence, and psycho-physiological components. Among these sub-competencies, instrumental sub-competence is defined as "predominantly procedural knowledge related to the use of documentation sources and an information and communication technologies applied to translation: dictionaries of all kinds, encyclopaedias, grammars, style books, parallel texts, electronic corpora, searchers, etc." (PACTE, 2003, p. 59). It points out the importance of developing the ability of consulting external resources for translators. Based on PACTE's (2003) study, Göpferich (2009) proposed another translation competence model, which includes "tools and research competence" as one of the sub-competencies. She defined this competence as:

> the ability to use translation-specific conventional and electronic tools, from reference works such as dictionaries and encyclopaedias (either printed or electronic), term banks and other databases, parallel texts, the use of search engines and corpora to the use of work processors, terminology and translation management systems as well as machine translation systems (Göpferich, 2009, p. 21).

Both translation competence models emphasise that developing the ability to consult external resources is an indispensable part of being a well-trained translator. This requirement then brings a new research question to light: *how* to improve translators' instrumental

competence? The existing studies that address this question typically follow two avenues: studies that aim to describe *what* the characteristics of consultation in translation are, and studies that consider *how* to improve these characteristics by comparing consultation behaviours under different circumstances (e.g., Atkins & Varantola, 1997; Enríquez Raído, 2014; Gough, 2016; Hvelplund, 2017, 2019; Krings, 1986; Olalla-Soler, 2018; Shih, 2019; Zheng, 2014). A detailed review of these studies and how they influence this thesis will be presented in Chapter 3. In general, the existing studies have listed the characteristics of online consultation that are worth investigating, but do not manage to present a comprehensive picture of the factors that influence consultation behaviours and therefore leave the question of how to improve consultation in translation remaining unsolved.

To address the increasing demand to explore online consultation in translation, the present study explores the use of online resources by examining translators' behaviours in English to Chinese translation. It adopts a triangulated data collection method with eye-tracking, screen-recording, and question-based retrospective interviews. The present study follows two avenues: firstly, the descriptive characteristics of consultation behaviours are summarised and are used to present a picture of *what* the features of consultation are; secondly, the correlations between information needs and consultation, between translation experience and consultation, and between consultation and translation products are used to illustrate *how* consultation can be improved.

1.2 Research Aims and Questions

The primary research aim is to illustrate how to improve consultation in translation. In order to achieve this aim, the present study compares translators' consultation behaviours under different conditions and investigates the effect of consultation on translation quality. In the present study, three groups of participants with different levels of translation experience were asked to translate three source texts (STs) from English to Chinese. Two independent variables were identified: information needs and translators' experience. The former was represented by the perceived translation difficulty of the STs and the types of individual translation problems,

while the latter was represented by translators' training and professional work experience. Three major correlations were investigated: the correlations between information needs and consultation, between translators' experience and consultation, and between consultation and translation product. A detailed introduction to these three correlations along with the relevant variables is presented in Table 1.

Table 1. An introduction to the three correlations investigated in the present study

Correlation	Level	Independent variable
Between information needs and consultation	Translation of the entire ST	Perceived translation difficulty
	Translation of individual segment	Translation problem type
Between translation experience and consultation	Translation of the entire ST	Translation training and professional working experience
	Translation of individual segment	
Between consultation and translation products	Translation of the entire ST	Quality of TTs
	Translation of individual segment	Acceptability of individual segments

The first correlation between information needs and consultation was investigated from two levels: translating an entire ST and translating an individual segment. When translating an entire ST, the level of information need was determined by the level of the perceived translation difficulty of the ST. The correlation was calculated based on the consultation behaviours conducted by the same group of participants when translating two STs with different levels of perceived translation difficulty. When translating an individual segment, the information need was evaluated by the translation problem type. Following Angelone's (2010) study, the problematic translation segments were categorised into three types: ST comprehension problem, ST–target text (TT) transfer problem, and TT production problem. The correlation between the information needs and consultation in translating individual segments was investigated by comparing the consultation behaviours between translating three types of problems by the same group of participants.

The second correlation focused on the effect of translation experience, including training and professional work experience, on consultation. Three groups of translators were recruited in the present study, who were named as language learners, translation students, and professional translators. The language learners had neither training nor work experience. The translation students only had training experience but no work experience. The professional translators had both training and work experience. The correlation between translation experience and consultation was investigated by summarising and comparing the differences of their consultation behaviours when translating the same ST and the same segment by three groups of participants.

The third correlation addressed the effect of consultation on translation products. Similarly, the effect was studied from both the entire translation process and the translation of individual ST segments. The translation products were evaluated by the quality of the TTs and by the translation acceptability of individual segments, respectively. In the investigation of this correlation, different aspects of consultations were used as the independent variables while the score of the translation products was used as the dependent variable.

In order to investigate these correlations, three overarching research questions were formulated.

Research Question 1:

What is the effect of information needs on consultation behaviour?

1a) What is the effect of the level of perceived translation difficulty on consultation behaviour?

1b) What is the effect of translation problem type on consultation behaviour?

Research Question 2:

What is the effect of translation experience on consultation behaviour?

2a) What is the effect of translation experience on holistic consultation behaviour?

2b) What is the effect of translation experience on consultation for translating individual segments?

Research Question 3:

What is the effect of consultation behaviour on translation quality?

3a) What is the effect of consultation behaviour on the holistic translation quality?

3b) What is the effect of consultation behaviour on the acceptability of individual translation segments?

1.3 Methodology and Data Analysis

In order to answer the three research questions listed above, a series of experiments were conducted in the eye-tracking labs at Durham University, Nanjing University of Posts and Telecommunication, Ningbo University, and Nanjing Normal University. In total, 68 participants were recruited, including 22 language learners, 23 translation students, and 23 professional translators. The participants were asked to translate three STs: two STs with different levels of perceived translation difficulty and one additional ST with an unfamiliar subject area.

The present study adopted a triangulated method to collect the participants' process and product-oriented data in their translation and consultation processes, including eye-tracking, screen-recording, questionnaires, question-based retrospective interviews, and text evaluation. The quantitative data, such as the eye-tracking measurements and translation quality scores, were used for statistical analyses; while the qualitative data, such as the screen-recording videos, were transcribed and used for summarising the consultation characteristics. The data collection and analysis methods are introduced briefly as follows.

Eye-tracking

Eye-tracking employs specially designed equipment and software to record participants' eye movements. In the present study, eye-tracking was used to collect data reflecting the participants' allocation of cognitive resources. The metrics used included: (1) total fixation duration (TFD), which was used to indicate the amount of attention and the proportion of

distributed attention; (2) fixation duration, which was used to indicate cognitive load; and (3) positions of fixations, which was used to calculate the number of between-task transitions. These metrics were used to reflect the characteristics of consultation in translation that could not be observed with other data collection methods, such as screen-recording and direct observation. The use of eye-tracking equipment to record the participants' data offers two main advantages. Firstly, it can provide objective and direct data of the allocation of cognitive resources by the participants. Secondly, it reduces the negative influence on ecological validity by allowing the participants to conduct their translation tasks in a natural environment. In the present study, the participants were asked to read the STs and type the TTs on a computer and were free to move within a certain range.

Screen-recording

Screen-recording allows researchers to record all interactions with a computer and to conduct video-based observations. It has been commonly used in empirical research including Translation Studies. In the present study, instead of running screen-recording software, the built-in screen-recording function of the eye-tracking software was used to record the participants' interactions with the texts and the online resources. The advantage of using screen-recording is that it can provide a complete record of the participants' translation processes in the form of videos without being intrusive to the experimental setting. In the present study, the screen-recording videos were used to annotate the eye-tracking metrics, calculate the number of online resource types and webpages consulted, summarise the characteristics of consultation, and collect the TTs produced by the participants.

Questionnaire

Questionnaire is one of the most commonly applied research methods in the social sciences as it is very useful for gathering first-hand responses. It is essentially "a vehicle for human communication" (Stone, 1993, p. 1264), which means that it has many potential uses in

empirical experiments as long as they involve human participants. In the present study, each participant was asked to fill out a questionnaire after completing the translation task. The questionnaire had two main purposes: collecting the participants' background information and assessing their subjective workload. The data collected with questionnaires were transcribed to divide the participants into different groups based on their translation experience and to assess the perceived translation difficulty levels of the STs.

Retrospective Interview

In a retrospective interview, a participant is required to report on his/her cognitive processes after a task has been completed (Ericsson & Simon, 1993). It can provide information that is not available from other sources like eye-tracking and screen-recording data, but this data collection method also poses some limitations. For example, participants might be motivated to provide biased results or could be questioned with an inappropriate data elicitation procedure (Huber & Power, 1985). In the present study, in order to eliminate the negative influence on data accuracy as much as possible, the retrospective interview was conducted with specific questions, and was only used to determine the accuracy of the ST segmentation and categorise the translation problem types of individual segments.

Text Evaluation

Apart from the process data, the product data, which referred to the TT evaluation, were also used in the present study. The evaluation data were used to investigate the correlation between the consultation behaviour and translation products. The TT evaluation was conducted from two aspects: the translation quality of the entire TTs and the acceptability of individual segments.

Microsoft Excel and IBM SPSS Statistic

The present study adopted Microsoft Excel to manage the data sets and SPSS (short for IBM

SPSS Statistics) for statistical analysis. Microsoft Excel is a spreadsheet developed by Microsoft. It was used to store and pre-process the raw data. SPSS is a software package for logical batched and non-batched statistical analysis, developed by International Business Machines Corporation (also referred to as IBM). A series of statistical models from SPSS were adopted to display the statistical results of the experiments, including independent *t*-test, paired *t*-test, ANOVA, etc.

1.4 Structure of the Thesis

This thesis is composed of nine chapters which can be divided into five parts: introduction (Chapter 1), the theoretical basis for the present study and the review of existing studies (Chapter 2-3), methodological framework (Chapter 4-5), reports on the findings and discussions (Chapter 6-8), and conclusion (Chapter 9).

Chapter 2 introduces the theoretical framework of this thesis from three perspectives: the existing models of information-seeking behaviours, the adoption of information-seeking behaviour models to explain consultation in translation, and the newly proposed model of consultation in translation. Section 2.1 clarifies the definitions of three terms (data, information, and knowledge) in Information Science, introduces several models of information-seeking behaviours, and summarises the advantages and disadvantages of these models. Section 2.2 illustrates how to adopt information-seeking models to explain the consultation of online resources in translation. Section 2.3 provides a new model of information-seeking behaviour that is specially designed for consulting online resources in translation.

Chapter 3 reviews the previous studies on the consultation of external resources in translation and on web searching. The structure of this review is based on the theoretical model proposed in section 2.3. This review covers four aspects: the descriptive research on consultation, the effect of information needs on consultation, the comparison of consultation across different groups of information users, and the effect of consultation on translation products.

Chapter 4 provides an account of the experimental design of the present study, including

the selection of the participants, the experimental setting and procedure, and the selection and presentation sequence of the STs.

Chapter 5 outlines the procedures by which the consultation process and product data were collected, prepared, and annotated for further analysis.

Chapter 6 provides the answers to the first research question by exploring the effect of information needs on consultation. The investigation concerned two levels of information needs: perceived translation difficulty in the holistic translation task and translation problem type when translating individual segments. For the former level, the investigated aspects of consultation included the amount and proportion of allocated attention, the number of online resource types, cognitive load, and the number of between-task transitions. For the latter level, the consultation behaviours were studied from the following aspects: the amount of attention, cognitive load, and information evaluation behaviours.

Chapter 7 answers the second research question by comparing the differences in consultation behaviours across language learners, translation students, and professional translators. The differences in their consultation when translating the same ST or the same individual segment were summarised. A qualitative metric was added in this Chapter: consultation style, which was based on the transcription of screen-recording data.

Chapter 8 answers the third research question by investigating the effect of consultation on the quality of translation products, including the quality of the entire TTs and the acceptability of individual segments. This Chapter also pays special attention to the effect of short-term preparation on translation quality.

Chapter 9 summarises the main findings of the present study, the strengths and limitations, and the possible avenues for future research on this topic.

Chapter 2: Consultation in Translation Process

2.1 Models of Information-seeking Behaviour

2.1.1 Term Clarification

Before examining consultation in translation, it is necessary to clarify the differences between the three terms: *data*, *information*, and *knowledge*. With the Critical Delphi method, which is a qualitative research methodology that aims to facilitate critical and moderated discussions among experts, Zins (2007) collected definitions and reflections on these three terms from 57 participants, who comprised leading scholars representing almost all of the major subfields and important aspects of Information Science. Based on the results, he produced two sets of definitions for these three terms. In the subjective domain, data are "the sensory stimuli" (Zins, 2007, p. 487) and information refers to the empirical perception of data. Knowledge can be empirical and non-empirical. It "is a thought in the individual's mind, which is characterized by the individual's justifiable belief that it is true" (Zins, 2007, p. 487). In the objective domain, data represent empirical stimuli or perceptions, information represents empirical knowledge, and knowledge represents the content of thoughts that the individual justifiably believes are true.

Based on this clarification, in the case of consulting online resources in translation, webpages serve as the carriers of *data* that provide both linguistic and extralinguistic *information*. By reading and comprehending the information, translators transfer it into *knowledge* and determine whether to use the obtained knowledge in translation or not. Even when translators read the same information, they may obtain different knowledge which leads to different consultation results. The central feature of this behaviour involves the seeking, receiving, and use of information, which can be considered an *information behaviour*. This term is commonly used in the discipline of Information Science and refers to "activities a person may engage in when identifying his or her own needs for information, searching for such information in a way, and using or transferring that information" (Wilson, 1999, p. 249) or a type of behaviour "involving how people need, seek, manage, give, and use information in different contexts" (Pettigrew et al., 2001, p. 44). In general, information behaviour is a broad

concept that may apply to a wide range of phenomena involving "the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking, and information use" (Wilson, 2000, p. 49). It includes both passive information behaviour and active information behaviour. Passive information behaviour refers to the opportunistic discovery and unexpected encountering of information (Erdelez, 1997), like watching a television programme. Even when the information is received without being intentionally sought, the reception of information is also considered to be an information behaviour. However, consultation in translation is a goal-driven activity with a clear purpose, which means that it is not conducted subconsciously by the participants. In this case, the notion of information behaviour is too broad to be used to define consultation in translation. Another term, "information-seeking behaviour" is thus introduced.

In order to explain the relationship and difference between information behaviour and information-seeking behaviour, Wilson (1999) presented a nested model (see Figure 1).

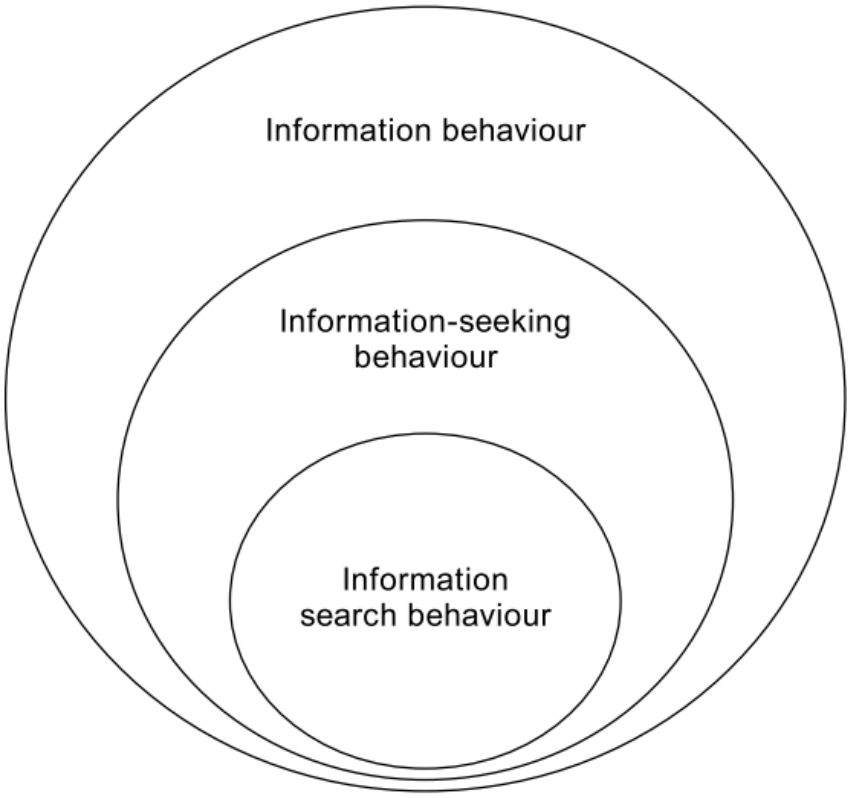

Figure 1. A nested model of the information seeking and information searching research areas (Wilson, 1999, p. 263)

Based on this model, information behaviour is considered to be an umbrella concept that covers information-seeking behaviour and information search behaviour. Information-seeking behaviour, as a sub-set of information behaviour, refers to the variety of methods people employ to discover and gain access to information resources and is defined as "the purposive seeking for information as a consequence of a need to satisfy some goal" (Wilson, 2000, p. 49). Other researchers have also proposed different definitions of information-seeking behaviour. For example, Case (2002) described it as a conscious effort to acquire information in response to gap in one's knowledge. Ikoja-Odongo and Mostert (2006) considered it to be "a process which humans engage to purposefully change their state of knowledge" (p. 148). It is thus a process in which knowledge states are changed through inputs, purposive outputs, and feedback and requires an information seeker to apply their personal knowledge and skills. Compared to *information behaviour*, a noteworthy feature of *information-seeking behaviour* is that it is performed consciously with an aim in mind. Therefore, this notion is more accurate when defining consultation in translation. Another concept mentioned in this model is information search behaviour, which is a sub-set of information-seeking behaviour. Information search behaviour is defined as "the interactions between information user (with or without an intermediary) and computer-based information systems, of which information retrieval systems for textual data may be seen as one type" (Wilson, 1999, p. 263). It consists of all the interactions with the system, whether at the level of human computer interaction (for example, clicking on links) or at the intellectual level (for example, adopting a Boolean search strategy), and also involves mental acts (for example, judging the relevance of data or information retrieved).

In summary, the consultation of online resources in translation, as a goal-driven information behaviour, is considered to be an information-seeking behaviour, which includes multiple information search behaviours. In order to comprehend and explore it, the fundamental step is understanding how an information-seeking behaviour is formulated based on proposed theoretical models. Therefore, the next section will introduce several models of information-seeking behaviour and how they can be applied to illustrate consultation in translation.

2.1.2 Models of Information-seeking Behaviour

Research into information-seeking behaviour dates back to 1948 when the Royal Society Scientific Information Conference took place. This event marked "the real beginning of a concern with understanding how people used information in relation to their work and, particularly, how they used it in science and technology" (Wilson, 2000, p. 50). The early studies of information-seeking behaviour were "concerned not so much with human aspects of information use, but with the use of information sources and systems" (Wilson, 2000, p. 50). Since the 1980s, there has been a shift in the research into information-seeking behaviour from the "system-centred" approach to the "user-centred" approach, which resulted in a considerable number of models being developed with the aim of improving information access to users (Ikoja-Odongo & Mostert, 2006). Since the present study aims to propose suggestions for translators but not for online resource designers, the models of information-seeking behaviour proposed from the user-centred approach are considered to be more suitable for illustrating consultation in translation. The selected models will be further discussed in this section.

Wilson (1981) developed an illustration of information-seeking behaviour that focused on the individual's physiological, cognitive, and effective needs (see Figure 2). He designed this illustration "not to 'model' information-seeking behaviour but to draw attention to the interrelationships among concepts used in the field" (Wilson, 1981, p. 4). This illustration suggests that information-seeking behaviour is a consequence of an information need perceived by the information user, who draws on information systems or sources, and the information-seeking behaviour may result in success or failure. If successful, the information user would then make use of the information they found, which might either fully or partially satisfy the perceived need or fail to satisfy the need. In the case that the information user fails to satisfy the information need, he/she may repeat the search process.

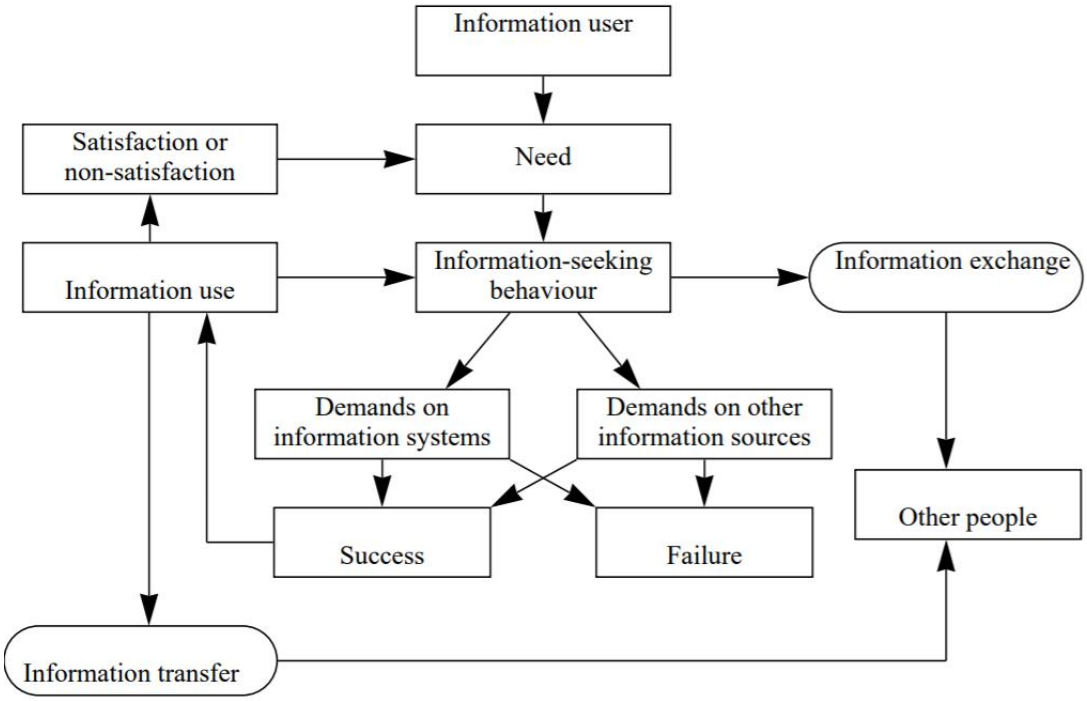

Figure 2. Wilson's illustration of information-seeking behaviour (based on the diagram presented in 1981 and redrawn in 1999)

From a cognitive and problem-solving perspective, in Wilson's (1981) illustration, problems and solutions are considered to be the cause of uncertainty and the goal of managing the uncertainty. More specifically, Wilson (1999) stated:

> *en route* to the goal, the individual moves from uncertainty to increasing certainty and that there are stages in the problem-resolution process that are identifiable and recognisable to the individual. These stages are: problem identification (where the person is asking the question, 'What kind of problem do I have?'), problem definition ('Exactly what is the nature of my problem?'), problem resolution ('How do I find the answer to my problem?') and, potentially, solution statement ('This is the answer to the problem', or, if a pragmatic, rather than a theoretically-based resolution has been found, 'This is how we are going to deal with the problem.'). (p. 266)

Wilson's (1981) illustration views the information-seeking behaviour as a problem-solving

process with the aim of reducing uncertainty. His understanding was shared by Dervin (1983), who proposed the sense-making theory. She suggested that an information-seeking behaviour exists within a *situation* in time and space, is triggered by a *gap*, which refers to the difference between the contextual situation and the desired situation, and results in an *outcome*, which is the consequence of the sense-making process. Dervin's (1983) sense-making theory is not simply a model of information-seeking behaviour but is rather "a human tool designed for making sense of a reality assumed to be both chaotic and orderly" (Wilson, 1999, p. 253). Nevertheless, similar to Wilson's (1981) illustration, this theory also considers that the purpose of an information-seeking behaviour is to reduce the uncertainty between the existing situation and the desired situation.

Similar to Wilson (1981) and Dervin (1983), Ellis (1989) also illustrated the information-seeking behaviour from a cognitive and problem-solving perspective. His illustration of information-seeking behaviour was not presented in a diagrammatic model because he implied that the behaviours did not necessarily occur in a sequence. Instead, he used eight "features", which were named and defined as follows: (1) starting: the means employed by the user to begin seeking information, for example, asking a knowledgeable colleague; (2) chaining: following footnotes and citations in known material or "forward" chaining from known items through citation indexes; (3) browsing: semi-directed or semi-structured searching; (4) differentiating: using known differences in information sources as a way of filtering the amount of information obtained; (5) monitoring: keeping up-to-date or current awareness searching; (6) extracting: selectively identifying relevant material in an information source; (7) verifying: checking the accuracy of information; and (8) ending: which may be defined as "tying up loose ends" through a final search. Although Ellis mentioned that his model was not a sequenced set of stages, Wilson (1999) pointed out that a certain pattern was imbedded in the process. For example, "starting" and "ending" always indicated the beginning and the end of an information-seeking behaviour, while the other steps also followed a certain sequence.

From a user-centred approach, Kuhlthau (1991) emphasised that the information-seeking behaviour should be considered as "the user's constructive activity of finding meaning from information in order to extend his or her state of knowledge on a particular problem or topic"

(p. 361). Based on a series of empirical studies (Kuhlthau, 1988a, 1988b, 1988c, 1989; Kuhlthau et al., 1990), she identified six stages in her model of information-seeking behaviour (see Table 2 for the model).

Table 2. Kuhlthau's six-stage model of information-seeking behaviour (Kuhlthau, 1991, p. 367)

Stages	**Feelings common to each stage**	**Thoughts common to each stage**	**Actions common to each stage**	**Appropriate tasks**
1. Initiation	Uncertainty	General/ vague	Seeking background information	Recognize
2. Selection	Optimism			Identify
3. Exploration	Confusion/frustration/ doubt		Seeking relevant information	Investigation
4. Formulation	Clarity	Narrowed/ clearer		Formulate
5. Collection	Sense of direction/confidence	Increased interest	Seeking relevant or focuses information	Gather
6. Presentation	Relief/satisfaction or disappointment	Clearer or focuses		Complete

The most distinctive development of her model is that it associates the stages of information-seeking behaviour with feelings, thoughts, actions, and appropriate information tasks. For example, according to her model, in the first stage of an information-seeking behaviour, which is initiation, information users might feel uncertainty, have general thoughts about the problem area, and seek background information to recognise the existence of the information need. The fundamental proposition of Kuhlthau's (1991) model is that information users perceive the feeling of uncertainty which triggers the information-seeking behaviour that gives rise to feelings of doubt, confusion, and frustration. As the search process proceeds and is increasingly successful, information users' feelings change. As relevant material is collected, confidence increases and is associated with feelings of relief, satisfaction, and a sense of direction. This model emphasises that information-seeking is an active process, which involves information users' affective processes.

Based on Ellis' (1989) information-seeking model, Choo et al. (1999) identified four main

modes of information-seeking on the Web: undirected viewing, conditioned viewing, informal search, and formal search (see Table 3).

Table 3. Behavioural modes and actions when information-seeking on the Web (Choo et al., 1999, p. 8)

	Undirected viewing	**Conditioned viewing**	**Information search**	**Formal search**
Starting	Identifying selecting starting pages, sites			
Chaining	Following links on initial pages			
Browsing		Browsing entry pages, headings, site maps		
Differentiating		Bookmarking, printing, copying Going directly to known site	Bookmarking, printing, copying Going directly to known site	
Monitoring		Revisiting 'favorite' or bookmarked sites for new information	Revisiting 'favorite' or bookmarked sites for new information	Revisiting 'favorite' or bookmarked sites for new information
Extracting			Using (local) search engines to extract information	Using search engines to extract information

In this model, undirected viewing refers to when users are exposed to information with no need in mind, which is essentially an explorative exercise involving a wide range of information sources that may or may not be of relevance. Conditioned viewing refers to viewing information on selected topics, but it is still not an active search, functioning mainly as a browsing action that results in the user noticing the sources' relevance to the topic of interest. Informal searching refers to actively searching for information to broaden and deepen knowledge on a specific

topic. This activity is an unstructured effort used to determine whether the action is needed. Formal searching is a planned, structured, and deliberate action used to obtain required information on a topic or an issue. The strength of this model is that it is a flexible model for describing the systematic changes in the searching process conducted by individuals. However, there is also an obvious deficiency: in real life, searching on the Web does not necessarily follow the systematic process proposed in this model (McKenzie, 2003).

Despite the difference in their focused perspectives, the models discussed in this section share two common features. Firstly, they all consider the information-seeking behaviour as a problem-solving process with the aim of reducing the uncertainty between the existing situation and the desired situation. From the cognitive perspective, translation process is also considered as a problem-solving activity. For example, Tirkkonen-Condit (2000) considered translation to be a goal-driven action that "cause[s] at least temporary uncertainty in the course of target production" (p. 123). Angelone (2010) also suggested that translation is "a chain of decision-making activities relying on multiple, interconnected sequences of problem solving behaviour for successful task completion" (p. 17). When translators face uncertainties or problems, they "engage in *uncertainty management* (UCM), the application of conscious strategies for reducing uncertainty by solving the problems of comprehension, transfer or production that arise at these junctures" (Angelone & Shreve, 2010, p. 109). Since the information-seeking behaviour is considered as a method for reducing the uncertainty, the use of this behaviour is consequently one of uncertainty management strategies. Secondly, all the models of information-seeking behaviour are summarised from the perspective of the information user with a sequential set of stages. This feature allows them to be easily applied to explain information-seeking behaviours in different scenarios, including the consultation of online resources in translation. To summarise, the models of information-seeking behaviours presented in this section present a structure of linear sequences when consulting external information in translation.

However, these models share an important limitation: none of these models provide any causative factors in information-seeking behaviour, which means that they do not suggest any hypotheses that need to be tested. Although this element is not an inherent limitation for the

models presented above, as the present study does not simply aim to present a descriptive picture of consultation in translation but also intends to investigate the factors that influence consultation, it is important to present hypotheses about causative factors in information-seeking behaviour. Therefore, the models of information-seeking behaviour focusing on the causative factors are introduced in order to supplement the current models as follows.

In addition to the sequential illustration of information-seeking behaviour, Wilson (1981) suggested that the behaviour should also be studied with the aim of understanding "*why* the information seeker behaves as he does" (p. 7). He thus presented a second model that focuses on the factors influencing information needs and information-seeking behaviour (see Figure 3).

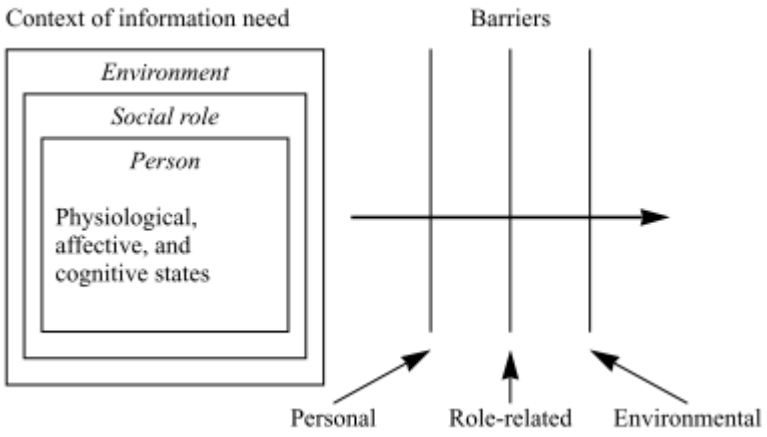

Figure 3. Factors influencing information-seeking behaviour (Wilson, 1999, p. 252)

Similar to Wilson's (1981) sequential illustration of information-seeking behaviour, this model suggests that individuals engage in information-seeking behaviours to satisfy needs, but it enhances the previous illustration by presenting what the needs are and what features may influence the needs. Based on the existing literature, Wilson (1981) divided human needs into three categories: (1) physiological needs, such as the need for food, water, shelter etc.; (2) affective needs, sometimes called psychological or emotional needs, such as the need for attainment and domination etc.; and (3) cognitive needs, such as the need to plan and to learn a skill etc. (p. 7). He suggested that these three categories of human needs are interrelated:

> physiological needs may trigger affective and/or cognitive needs; affective needs may

> give rise to cognitive needs; and problems relating to the satisfaction of cognitive needs (such as a failure to satisfy needs, or fear of disclosing needs) may result in affective needs (for example, for reassurance) (pp. 7-8).

Wilson (1981) considered these three categorises of human needs as primary needs and information needs as secondary needs. Individuals do not conduct further actions to satisfy their secondary needs unless their primary needs are satisfied. In other words, when individuals are conducting information-seeking behaviours, their primary needs may inhibit their search for information (Wilson, 1999, p. 252). For example, if the cost of conducting information-seeking is higher than the penalty of acting in the absence of full information or if satisfactory information sources are not available for the users, information-seeking behaviours would not occur at all. Therefore, information needs do not unequivocally trigger information-seeking behaviours. Furthermore, there can be barriers between the occurrence of information needs and the information-seeking behaviour. Wilson (1981) divided the potential barriers into three categories: (1) personal barriers, which relate to the person him- or herself; (2) role-related barriers, which relates to the role demands of the person's work or similar; and (3) environmental barriers, which relates to the environment (political, economic, technological, etc.) within which the life or work of the individual takes place. From the perspective of information users, this model highlights two main influential factors of information-seeking behaviours: whether the user perceives the existence of an information need and whether the user considers it necessary to satisfy the information need. In relation to whether the user perceives the existence of an information need, when facing the same problem, some information users may not perceive the existence of information needs and would not conduct any information-seeking behaviours while others may perceive it differently. Regarding whether the information user considers it necessary to satisfy the information need, some information users who perceive the existence of an information need may or may not conduct information-seeking behaviours depending on their perception of the potential barriers.

Similar to Wilson (1981), Foster (2004) developed a non-linear model of interdisciplinary information-seeking behaviour, which is represented in terms of three core processes and three

levels of contextual interaction (see Figure 4).

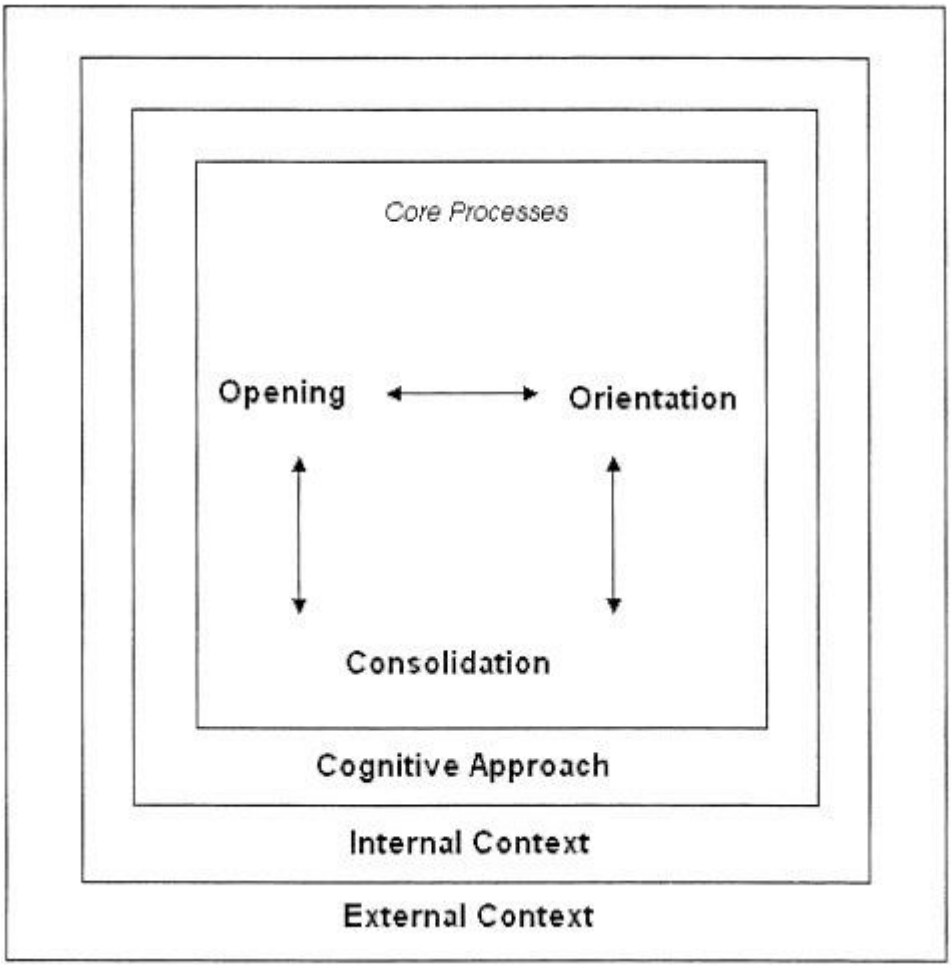

Figure 4. Non-linear model of information-seeking behaviour (Foster, 2004, p. 232)

The three core processes represent the phases of an information-seeking behaviour, including Opening (breadth exploration, eclecticism, networking, keyword searching, and browsing); Orientation (problem definition, picture building, reviewing, identifying keywords, and identifying the shape of existing research); and Consolidation (knowing enough, refining, sifting, incorporation, verifying, and finishing). The names of these concepts seem to suggest a sequence of activities, but they actually represent "the interactivity of the core processes" (Foster, 2004, p. 235). The three levels of contextual interaction include external context (social and organisation, time, the project, navigation issues, and access to sources); internal context

(feelings and thoughts, coherence, knowledge and understanding); and cognitive approach (aspects of the mode of thinking observed in the participants and a willingness to identify and use information that might be relevant). In contrast to the linear models, this model does not intend to propose a descriptive picture of the information-seeking behaviour; instead, it focuses on the interaction between the external factors and the information-seeking behaviour.

To conclude, the models presented in this section reveal the structure of information-seeking behaviours and propose the factors that may affect how information users conduct information-seeking behaviours. Generally, an information-seeking behaviour is triggered by the reception of an information need, which is defined as "a state or process started when one perceives that there is a gap between the information and knowledge available to solve a problem and the actual solution of the problem" (Miranda & Tarapanoff, 2008, p. 2). However, the existence of the information need does not necessarily lead to the start of the information-seeking behaviour, which is further influenced by the environmental context (such as the political or technical environment), the user-related context (such as the users' personal role), and the cognitive state of the user (such as the users' willingness to identify and use information that may be relevant).

As these models were developed through general information-seeking research, they were not designed for a specific research field. Translation, as a "knowledge-based" (Enríquez Raído, 2014, p. 1) activity, has a high possibility of involving information-seeking activities, such as the consultation of online resources. Based on the previously discussed models, the following sections illustrate how consultation is formed and propose a model specially designed for consultation in translation.

2.2 Information-seeking Behaviours in Translation

From a cognitive perspective, translation can be seen as a goal-driven activity that aims to solve a series of problems. Angelone (2010) described translation as "a chain of decision-making activities relying on multiple, interconnected sequences of problem solving behavior for successful task completion" (p. 17). As illustrated in section 2.1, information-seeking behaviour

is considered to be a problem-solving process that aims to reduce the uncertainty between the existing and desired situation. Therefore, the consultation of online resources, which is the information-seeking behaviour within the translation process, can be considered as an activity that aims to solve the translation problems. The investigation of the consultation behaviours is conducted by considering it as an internal part of the translation process, which is divided into three different steps: problem recognition, solution proposal, and solution evaluation (Angelone, 2010; Angelone & Shreve, 2010).

The first step of a translation process is the recognition of a problem. The problems encountered by translators can be identified on different levels, including linguistic problems, textual problems, extralingual problems, cultural problems, and so on (Nord, 1991). Based on Nord's (1991) study, Angelone (2010) proposed another categorisation that divided translation problems into three types: (1) source language comprehension problem, which refers to the inability to understand the source text; (2) source language-target language transfer-of-meaning problem, which refers to the difficulty of finding the satisfactory equivalent in the target language; and (3) target language text production problem, which is usually in relation to the style or cultural references in the text. The strength of Angelone's categorisation is that it covers all the levels classified by Nord (1991) and presents them in a more concise way that can be easily distinguished and applied in empirical studies. It is worth mentioning that problem recognition is dynamic and relative. For instance, on the one hand, the comprehension of a certain ST segment might cause a translation problem for an inexperienced translator, but would not necessarily be a problem for a professional translator. On the other hand, meeting the client's specific requirement might be a consideration when producing the TTs for a professional translator, but this issue might not be considered by an inexperienced translator. The recognition of a translation problem is not equal to the perception of an information need and certainly does not always lead to information-seeking behaviours. It only suggests that translators need to use further translation strategies, which leads to the next step of the translation process: solution proposal.

The solution proposal step consists of "strategy planning and/or application, with the immediate objective of generating and, as Tirkonnen-Condit has suggested, 'trying out'

potential solutions for the encountered problem" (Angelone, 2010, p. 20). Translation, as a goal-driven activity, has the ultimate aim of producing the most appropriate TT solutions, which requires translators to use different translation strategies. Translation strategy is an ambiguous term in Translation Studies. It is also known as "procedure", "technique", "method", "tactic", "approach", and so forth (Sun, 2013). Multiple researchers have attempted to distinguish and categorise translation strategies from different perspectives. From the perspective of considering translation as a problem-solving process, translation strategy is defined as a kind of operation in the translator's mind while translating (Lörscher, 1991; Jääskeläinen, 1993). Rather than being an established element of a general translation theory, it is more a tool that is used to tackle the possible translation problems. While using this tool to propose translation solutions, if translators' internal knowledge is not sufficient, they would perceive the gap in knowledge between the existing situation and the desired situation, which leads to an information need. Based on the models of information-seeking behaviours discussed in the previous section, the information need does not necessarily trigger the consultation of external resources, which is influenced by the external context, internal context, and cognitive approach (Foster, 2004). Under the scenario of using online resources in translation, the external context includes environmental influences such as the working environment, time pressure, project requirement, access to information resources, etc; the internal context refers to translators' feelings, thoughts, and working habits; and the cognitive approach relates to translators' willingness to consult external information. In other words, even when translators encounter the same translation problem and recognise the need for external information, their consultation behaviour might be affected by these elements.

The third and the final step of the translation process is the solution evaluation. It may result in a successful solution to the problem (producing the desired TT); a recognition of failure (failing to produce the desired TT or producing an uncertain TT), or postponing the problem (Shreve, 2006). This step can either be the end or the beginning of an information-seeking behaviour. If the translator perceives the solution to be successful, he/she would end the problem-solving process, which automatically ends the information-seeking behaviour. However, if the translator perceives the solution to be a failure, he/she needs to re-evaluate the

necessity of starting a new information-seeking behaviour. Depending on the re-evaluation result, the translator might restart the information-seeking behaviour or adjust the translation strategy.

2.3 Model of Consultation with Online Resources in Translation

Based on the previous summary of information-seeking behaviour models and the discussion of how an information-seeking behaviour is integrated in the translation process, a model of consultation behaviour with online resources in translation is proposed (see Figure 5).

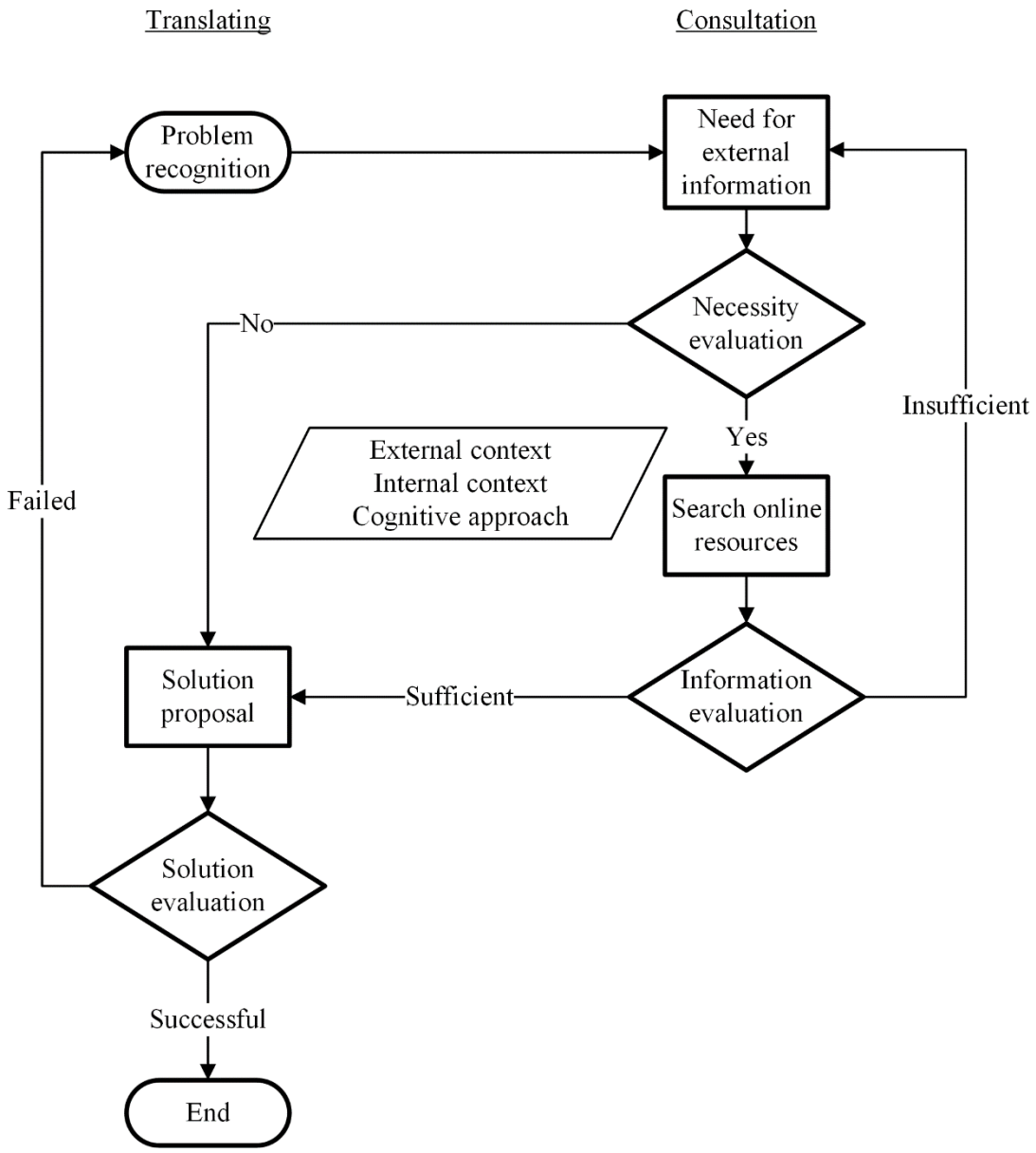

Figure 5. Model of consultation behaviour with online resources in translation

This model is divided into three sections: three steps of the translation process; sequential stages of consultation; and factors influencing their interactions. The first section of this model follows the three steps of the translation process from the problem-solving perspective proposed by Angelone (2010): the recognition of a translation problem, solution proposal, and solution evaluation. The structure of the second section follows the linear model of information-seeking behaviour presented by Wilson (1981), which contains four main stages: need for external information, searching online resources, information evaluation, and information use

(represented as a solution proposal in the context of translation). The first stage, need for external information, reflects Wilson's theory that the information need could only be satisfied when the primary need is satisfied. At this stage, participants' evaluation of information need would affect the following consultation behaviour. The second stage, searching online resources, refers to the information-search behaviours within this process. The third stage, information evaluation, refers to the process by which translators assess the value of the information they have obtained and decide whether to use the information in translation production or not.

The feature that makes this model specially designed for consultation in translation is that it considers translating and consultation as two sub-sections of translation. Translating is specifically used to refer to the pure translation activity that does not involve any consultation. Within the translation process, the relationship between translating and consultation is both intertwined and conflicting. On one hand, translating serves as the trigger for consultation and consultation serves as an aid for producing translation solutions. The features of translating tasks, such as the ST and the external requirements also influence translators' consultation behaviours. On the other hand, since these two activities cannot happen simultaneously, translators can only focus their attention on one of them. This means that translating and consultation compete for a limited amount of cognitive resources. If a translator allocates too much attention to consultation, he/she would have to sacrifice the task efficiency by allocating more attention to translating or sacrifice the translation quality by not allocating sufficient attention to translating.

This model proposes three perspectives when examining consultation in translation. Firstly, it can be investigated as a type of information-seeking behaviour by exploring its descriptive characteristics. Secondly, the interactions between translating and consultation can be explored to discover the factors that affect the efficiency and effectiveness of consultation, such as different levels of information needs and translator attributes. Thirdly, the effect of consultation on the production of translation solutions can be examined.

Following these three perspectives of this model, the investigation of consultation in translation is presented in this thesis as follows. Firstly, the present study aims to present a descriptive picture of consultation by summarising its characteristics. From this perspective,

translating is considered to be a task involving the information need that triggers the start of consultation and consultation is studied as an isolated and independent activity. However, a simple descriptive study of consultation cannot effectively provide further suggestions for translation practice and pedagogy. Secondly, the present study intends to explore how the first step of translating, which is problem recognition, leads to consultation. This aspect of the study considers the differences in consultation when it is triggered by different levels of perceived translation difficulty or different types of translation problems. Thirdly, another influential factor of information-seeking behaviour relates to the attributes of individual users. Therefore, the present study examines the effect of translation experience on consultation by comparing the differences in the consultation behaviours between translators with different levels of experience. Fourthly, the present study aims to explore the correlation between consultation and solution proposal in translating. In other words, when the translators have obtained sufficient knowledge and completed the consultation phase, their translation quality will be used to determine whether their consultation is effective or not. From this perspective, the present study also investigates the features of consultation that could help to produce higher quality translations.

Chapter 3: Literature Review

This Chapter reviews the existing empirical studies on the consultation of external resources (both online and offline) in translation, summarises their contributions and limitations, and proposes research questions for the present study. Since "not enough attention has been paid to how translators access and utilise the external resources available to them" (Gough, 2016, p. 16), some relevant studies on general information-seeking behaviours and web searching will also be reviewed in this Chapter to explore their insights.

Based on the model of consultation in translation proposed in section 2.3, this review is carried out from four aspects: (1) the descriptive investigation of consultation, (2) the interactions between information needs and consultation, (3) the interactions between user attributes and consultation, and (4) the effect of consultation on proposed translation solutions. In the first section, the existing studies that provide a descriptive picture of the characteristics of consultation will be reviewed from two perspectives: the characteristics of consultation summarised in these studies and the data collection methods these studies used. The second section mainly reviews the studies that analyse the correlations between information needs and consultation. The review in this section will be conducted from two aspects: the perceived translation difficulty of the STs as the information needs in the holistic translation process and the translation problem types of individual segments as the information needs in the embedded translation tasks. The third section reviews the studies that compare the consultation behaviours between translators with different levels of experience to explore the effect of translators' attributes on consultation. The fourth section reviews the studies that investigate the effect of consultation on the proposed solutions, which are evaluated by both the quality of the TTs and the acceptability of individual solutions. Based on the previous aspects of the review, the fifth section summarises the existing research gaps and proposes three research questions of the present study.

3.1 Descriptive Investigation of Consultation

The shared characteristic of the empirical studies on consultation reviewed in this section is that they tend to focus on *what* the characteristics of consultation are instead of *why* consultation

is formulated in such a way. Due to the shared research focus, most of these studies examine consultation from the users' perspective using qualitative methods, which are believed to be "particularly appropriate to the study of the needs underlying information-seeking behaviour if our concern is to uncover the facts of the everyday information life of the people being investigated" (Pinto & Sales, 2007, p. 537). However, as the present study aims to take cognitive measurements into consideration, qualitative methods alone would not be sufficient to collect all the required data. Taking into account these two points of view, the review in this section had two purposes. Firstly, it intends to summarise the characteristics of consultation in translation that have been examined in previous studies, present the relevant findings and limitations, and state the existing research gaps. Secondly, this review aims to explore the advantages and shortcomings of research methods used in the previous studies and propose the most suitable combination of data collection methods for the present study. The empirical studies reviewed in this section are presented in Table 4.

Table 4. Studies on the descriptive investigation of consultation in translation

Author	Year	Consultation characteristics	Methods
Krings	1986	1. Consultation purposes 2. Reliance on external materials	1. Direct observation
Atkins & Varantola	1997	1. Consultation purposes 2. Information evaluation 3. Resource preference 4. Consultation result	1. Recording sheets
Varantola	1998	1. Consultation purposes 2. Resource preference	1. Direct observation 2. Recording sheets
Enríquez Raído	2011, 2014	1. Consultation purposes 2. Resource preference 3. Query formulation 4. Consultation result	1. Screen-recording 2. Recording sheets 3. Retrospective interview
Gough	2016	1. Translator taxonomy	1. Questionnaire 2. Screen-recording
Hvelplund	2017	1. Cognitive resource allocation 2. Resource preference	1. Eye-tracking
Shih	2017	1. Resource preference 2. Query formulation	1. Screen-recording 2. TAPs
Hvelplund	2019	1. Cognitive resource allocation 2. Processing flow	1. Eye-tracking
Shih	2019	1. Query formulation 2. Consultation result	1. Screen-recording 2. TAPs
Sycz-Opoń	2019	1. Query formulation 2. Information evaluation 3. Resource preference	1. Direct observation 2. TAPs

Although the present study only aims to investigate the consultation of online resources, studies on the use of printed materials, such as printed dictionaries and encyclopaedias, should not be ignored as these studies are also concerned with information-seeking behaviours and can inspire follow-up studies on the consultation of online resources. One of the earliest empirical studies involving the use of external resources was conducted by Krings (1986), who was one of the early process researchers that examined translators' dictionary use strategy. He recruited eight language learners (not translators) and asked four of them to translate into their second

language (L2) and the other four to translate into their first language (L1). Apart from a monolingual dictionary in their L2 provided by the researcher, all the participants were asked to bring along "those reference books they were accustomed to use at home, such as monolingual dictionaries, bilingual dictionaries, grammars etc." (Krings, 1986, p. 265) to avoid the interference with the experimental data by providing reference material that might be unfamiliar to the participants. This decision turned out to be the biggest drawback in his research design: some participants only brought one bilingual dictionary which resulted in a limited selection of resources. Nevertheless, he managed to outline four types of consultation purposes: (1) solving comprehension problems, (2) retrieving equivalents, (3) monitoring equivalents, and (4) decision-making. He also observed that in solving comprehension problems, participants only relied on their internal knowledge after failing to obtain an acceptable result from consulting dictionaries. It is worth mentioning that although two language directions were involved in the experiments, he did not compare the differences in consultation in relation to which language direction the participants were working in. As one of the earliest empirical studies on the use of reference material in translation, despite its valuable contribution to furthering research on this topic, Krings' (1986) study reveals several shortcomings. Firstly, as his studies were limited by only recruiting a small number of participants, he could not collect sufficient data. Secondly, the amount and variety of resources consulted in his experiments was restricted. Since the participants in his study were not professional translators, they were not familiar with the reference materials that might be most relevant and helpful for translation. The materials brought by these participants were of limited help in the translation. These two shortcomings in Krings' (1986) study reveal the potential methodological improvements that can be made in further studies.

Noticing the existing methodological drawbacks in Krings' (1986) study, Atkins and Varantola (1997) proposed the use of *Recording Sheets* when investigating participants' dictionary use behaviours. The Recording Sheet was a structured questionnaire used to record details of each single look-up, which referred to "the looking up of one entry, once, in one dictionary" (Atkins & Varantola, 1997, p. 5). It covered several aspects of dictionary look-up, including the word(s) from the ST that triggered the dictionary use, the types of dictionaries

that were consulted, the reasons for the look-up, the search result (successful or unsuccessful), the subsequent actions, and their feelings towards the look-up. The most significant advantage of using the Recording Sheet was that it provided a comprehensive and detailed transcription of the look-ups, which was especially informative and beneficial in a descriptive study. Atkins and Varantola (1997) managed to collect over 1,000 look-ups from 103 participants and proposed several findings: (1) with regard to the types of dictionaries consulted, bilingual dictionaries were more useful than monolingual dictionaries; (2) with regard to the look-up processes, the largest proportion of successful results were found in headword translations; and (3) with regard to the look-up results, 59% of the problems were considered to be resolved by the participants. This study proposes a good methodological example of using Recording Sheets for further descriptive studies on consultation in translation. Varantola (1998) also used Recording Sheets to monitor and record the use of reference materials, particularly the use of dictionaries, by four translation students when performing an L1-L2 translation. She reported that the translation students preferred to use bilingual dictionaries more than the other types of external resources even when searching for information that was not typically available in dictionaries. She argued that the other types of external resources could not provide systematically available information for translators, so she suggested that dictionaries should be designed better, and that users' dictionary skills should be improved. One difference between Varantola's (1998) and Atkins and Varantola's (1997) Recording Sheets was that Atkins and Varantola (1997) asked the participants to work in pairs with "one partner using dictionaries, and the other recording every step of this activity" (Atkins & Varantola, 1997, p. 85). In contrast, Varantola (1998) followed a combined method of direct observation and Recording Sheets by assigning an observer to record the dictionary look-ups and search processes in her study. This difference is considered to be an improvement for two reasons. Firstly, the uniformity and consistency of the qualitative data is maintained when the same people, such as the researchers, are asked to record the results. Secondly, if participants are required to record the consultation processes, they should be trained, or at least instructed, on how to record the results before the experiments. By observers or researchers recording the search processes, it could save the time as participants would not have to be trained on how to record the data and it would also

eliminate the possibility of the participants becoming fatigued and this affecting the translation tasks.

With or without using Recording Sheets, the studies mentioned above all collected the data by directly observing the consultation and translation processes. In light of its universal and extensive scope, direct observation is one of the most widely used research methods as it "allows the researcher to see what dictionary users really do, rather than relying on what users say they do" (Mackintosh, 1998, p. 126). However, it also highlights a drawback of having "the lack of access to important non-visual information, particularly cognitive processes" (Mackintosh, 1998, p. 126). To overcome this issue, the combination of direct observation and other data collection methods is a more suitable methodological choice for researchers. Mackintosh (1998), for instance, used a combination of direct observation and think-aloud protocols (TAPs) to investigate how translation students translated a specialised text with the help of various dictionaries and a term bank. He summarised three findings: (1) the need for an equivalent only and the need for both a comprehension problem and an equivalent were the two most common types of problems; (2) the general bilingual dictionary was used the most by the participants; and (3) the majority of look-ups involved consulting either a definition, an equivalent, or both, which was the most satisfactory strategy for comprehension or meaning verification problems.

Despite the value of conducting the descriptive analysis of consultation in translation with Recording Sheets, direct observation, and TAPs, none of these methods can provide a complete recording of all the details of the experimental processes and thus might involve "a considerable margin of error" (Pavlović, 2007, p. 52). This shortcoming is easy to overcome with emerging technology. Both video recording and screen-recording allows data to be collected in a more complete way. These two methods also have the drawback that they might "leave the researcher with the same problem of identifying non-explicit messages and classifying e.g. facial expressions, nods of approval and disapproval, etc." (Pavlović, 2007, p. 52). Therefore, a mixed data collection method that combines these two recording methods with verbal data collection methods, such as think-aloud or retrospective interviews, is a better choice for researchers.

Combining screen-recording, recording sheets (which were referred to as "online search

report [OSR]" in her study), and question-based retrospective interviews, Enríquez Raído (2011, 2014) combined the exploratory research approach with case study research and provided one of the earliest comprehensive investigations of the consultation of online resources in translation performed by four translation students, one PhD student, and one translation lecturer. The data in her study were mainly collected using three methods: (1) OSR in which the participants were asked to specify their level of ST domain knowledge and describe the web search tasks performed for translation problem solving; (2) transcription of screen-recording videos, which included the details of each web search episode; and (3) transcription of retrospective interviews, in which the participants were asked about:

> (a) any potential influence that the screen recorder and the OSR may have had on translation and web-searching processes; (b) the (dis)advantages of using such tools for teaching and learning about translation; (c) the type of web search and navigation actions carried out by the participants, as well as the translation resources they consulted; and (d) their strategies for evaluating information and resources on the web (Enríquez Raído, 2014, p. 100).

In Enríquez Raído's (2014) study, the biggest advantage of the combined data collection method was that it could reflect more thoroughly and critically on the nature of the translation problems encountered by translators. Using the OSR particularly had an advantage that it could encourage translators' awareness of perceived problems in general and the importance of problem detection and solving in particular. It was also observed that in her study, translation students tended to focus on how they dealt with problematic technical terms rather than general lexical problems. This advantage of the OSR makes it a useful tool to demonstrate the consultation process by students and to provide further guidance in translation training. However, there are several drawbacks in the use of the OSR as a data collection method in empirical studies. For instance, the presence of such a problem reporting tool heightened "students' metacognitive levels of awareness, thus introducing an unnatural element into the translation process, which in turn threatens the reliability and validity of this tool" (Enríquez Raído, 2014, p. 184). In addition, it was also observed that the participants in her study tended

not to report general lexical problems for which they were mainly looking for confirmation (or "reassurance") of existing tentative solutions. This behaviour pattern would lead to a lack of detail being provided, which could be a downfall of using OSR as a data collection method. Enríquez Raído's (2011, 2014) studies covered various aspects of the consultation of online resources in translation, including consultation goals (comprehension, production, and both), search process, resource preferences, and search results. Her findings can be summarised as follows: (1) comprehension problems accounted for the largest proportion of all translation problems; (2) dictionaries were preferred to other reference materials, like Wikipedia; (3) direct address was the preferred initial search action, followed by search engine queries, browse searches that led to new searches in some instances, and navigational query; and (4) translators' perceptions of search success, satisfaction, and difficulty matched their web searching styles, which were described as checking and comparing search behaviours. In addition, she also advocated that information literacy should be developed for each specialised translation field and closely linked to professional practice. She suggested that pedagogy relating to successful query construction should not just rely on general knowledge about the search engine, but should focus on the importance of the combination of information needs analysis and its resulting selection of key ST terms.

Adopting a similar data collection approach (a combination of screen-recording and TAPs), Shih (2017) retrieved data from six postgraduate Chinese trainee translators while translating a semi-specialised scientific text. She presented an empirical observation of the variety of queries and online resources employed by the participants, and more importantly, how different combinations of resources were used by the trainee translators. For example, she highlighted an interesting phenomenon where a trainee translator used a Chinese Statistical Machine Translation system exclusively as if it was a dictionary. She also noted how the ergonomics and dynamics of the web search process were dramatically altered when a trainee adopted a hybrid dictionary and information seeking tool online (i.e., Lingoes). In this case, cognitive effort commonly spent on locating different types of online resources and going back and forth between them were dramatically minimised; instead, cognitive effort was spent on assessing and deciphering a sizeable number of search results that were presented in one single window

in the hybrid tool. In a later study, with the same data collection method, Shih (2019) studied the consultation of online resources by 18 translation students. Instead of investigating all the consultation behaviours during the entire translation processes, she focused on the web search episodes, which refer to the web search processes that are associated with translating specific segments known as Rich Points (PACTE, 2011). By illustrating the characteristics of unsuccessful and successful web search episodes, she concluded that the biggest difference between them "was related to 'secondary actions', i.e., engagement with SERPs, rather than 'primary actions', i.e., query-related actions, whether this was by means of clicking beyond the top three search results or taking the time to process potentially relevant contents in selected search results" (Shih, 2019, p. 920). With direct observation and TAPs, Sycz-Opoń (2019) investigated the information-seeking behaviour of 104 translation students in legal translation. Her findings can be summarised as follows: (1) dictionaries were consulted in around three-quarters of all look-ups, and only bilingual dictionaries proved popular among the participants; (2) electronic sources were favoured over printed sources because they were more convenient to use; (3) the type of information most often sought by the participants was the equivalent of a source language lexical unit, but it was mostly looked for in bilingual dictionaries, rather than using monolingual dictionaries or encyclopaedic sources; (4) When facing uncertainty and doubt about the information that was found, the methods used by the participants to gain confidence in the information were often ineffective; and (5) the observation of individual participants revealed that, in their search for information, they stuck to their best-known information-seeking paths.

The studies reviewed above cover almost all the observable aspects of consultation in translation, but they omit the cognitive aspect, which can be explored from two perspectives: the amount of attention allocated to consultation and the cognitive efficiency of consultation. Attention refers to focusing the conscious awareness on a certain object while extracting information, but suppressing and ignoring non-relevant information (Hvelplund, 2021). It involves focusing on a specific environmental stimulus while ignoring other stimuli. In the translation process involving consulting external resources, when the translator focuses on consultation, he/she is not able to pay attention to translating. During the translation process,

translating and consultation are two sub-tasks that consume temporal and cognitive resources simultaneously. On the one hand, if translators allocate a large amount of temporal and cognitive resources to consultation, they may ignore the importance of applying their internal knowledge and using other translation strategies, which would decrease translation efficiency. On the other hand, if translators aim to produce the translation solutions as quickly as possible and reduce the amount of temporal and cognitive resources allocated to consultation even when it is necessary, they might sacrifice the quality of the translation solutions, which would reduce consultation effectiveness. Therefore, in order to obtain the optimal result, translators should maintain a balanced allocation of temporal and cognitive resources between translating and consultation. Thus, the amount of attention devoted to consultation and the proportion of the entire translation process it takes up is assumed to be affected by the translator's personal preference and to influence the quality of the translation product. The cognitive efficiency of consultation in translation requires further explanation. In social sciences, cognitive efficiency "is described as increases in the rate, amount, or conceptual clarity of knowledge, versus costs, such as cognitive effort, needed to attain knowledge" (Hoffman, 2012, p. 133). It might be difficult to consider consultation as a conflicting factor in translation, since it provides so much help in translation practice. In this case, the findings in driver behaviour studies can be extrapolated to explore whether consultation can be considered to be a conflicting factor in translation. Similar to a translation task with consultation, a driving task also involves various secondary tasks such as using a GPS system as a navigation aid, which requires attention to "be divided between the primary driving task and the secondary task" (Metz et al., 2011, p. 369). By examining eye movement data in simulation driving tests with secondary tasks, Metz et al. (2011) found that, if drivers allocated too much attention to the secondary tasks, they were more likely to be distracted from driving, since "the amount of attentional resources used for the driving task is reduced compared to undistracted driving" (p. 379). Studies on driving with secondary tasks report that the gaze repeatedly switched between the driving task and the secondary task (Sodhi et al., 2002; Wierwille, 1993) and more complex and visually more demanding tasks required more views (Dingus et al., 1989; Sodhi et al., 2002; Victor et al., 2005; Wierwille, 1993).

Few studies have been conducted on the cognitive aspect of consultation. By calculating the total amount of time allocated to translation drafting, translation revision, and digital resource consultation, Hvelplund (2017) studied the eye-tracking data collected from 18 professional translators using digital resources during translation, and concluded that a considerable proportion of attention (19.4%) was allocated to consultation, and consultation required higher cognitive load than translation drafting and revision. He also found that digital resource consultation accounts for a considerably larger proportion of the total translation task time in translating language for special purposes (LSP) texts compared to translating literary texts. He suggested that since "the translation of LSP texts, as a case in point, implies more frequent dictionary lookups to solve a higher number of terminological problems" (Hvelplund, 2017, p. 76), consultation when translating LSP texts is more complex than when translating literary texts, which leads to an increase in the proportion of attention allocated to digital resource consultation. In a later study, Hvelplund (2019) suggested that "translation is not exclusively linear with processing alternating between source and target texts but is instead characterized by re-reading, reading ahead, jumping back and forth inside the text, between source text and target text, consultation of external resources, etc" (p. 513). In order to explore how digital resources are integrated into the translation process, he distinguished four types of between-task transitions: drafting to digital resources, digital resources to drafting, revision to digital resources, and digital resources to revision, and calculated the number of each type of transition. Although these two studies consider the conflicting relationship between translating and consultation and explore consultation in translation from a new perspective, they do not provide enough empirical evidence regarding the effect of consultation on translation efficiency or the effect of different translation tasks on the cognitive efficiency of consultation.

Whyatt et al. (2021) used eye-tracking to measure the amount of temporal and cognitive resources allocated to the entire translation process and to the use of online resources in L1 and L2 translations. They reported the following findings:

> (1) searching for information adds more cognitive effort to the already demanding process of translation, and slightly more when the translators work into their L2; (2)

> professional translators experience more uncertainty when producing translation into their L2; (3) the majority of problems are of a linguistic nature and bilingual resources are most frequently used but significantly more in the L2 direction; (4) translators follow the least effort principle and single searches are most common irrespective of the direction; (5) skilful searching for information might have a positive effect on the quality of translated texts, including L2 translations (p. 168).

In addition, Gough (2016) focused on the use of online resources specifically by professional translators with at least 5 years' experience of working from English into other languages. Her study consisted of two stages: a large-scale web-based survey (N=540) and a screen-recorded translation task followed by post-task questionnaires (N=16). Her investigation of consultation in translation was also conducted from two aspects: consultation as a whole in the translation process and consultation in individual translation units. For consultation as a whole in the translation process, she focused on the nature and quantity of online resources used, and the time spent on online resources. For consultation in individual translation units, she focused on the different types of resources used, how they were used, and the time factors involved in using these resources. Her main contribution was the formulation of two taxonomies: the Resource Type User Taxonomy (RTUT) and the Typology of Translation Research Style (TTRS). Both taxonomies were used to categorise translators based on their preferences. The RTUT was based on their preferred type of online resources and consisted of four types of resource users:

> **The Dictionary Enthusiast** prefers to consult termino-lexicographic resources such as dictionaries, term banks or glossaries. It could be someone who uses a variety of different dictionaries, glossaries etc., but not necessarily very often or someone who uses just one dictionary, but very frequently. Dictionary Enthusiasts will often have their favourite resources bookmarked or otherwise organised for quick access. They will often initiate searches in their source language and because of the extensive use of the resources they know well, the preferred way of accessing them is bottom-up.

> **The Parallel Text Fan** is the opposite of the Dictionary Enthusiast. Their preferred modus operandi for accessing resources is via a keyword in a search engine, i.e. top-down, and they will often go several pages deep in their search. They will not normally have an organised system of resources and will often use the search engine to find them. T4, for example, typed a resource she had in mind into Google each time she wanted to access it. They will often perform extensive TT-oriented research and will do so using parallel texts in the form of web pages and online documents. T11, for example, used eighteen different websites to conduct the parallel text research not only to understand more about the subject but also to find equivalents.
>
> **The Mixed Type** shares the characteristics of both the Dictionary Enthusiast and the Parallel Text Fan and **the MT Adopter** can be any of these types who uses machine translation in their work (Gough, 2016, p. 191).

The TTRS was based on the consultation behaviours of 16 participants in the screen-recorded translation tasks. The TTRS consisted of five research styles: the Prolific Translator, the Explorer, the Methodical Translator, the Economical Translator, and the Understated Translator. According to Gough (2016), the Explorer spent the largest amount of time and effort on online consultation while the Prolific Translator also used a large volume of resources but somehow spent less time on them. As the opposite of the Explorer, the Economical Translator spent the minimal amount of time and effort on online consultation whereas the Understated Translator spent extended amounts of time on online consultation but with relatively low volume. Finally, in between these two kinds of translators was the Methodical translator who spent a moderate amount of time and effort on online consultation. Gough (2016) chose an interesting perspective to investigate consultation in translation. Instead of presenting the characteristics of consultation behaviours like the previous studies, she aimed to propose a categorisation of translators' idiosyncratic styles. In fact, the findings of Gough's (2016) study do not provide any direct suggestions for the present study, but they were taken from a large-scale global investigation, which is a different data collection method compared to the others used in the empirical studies. Moreover, although these two taxonomies were formed from the

data taken from professional translators, it was assumed that they could also be used to categorise translation students and provide more specific guidance for translation training in further studies.

To summarise, the review of the descriptive studies on consultation in translation influences the present study from two perspectives: the characteristics of consultation and the data collection methods.

In relation to the characteristics of consultation, previous studies have investigated five features of consultation: (1) consultation purpose, which refers to the type of translation problem encountered by translators; (2) the preference of resource type; (3) consultation formulation, which involves the details of the individual consultation behaviours, such as its complexity, the number of webpages involved, etc; (4) information evaluation, which concerns translators' perception and evaluation of consulted information; and (5) the allocation of cognitive resources, which includes both the allocation of attention and cognitive load. Among these five features, the investigation of the fifth feature is covered the least. Therefore, in aiming to cover these features, the present study takes a special interest in the cognitive aspect of consultation in translation.

Regarding the data collection methods, various data collection methods have been used in previous studies, including direct observation, recording sheets, questionnaires, screen-recording, TAPs, eye-tracking, and retrospective interviews. All these methods have some level of shortcoming, so a combination of different methods is ideal when investigating consultation in translation. The present study follows three standards when collecting data: to be consistent, complete, and non-intrusive. With these standards in mind, a combination of eye-tracking, screen-recording, and retrospective interview is considered to be the ideal data collection method for the present study. As the cognitive aspect of consultation in translation is the focus of the present study, eye-tracking is the most appropriate method to collect cognitive data. This data collection method has been extensively applied in the analysis of reading and translation process. For example, O'Brien (2006), who was one of the first researchers to use eye-tracking in translation process research, argued that eye-tracking is the link that has been firmly drawn between cognitive effort and eye movement. Jakobsen and Jensen (2008) used eye movement

metrics such as the duration and length of saccades and the duration of fixations. They found that eye fixations are affected by factors such as word familiarity, predictability, length, complexity, and ambiguity. However, the cognitive aspect is not the only feature of consultation that will be examined in the present study. The investigation of other observable features (such as the consultation formulation and the preference for online resource types) requires a different data collection approach. Screen-recording is believed to be the most suitable choice for two reasons. Firstly, it can capture any screen activity carried out on a computer. Secondly, it is not intrusive at all, as the screen-recorder only works "in the background and [is] invisible to the subject. They do not affect the translator's natural working environment, an important factor in maintaining the ecological validity of the data" (Asadi & Séguinot, 2005, p. 523). With the aim of evaluating the methodological validity of several data collection methods, Lauffer (2002) recorded the actual translation process with think-aloud, computer recordings, direct observation, audio and video recording, and retrospective interviews with and without computer playback of the translation processes. She noticed that both think-aloud and video recording could influence participants' behaviour as "the testing environment influences both motivation and the translation process no matter how comfortable the translators feel in their natural setting" (Lauffer, 2002, p. 65). However, screen-recording does not negatively influence ecological validity. Considering these two advantages of screen-recording, it was chosen to collect qualitative data on consultation in translation. The shared shortcoming of eye-tracking and screen-recording is that they do not reveal participants' subjective perception of consultation, such as their intention when carrying out consultation. Retrospective interview is proposed as a third data collection method. In concurrent verbal reports such as TAPs, information is verbalised while the participant is completing the task. In contrast, retrospective verbalisation requires the participant to produce the report after completing the task. This time delay could lead to a loss in the completeness of the information that is gathered. As Enríquez Raído (2014) pointed out:

> Depending on the time delay between the completion of the task and the retrospective verbalization, the latter will be regarded as more or less complete: the greater the delay

> (as in "delayed retrospection"), the more challenging the recall of information, and hence the lower the likelihood of obtaining a complete retrospective report. Conversely, the shorter the time delay is (as in "immediate retrospection"), the less fallible the retrieval of information and the higher the likelihood of obtaining a more complete verbal report. Memory, recognition, and retrieval of information are therefore key factors in retrospective verbalization. (p. 70)

This shortcoming was also observed and reported by Lauffer (2002), who found that in retrospective interviews, participants "gave more general descriptions rather than detailed step-by-step accounts of how they had worked something through" (p. 66). Immediate retrospection therefore seems to yield more reliable data than delayed retrospection. Considering this drawback of using retrospective interview, the interview will be guided by well-structured questions and only be used to collect participants' categorisation of individual translation problems and to evaluate whether the ST segmentation is correct. In conclusion, based on the review of the previous descriptive studies on consultation in translation, a combination of eye-tracking, screen-recording, and question-based retrospective interview is believed to be the most optimal data collection method for the present study.

3.2 Information Needs and Consultation

The second aspect of this review focuses on the correlations between information needs and consultation in translation. The information need is defined as "a state or process started when one perceives that there is a gap between the information and knowledge available to solve a problem and the actual solution of the problem" (Miranda & Tarapanoff, 2008, p. 2). Based on this definition, in the translation process, the information need is considered to be the need perceived by translators as they aim to complete the translation task. The term *task* might require further clarification. Wildemuth and Hughes (2005) suggested that "the person's information behaviors are situated within the context of some larger task or set of tasks" (p. 275). The larger task refers to the context in which information behaviours are embedded and

the set of tasks refers to "specific goals undertaken or the search tasks assigned to study participants" (Wildemuth & Hughes, 2005, p. 275). These two levels of tasks also exist in the translation process, with the larger task referring to translating the entire text while the specific task refers to translating individual segments. The difference between these two levels of tasks triggers different levels of information needs. Translating the entire text can be considered to be an information need that triggers a large-scale of consultation, while translating specific ST segments can also be considered to be information needs that lead to individual information-seeking behaviours. While these information-seeking behaviours are investigated as individual consultation tasks when translating specific segments, they also form the larger task of consultation when translating the whole text.

In previous studies, there is no clear terminological clarification for these two types of tasks in translation and the associated consultation behaviours. Enríquez Raído (2014) referred to the larger task of translating an entire text as the "embedding task", a notion taken from Pirolli and Card's (1999) theory of information foraging. She used this term to emphasise that translating the domain-specific texts is a task "in which a need for information emerges" (Hansen, 2005, p. 393). She named the ST segments that triggered the consultation of online resources as "information needs" and referred to the participants' search needs, search goals, search processes, and search outcomes embedded in solving the information needs as the "web search task". She also defined an integral part of web searching as "queries", which are the "expression of a searcher's information problem" (Spink & Jansen, 2004, p. 77). For example, the first query in a web search task is known as the initial query, while the following queries are known as subsequent queries. Enríquez Raído's (2014) classification method is systematic and covers all levels of translation tasks, but some of the terms that she used could be confusing. For example, she used "information needs" to refer to the ST segments. Since the present study uses the models of information-seeking behaviour to explain consultation behaviour, information needs mark the start of an information-seeking behaviour, but is not the task that triggers this behaviour. Shih (2019) focused on web search processes associated with specific Rich Points and did not explore the consultation in the larger task. She named the web search process associated with each of these Rich Points a "web search episode", which "commenced

with a query action associated with a particular Rich Point and ended with the searcher moving onto actions unrelated to the Rich Point (although occasionally, a searcher might move on and then decided to return to the same Rich Point" (Shih, 2019, p. 914). In addition, she used "query" to indicate the embedding web search actions within a web search episode. There are also studies that do not provide a specific term for these two tasks. For instance, Zheng (2014) simply used the term "consultations" to refer to both types of tasks.

The terminological clarification of the present study mainly follows Enríquez Raído's (2014) and Shih's (2019) studies with some adjustments. Two levels of tasks are involved in the present study: (1) translating the entire ST, which is referred to as the "holistic translation task"; and (2) translating individual ST segments, which is referred to as the "individual translation task". The naming of these two types of tasks is formulated to differentiate and emphasise their levels. In addition, three terms of consultation involved in the translation process need to be clarified. Firstly, the consultation for completing the holistic translation tasks is referred to as the "holistic consultation". It starts with the beginning of the translation task and ends with the termination of the translation process. It is worth mentioning that even though the observable part of the holistic consultation starts when the translators initiate a search, like opening a webpage, the part in which the translators perceive the information needs when they read the ST should be considered as an integral part of the holistic consultation. Secondly, the consultation for completing the individual translation tasks is referred to as the "web search task". The observable part of each task starts when the translator initiates an information-searching behaviour, such as opening a webpage or starting to type a query term, and ends when he/she leaves the webpage. Thirdly, the embedded information search action within the web search task is referred to as the "query". This refers to the information search action conducted on one single webpage with one query term. In general, in translating one ST, there would be one holistic consultation with multiple web search tasks. Each web search task contains at least one query.

Once these terms have been clarified, it is possible to review the previous studies on the effect of task attribute on consultation. Based on both theoretical and empirical findings from previous studies, Vakkari (1999) proposed a model illustrating the correlative elements of

information actions, including task complexity, problem structure, and prior knowledge. Among these three features, prior knowledge is the only feature concerned with the users, so the effect of this feature on consultation will be further illustrated and reviewed in section 3.3. In this section, the review of the existing studies on the investigation of the effect of task attribute on consultation is developed from the perspectives of the other two features: task complexity and problem structure. Table 5 presents the empirical studies that will be reviewed in this section. It is worth mentioning that not only will the empirical studies on consultation in translation be reviewed, but some studies about general information-seeking and web searching will also be included.

Table 5. Studies on the effect of task attribute on consultation

Author	Year	Task	Variable
Tushman	1978	General information task	Task complexity
Matthews et al.	1983	Web searching	Problem structure
Marchionini	1989	Web searching	Problem structure
Qiu	1993	Web searching	Problem structure
Byströml & Järvelin	1995	General information task	Task complexity
Shneiderman	1997	Web searching	Problem structure
Navarro-Prieto et al.	1999	Web searching	Problem structure
Vakkari	1999	General information task	Task complexity
White & Iivonen	2001	Web searching	Problem structure
Broder	2002	Web searching	Problem structure
Byströml	2002	General information task	Task complexity
Jeonghyun Kim	2006	Web searching	Task complexity
Lorigo et al.	2006	Web searching	Problem structure
Zhang	2012	Web searching	Problem structure
Enríquez Raído	2014	Translation	Task complexity Problem structure
Zheng	2014	Translation	Problem structure
Jaewon Kim et al.	2015	Web searching	Problem structure
Hvelplund	2017	Translation	Text type
Chen et al.	2020	Web searching	Task complexity

3.2.1 Task Complexity and Consultation

Task complexity, as “a central feature in determining [the task’s] performance and consequent

information needs" (Vakkari, 1999, p. 825), can be understood in various ways. In information-seeking research, it was usually associated with the predeterminability of, or uncertainty about, the task (Vakkari, 1998). In other words, task complexity is associated with the gap between users' internal knowledge and required information. As Vakkari (1999) pointed out:

> The more the actor knows about the dimensions of the task, the less complex it becomes, and the easier it is to accomplish. Thus, we can connect the degree of predeterminability of a task to the structuredness of the knowledge or conceptual space of the performer about the task. The structure of the conceptual space depends on a person's prior knowledge of the dimensions of the task. If there is a severe lack of knowledge about the task, we can say that the person is in a problematic situation and has an anomalous state of knowledge. (p. 826)

The concepts of "complexity" in Information Studies and Translation Studies are different. In Information Studies, complexity usually refers to "task complexity", which is defined as "resource requirements or other similar concepts in human information processing" (Liu & Li, 2006, p.554) and is influenced by various elements including receptivity, analysability, the number of alternative paths taken during task performance, and outcome novelty (Campbell, 1988; MacMullin & Taylor, 1984; March & Simon, 1967; Van de Ven & Ferry, 1980). However, in Translation Studies, Sun (2015) pointed out that although complexity is similar to difficulty, these two notions are not the same. According to Dahl (2004), difficulty is a notion that primarily applies to tasks, and is always relative to a person. Complexity, as an information-theoretic notion, is more objective in the sense of being independent of use and can be computed mathematically. It is usually used to define an intrinsic feature of the text and is connected to a measurable metric, such as the readability of the text. A more complex ST does not mean that translating it is more difficult. Translation difficulty can be affected by various factors including translation-specific difficulty and translator factors (Sun & Shreve, 2014). In order to unify these two concepts, in the present study, the notion of complexity in translation is considered to be the complexity of completing the translation task, which is partially reflected in the perceived translation difficulty.

Few studies investigate the effect of perceived translation difficulty on the consultation of external resources. Enríquez Raído (2014) compared the consultation behaviours of four translation students when translating two texts. She found that when translating the more difficult text, students conducted a significantly wider range of search behaviours and more diverse choice of initial search actions. However, she did not make a clear comparison between these two STs regarding their perceived translation difficulty. The more difficult ST was in fact shorter than the easier ST. Therefore, her results are only partially reliable when indicating the effect of perceived translation difficulty on consultation. Hvelplund (2017), on the other hand, investigated the effect of translation difficulty triggered by text type on consultation. He found that professional translators allocated a larger proportion of time to digital resources when translating LSP texts than when translating literary texts and argued that this is because LSP texts result in "more frequent dictionary lookups to solve a higher number of terminological problems" (p. 76). The fact that LSP texts contain more terminological problems could be one potential indicator that the text may be more difficult to translate, since word frequency is considered to be "a potential indicator of the internal lexical levels of complexity" (Jensen, 2009, p. 69). However, Hvelplund's (2017) study has the same shortcomings as Enríquez Raído's (2014): neither of them presents a reliable and systematic comparison between the perceived difficulty levels of the STs. Therefore, the findings from these two studies can only partially suggest that an increase in task complexity leads to more frequent web search tasks.

Since only a limited amount of research in Translation Studies have been conducted on this topic, some of the relevant studies in Information Science are reviewed. For example, Tushman (1978) asked the participants to complete four types of information tasks (from technical service as the least complex task to basic research as the most complex task), and found that the participants conducted oral communication to exchange information more frequently in research projects than in technical services projects. Adopting the concept of a prior determinability to characterise complexity, Byströml and Järvelin (1995) proposed a framework for classifying tasks according to the level of task complexity as ranging from automatic information processing tasks to genuine decision tasks. They found that as task complexity increased, the successfulness of information seeking decreased, and the number of

sources used by the participants increased. In a later study, Byström (2002) further summarised two statements regarding the effect of task complexity on information behaviours: (1) the more complex a task was perceived to be, the more probable the acquisition of multiple information types was; and (2) an increase in task complexity lead to more interpersonal communications as a type of information resource. Focusing on web searching, Jeonghyun Kim (2006) investigated the effect of perceived task difficulty on three types of web searching tasks (factual, interpretive, and exploratory). She found that in both factual and exploratory tasks, the perceived task difficulty significantly correlated with the number of viewed webpages and the number of query reformulations, and a significant correlation was also reported between task difficulty and the length of time spent on factual tasks only. Taking task complexity as one variable among others (including space-time limitation and the use of search devices), Chen et al. (2020) observed the search behaviours conducted by 200 participants and reported a significantly positive correlation between task complexity and the length of time spent on web searching.

To summarise, the previous studies report a consistent result that there is a significant correlation between task complexity and information behaviours. These studies prove that an increase in task complexity leads to a higher need for information, which is revealed by a larger amount of time spent on consultation and a larger number of webpages being visited. However, these studies are mostly conducted on general information-seeking behaviours and the investigation into the correlation between perceived translation difficulty and consultation in translation remains unclear.

3.2.2 Problem Structure and Consultation

Problem structure is usually defined by the type of problems. Generally, a structured problem means that the variables involved and their relationships are well known while an unstructured problem means that they are unknown or vaguely correlated with each other (Partridge & Hussain, 1995). In the translation process involving consultation, the problem structure is determined by the types of translation problems that trigger the consultation. The categorisation

of translation problem type is not consistent across different empirical studies of consultation in translation. For example, Zheng (2014) referred to the translators' intention when consulting sources as the consultation aim, which was divided into three categories: (1) discovering meaning, i.e., the subject exhibited ignorance of the word or phrase, and searched for its meaning by consulting sources; (2) verifying meaning, i.e., the subject exhibited a hesitant attitude towards his/her initial understanding of the word or phrase, and verified it by consulting sources; and (3) optimising expression, i.e., the subject exhibited a correct understanding of the word or phrase, and searched for extra optimised expressions or appropriate collocations to fit the particular context. Since the predominant research topic of Zheng's (2014) study was the correlation between translators' experience and consultation, he did not investigate the effect of consultation aim on the use of external resources, but his categorisation is an inspiration for the present study, in that the translation problem structure should be defined from the perspective of consultation purpose rather than the intrinsic characteristics of the ST segments. A similar categorisation was also applied by Enríquez Raído (2014), who defined three types of information goals: ST comprehension, TT production, and the combination. She argued that information goals determine the types of information sources that need to be consulted. For instance, the consultation for ST comprehension problems usually involves searching for definitions and translation equivalents, which tends to yield closed questions with clear answers. The consultation for TT production or the combination types of translation problems usually involves the contextual meaning, phraseological information, or thematic information, which could lead to open questions that require the combined use of multiple information resources to find satisfactory answers. Enríquez Raído's (2014) did not find noteworthy correlation between information goals and the participants' search actions. A possible reason for this shortcoming was that she only recruited six participants, which is a relatively small number to summarise any reliable and systematic findings.

Since the existing empirical studies do not provide clear results about the effect of problem type on consultation in the translation process, the relevant studies in web searching research are reviewed for further inspiration. Several taxonomies have been proposed for "classifying task types, users' types of information needs, or users' goals in information searches" (Aula,

2005, p. 29). They can be generally divided into two types: two-dimensional categorisation and multi-dimensional categorisation. For the former type, these taxonomies tend to distinguish between closed questions that yield fact-finding searches with a specific answer and open questions that yield exploratory answers or subject searches. In a series of studies on users' information-seeking behaviours with online catalogues, Matthews et al. (1983) categorised search tasks into known-item search and subject search. This two-dimensional categorisation is widely accepted as a foundation for further development of web searching taxonomies and future investigation of the effect of problem type on web searching behaviours. For instance, Marchionini (1989) investigated elementary students' information search behaviour in a full-text online system with a "closed" task, which required students to find a fact, and an "open" task, which required students to find information about women who have travelled in space. Although he did not use the same terms, these two types of tasks in his study shared the characteristics of the known-item search and subject search proposed by Matthews et al. (1983). He found that the students needed to spend more time and conducted a higher number of actions and look-ups for the open task than for the closed task. Qiu (1993) investigated the effect of task type on search strategies in a hypertext information system with two types of tasks: general and specific tasks. For the general search task, users searched for general information about a broad topic; while for the specific search task, users sought more specific information that was known to exist. She found that the general task led to the frequent use of browsing, whereas the specific task led to the frequent use of analytical search strategies. With a focus on using a specific online resource, Zhang (2012) investigated how 38 undergraduate students used MedlinePlus, which was an information-rich web space providing consumer health information to the general public. She divided the participants into two groups, with one group completing simple tasks (well-defined questions with answers that could be easily found) and the other group completing complex tasks (open-ended questions). Her findings can be summarised as follows. Firstly, the simple task group developed a practical view, thinking of MedlinePlus as a place for seeking medical help; whereas the complex task group viewed the system from a more educational point of view, thinking of the system as a good educational site that can support research. Secondly, in representing information types, the simple task group perceived

information types that provide factual information useful for completing the simple tasks, such as fact sheets and what-to-do articles, whereas the complex task group represented information types that provide more in-depth information that was required by the complex tasks, such as scholarly articles and clinical trials. Similarly, in representing the presentations of information, the simple task group perceived more presentation forms that were likely to contain factual information, such as summaries and figures. Thirdly, the simple task group focused on the general behaviour of the system, such as pop-up windows, but the complex task group focused more on specific instances, such as ‘‘some links did not work’’ and ‘‘the search function tends to bring up several links to the same article” (Zhang, 2012, p. 117).

Some other researchers found that the two-dimensional taxonomy of web searching tasks is too broad, so they proposed more detailed categorisations and investigated the effect of problem type on web searching behaviours. With the aim of improving how websites are designed, Shneiderman (1997) varied the search tasks from specific fact-finding to more unstructured open-ended browsing of known databases and the exploration of availability of information on a topic. His categorisation included four items: specific fact-finding (known item search, i.e., find the phone number of Bill Clinton), extended fact-finding (i.e., find the kinds of music published by Sony), open-ended browsing (i.e., discover whether there is a relationship between carbon monoxide levels and desertification), and exploration of availability (i.e., discover whether NASA data sets can show acid rain damage to soy crops). Another avenue of improving the taxonomy proposed by Matthews et al. (1983) was to add a new perspective. For example, based on Shneiderman's (1997) study, Navarro-Prieto et al. (1999) combined information structure into the categorisation of web searching task types and defined four types of tasks: (1) specific fact-finding tasks with a dispersed searching condition (such as looking for data base algorithm in Java), (2) specific fact-finding tasks with a categorical searching condition (such as looking for the definition of a word), (3) exploratory tasks with a dispersed searching condition (such as finding all the available jobs for a profession), and (4) exploratory tasks with a categorical searching condition (such as finding all the information about the 1997 Nobel Prize for Literature). Similarly, White and Iivonen (2001) added the categorisation of information sources as another dimension of web searching

task categorisation. They divided web searching tasks into tasks with “open” or “closed” questions using “predictable” or “unpredictable” sources and investigated the effect of task type on search strategies. They found that participants relied most heavily on search engines. For both open and closed tasks with unpredictable sources, participants used search engines in most cases. Directories were the second most used sources for both open/unpredictable and closed/unpredictable questions, but the use of directories was more pronounced for the open/unpredictable questions. For the questions with predictable sources, the preferred strategy was direct address. If the questions were open, the next preferred option was to go to a search engine. If the questions were closed, participants’ preference towards directories and search engines was almost the same. The open and closed characteristics of tasks seemed to have less effect on the choice of strategy than the predictable/unpredictable source variable.

Another type of web searching taxonomy was based on users’ intention. With the data from questionnaires and log data from a search engine, Broder (2002) categorised web searching tasks into three types: navigational (with a view to finding a particular website), informational (with a view to acquiring some information), and transactional (with a view to performing a web-mediated activity). Navigational search refers to the immediate search to reach a particular site, such as searching for the name of a particular website in the search engine. This type of web search is usually used to answer a closed question with only one correct result. Informational search refers to finding information that the user assumes is available. It can be used to answer an extremely wide range of queries, including answering a closed question or collecting general information about a certain topic. Transactional search is used when the query requires the user to reach a site where further interaction will happen, such as shopping, finding various web-mediated services, downloading various types of files, accessing certain databases, finding servers, etc. This categorisation is widely accepted and used in various studies on the effect of task type on web searching behaviours. For instance, Lorigo et al. (2006) used task type and gender as two independent variables in the investigation of web searching. They found that compared with navigational tasks, informational searches took more effort and time on average, and required higher cognitive load, which was indicated by an increase in pupil dilation. Kim et al. (2015) also adopted two task types, informational

and navigational, to investigate the influence of task type on web searching behaviours on both large and small screens. They reported significant correlations between task type and several variables, including search speed, search accuracy, the number of visited pages, and fixation duration. Participants tended to take more time, visited more webpages, allocated higher cognitive load, and were more likely to fail in informational searches than navigational searches.

In summary, the review in this section has two purposes. The first purpose is that the previous studies are reviewed in order to inform how the present study should categorise the translation problem types. On the one hand, the existing studies on consultation in translation tend to categorise the translation problem types based on the consultation intentions. On the other hand, the existing studies on web searching propose two types of taxonomies, with one dividing web searching tasks into open and closed tasks and the other dividing them into navigational, informational, and transactional tasks. The former type of categorisation is based on the inquiry typology. It is considered to be more suitable for individual web searching tasks in translation, since the initial step in these tasks is the perception of information needs. The latter type is developed based on how Internet users consult the online information sources, so it is more suitable for individual queries that only contain information searching behaviours.

The first correlation investigated in the present study is between information needs and consultation. According to the models of information-seeking behaviours reviewed in Chapter 2, information needs are determined by inquiry types, which are defined in relation to the structure of translation problems. As illustrated in section 2.3, from the perspective of considering translation as a problem-solving process, the categorisation of translation problem type proposed by Angelone (2010) is considered the most suitable for the present study. It divides translation problems into three types (referred to as Type 1, Type 2, and Type 3 in this thesis): (1) source language comprehension problem, (2) source language-target language transfer of meaning problem, and (3) target language text production problem. The information required for these three types of translation problems is different. For example, for Type 1 problems, consultation involves looking for a specific answer, such as definitions in dictionaries. In this case, this type of problem can be categorised into specific fact-finding tasks. Table 6 presents the two-fold categorisation of translation problem types.

Table 6. Categorisation of three types of translation problems

	Definition	**Information task type**
Type 1	Comprehension of the source language	Specific fact-finding task
Type 2	Production of satisfactory equivalence	Extended fact-finding task
Type 3	Production of target language	Exploratory task

Another purpose of this review is to summarise the existing findings on the effect of problem structure on consultation. Generally, it is found that compared to fact-finding tasks, exploratory tasks require longer searches, more visits to webpages, greater cognitive load, and more diverse web searching strategies. Since the existing studies on consultation in translation do not manage to provide sufficient findings on the effect of translation problem type on consultation, this issue is considered to be an existing research gap and will be investigated using empirical methods in the present study.

3.3 User Attributes and Consultation

When considering the consultation of online information in translation as a type of information-seeking behaviour, translators can be thought of as information users. The effect of user attributes on consultation is investigated by comparing the difference across different groups of translators. In his theoretical analysis of the acquisition of translation competence, Chesterman (1997) applied Dreyfus and Dreyfus' (1986) skill acquisition model, which includes five stages: novice, advanced beginners, competent, proficient, and expert. However, due to practical time restrictions, the difficulty of recruiting participants, and the need for in-depth investigation, the existing empirical studies rarely cover all five stages. Instead, most of these studies divide participants into two or three categories. The studies that divide participants into two categories mainly compare the difference between translators with or without professional experience (Englund-Dimitrova & Jonasson, 1999; Jääskeläinen, 1989a, 1989b; Jensen, 1999; Olalla-Soler, 2019; PACTE, 2009), while the studies that divide participants into three categories mainly consist of translators without neither training nor professional experience, with only training experience, and with professional experience (R. Kim, 2006; Zheng, 2014). Table 7 presents a list of studies reviewed in this section.

Table 7. Studies on the effect of user attribute on consultation

Author(s)	Year	Participants
Jääskeläinen	1989a, 1989b	Language learners and translation students
Jensen	1999	Translation students and professional translators
Englund-Dimitrova & Jonasson	1999	Translation students and professional translators
Navarro-Prieto et al.	1999	Novice and experienced information users
H. Kim	2006	Language learners, translation students, and professional translators
R. Kim	2006	Language learners, translation students, and professional translators
Desjarlais & Willoughby	2007	Students with different background
PACTE	2009	Professional translators and foreign-language teachers
Massey & Ehrensberger-Dow	2011	Students (beginners, advanced students, recent graduates) and professionals
Enríquez Raído	2014	Postgraduate translation students, a PhD student, and a translation lecturer
Zheng	2014	Novice translators, semi-professional translators, and professional translators
Hvelplund	2016	Translation students and professional translators
Olalla-Soler	2019	Translation students and professional translators

Based on the research results from Krings' (1986) and a series of other experiments, Jääskeläinen (1989a, 1989b) compared the difference in the use of reference materials by foreign language learners and translation students. In contrast to Krings' (1986) study, Jääskeläinen (1989a, 1989b) changed the research design by providing several monolingual and bilingual dictionaries and other reference materials to the participants instead of asking them to bring their own like Krings did. A noteworthy improvement in her study is that she analysed participants' consultations "according to the individual items that were looked up in a dictionary etc." (Jääskeläinen, 1989b, p. 187). By analysing the consultation in a word/phrase-wise method, she managed to provide a specific comparison between foreign language learners and translation students, and to obtain three main findings. Firstly, inexperienced translators looked up items in dictionaries more frequently than experienced translators, while the latter group of translators tended "not to trust just one source, but to check the given information in

other sources, too" (Jääskeläinen, 1989b, p. 188). Secondly, inexperienced translators preferred to use bilingual dictionaries as their primary source of consultation, while experienced translators showed a higher preference towards monolingual dictionaries. Thirdly, experienced translators did not like to use bilingual dictionaries for solving comprehension problems and were highly cautious in using them for solving production problems. This characteristic was especially obvious in one participant, who rejected the target language equivalent that she found during consultation, even when she "had no alternative for the equivalents offered by the bilingual dictionary" (Jääskeläinen, 1989b, p. 192). These three findings set a solid foundation for further studies as they cover three aspects of consultation in translation: (1) translators' reliance on consultation, (2) translators' preference of resource types, and (3) translators' preferred consultation strategies. The following review will also be developed from these three aspects.

The first finding of Jääskeläinen (1989a, 1989b), which reveals that inexperienced translators have a greater reliance on external consultation than experienced translators, is confirmed in other studies. In Jensen's (1999) study of the effect of time pressure on translation quality, she reported a similar finding that inexperienced translators consulted external resources more frequently than experienced translators. She suggested that the use of dictionaries "decreased with increased experience, and when comparing the young professionals with the expert group we find that the experts had only half as many dictionary look-ups as the young professionals" (Jensen, 1999, p. 113). Based on a think-aloud study investigating the use of dictionaries, encyclopaedias and other general reference material by professional translators and translation students, Englund-Dimitrova and Jonasson (1999) also reported that professional translators consulted external references less frequently than translation students.

Instead of comparing the difference between professional translators and translation students as previous studies did, PACTE (2009) investigated the effect of translators' experience on translation process with 35 professional translators and 24 foreign-language teachers, who had no experience in translating but at least five years' experience in teaching foreign languages. Their investigation mainly explored the consultation strategies used by the participants. These

strategies were organised into five types depending on the sequences of actions: Internal Support (producing the solution with no consultation), Predominantly Internal Support (producing the solution without consulting bilingual resources), Predominantly External Support (producing the solution with any combination of consultations that includes consultations of bilingual resources from which the variant offered is adopted in translation), and External Support (producing the solution exclusively based on the consultation of bilingual resources). They found that Internal Support was more characteristic of teachers and Predominantly Internal Support was more characteristic of translators and indicated that the instrumental competence should be considered a further characteristic of expertise in translation. Using TAPs and retrospective interviews, Zheng (2014) collected consultation process data from six novice translators (with limited translation training or working experience), six semi-professional translators (postgraduates in a Translation Studies programme with no professional translation experience), and six professional translators (with more than four years' full-time translation experience). He used the same classification of consultation strategies and reported a similar finding that the reliance on external consultation was inversely proportional to a translator's experience.

In order to examine the use of extralinguistic knowledge in translation, R. Kim (2006) recruited five professional translators, 11 translation students, and 21 language learners to translate a financial news article from English (L2) to Korean (L1). She asked the participants to take the text home and use whatever resources were available with no time limit. R. Kim (2006) reported a major difference across the three groups of translators based on the data collected from the second section of the experiment: competent translators, including the professional translator and the translation student, tended to use the strategy of inferencing in addition to a dictionary search to justify an efficient and successful translation, while the language learner had a strong tendency to use a dictionary whenever possible. She found that the language learner had an excessive reliance on the external resources because of a lack of self-confidence and suggested that "teachers need to help students refrain from using dictionaries too much and move their focus toward developing strategies for extracting and assessing meaning and finding and selecting an appropriate target rendering" (R. Kim, 2006, p.

297). Similar to R. Kim (2006), Olalla-Soler (2019) developed an investigation into the effect of translators' experience on consultation with a specific focus on translating cultural translation problems. He analysed the screen-recording data of 12 first-year, eight second-year, nine third-year, nine fourth-year students, and 10 professional translators who translated a cultural text. He summarised the following findings: (1) translators with more experience showed a lower tendency to use external cultural resources to solve cultural translation problems regardless of the level of internalised source-culture knowledge; and (2) despite the possibility of allocating greater cognitive load to the task, students tended to favour the use of information-seeking strategies that provided equivalents in the target language. He argued that this was possibly because they did not trust their internalise source-culture knowledge and considered it safer to look for the necessary knowledge in external resources.

The studies investigating the effect of user attribute on translators' reliance on consultation propose a consistent finding that translators with more experience have a lower reliance on external consultation. However, the studies on the second aspect, which is translators' resource type preference, present controversial results. Based on a think-aloud study investigating the use of dictionaries, encyclopaedias and other general reference material by professional translators and translation students, Englund-Dimitrova and Jonasson (1999) found that professional translators preferred to use monolingual dictionaries than bilingual dictionaries. They argued that professional translators "have formed quite firm opinions as to which dictionary will serve them best in solving a given problem" (p. 22) and thus were not confident about the results yielded from bilingual dictionaries. Translation students, due to a lack of dictionary using experience, showed a greater reliance on bilingual dictionaries. Contrary to Jääskeläinen's (1989a, 1989b) and Englund-Dimitrova and Jonasson's (1999) finding that professional translators prefer to use monolingual dictionaries over bilingual dictionaries, Zheng (2014) did not record this preference in his study. He divided the resources into six types: bilingual software dictionary, monolingual software dictionary, bilingual hardcopy dictionary, monolingual hardcopy dictionary, Internet reference, and paper reference. In his study, the percentage of monolingual dictionary consultations was very low for all participants, and professional translators showed no specific preference for monolingual dictionaries over

bilingual dictionaries. Gough (2016) did not investigate the effect of translators' experience on the consultation of online resources, but she reported the frequency of resource types used by professional translators, with 28 and 152 instances of consulting monolingual dictionaries and bilingual dictionaries respectively. Her result partially supports Zheng's (2014) finding that professional translators do not have a preference towards monolingual dictionaries. Noting this contradictory finding, Zheng (2014) argued that:

> consultation methods are related to multiple factors such as text style, time pressure and personal preferences. For example, in literary works, words or phrases often have associative meanings in addition to their general meaning, and monolingual dictionaries can provide translators not only with complete and detailed definitions of each but also authentic examples of sentences in which they occur. This can be very helpful in ST comprehension and in the clarification of ambiguity. Technical texts, however, are comparatively more straightforward to translate, since their contents are of universal application rather than culture-specific, and the lexis used includes exact equivalents. Although subject knowledge is of course more important in this area, what translators generally need when consulting dictionaries is to be able to find the equivalent expressions for specialist terms. In such cases, bilingual dictionaries in the required specialist field are more helpful to translators. Time pressure also affects the choice of consultation methods. Although time was not strictly limited in the present research, most subjects mentioned in their interview that they preferred to complete translation tasks within the reference time indicated. Therefore [software dictionaries] (especially bilingual ones) were used by most subjects as the fastest and easiest consultation method (pp.124-125).

Apart from these two possible factors, the fact that external resources, especially online resources, are easier to access by translators might be another reason for this finding. Jääskeläinen (1989a, 1989b) suggested that professional translators are more familiar with bilingual dictionaries than translation students. However, this might not be the case now. At the present time, translation students use online bilingual dictionaries constantly in translation and

language learning. Therefore, students may be as familiar with these resources as professional translators. The findings from these studies show that the resource type preference across translators with different experience levels still requires further investigation. It is also worth mentioning that Jääskeläinen's (1989a, 1989b) study only used printed dictionaries. As Varantola (1998) argued, although dictionaries are not the most appropriate information source for translators, it is difficult for translators to find other types of external resources with ready and systematic linguistic information. However, with new emerging technologies, dictionaries are not the only type of resource used by translators. Other types of resources include online encyclopaedias, parallel texts, search engines, terminology databases, and online documents.

The third aspect of research focusing on the effect of translation experience on consultation is the aim of the consultation, which refers to the translator's intention when consulting resources. Enríquez Raído (2014) categorised the consultation aims (which were referred to as information goals in her study) into comprehension, production, and both. She found that translation students primarily reported search needs requiring information in relation to ST comprehension while translators with more experience (a PhD student and a translation lecturer) placed more emphasis on target-text production goals. Zheng (2014) classified the consultation aims of participants in his study under three headings: (1) discovering meaning, which was defined as the subject exhibiting ignorance of a word or phrase, and searching for its meaning using external sources; (2) verifying meaning, which referred to the subject exhibiting a hesitant attitude towards his/her initial understanding of a word or phrase, and verifying it by consulting sources; and (3) optimising expression, which referred to the subject exhibiting a correct understanding of a word or phrase, and searching for additional optimised expressions or appropriate collocations to fit the particular context. He found that the percentage of consultations that were performed to discover meaning decreased significantly with higher levels of translation proficiency while the percentage of consultations that were performed to optimise expressions increased greatly with higher levels of translation proficiency.

Another aspect of the investigation on the effect of translators' experience on consultation is to ascertain if different translators come up with different results. Massey and Ehrensberger-Dow (2011) explored the performance of different groups of translators with various levels of

experience when they translated "certain source text (ST) segments containing translation problems" (p. 205). Their findings could be summarised as follows. Firstly, most of the beginners researched the terms but only one-third were successful. Secondly, all the advanced students researched the term and most of them performed very quickly and successfully, although one (unsuccessfully) referred to online bilingual dictionaries rather than the resources that the other students accessed by using Internet search engines. Thirdly, all the recent graduates researched the term and came up with a successful solution. In relation to this finding, Massey and Ehrensberger-Dow (2011) noted that:

> We had hoped for a higher research and success rate as students gain experience, and that is exactly what we found. What we did not expect was that the advanced students and recent graduates would be faster and more successful than the professionals. (p. 205)

They offered four possible explanations for their results. Firstly, as the professional translators were working into their L1, they suspected that these professionals "[might] have been overly confident, whereas the students might have been cautious because they were translating into their second language" (Massey & Ehrensberger-Dow, 2011, pp. 205-206). Secondly, the fact that the professionals were not translating in their customary workplaces might have affected the ecological validity of the study. Thirdly, both the student and novice translators were younger than the professionals, so they might be generally more media-competent. Fourthly, training experience could be an influential factor since "the students and recent graduates had all participated in a course in research techniques as part of their under-graduate program and were accustomed to using Internet resources as part of their translation course demands" (Massey & Ehrensberger-Dow, 2011, p. 206).

Apart from translation experience, translators' domain knowledge is also considered to be an influential factor on their consultation behaviours. The existing studies found that translators with subject knowledge of the ST produce better translation products. R. Kim (2006) reported that translators with similar experience obtain better translation results if they have more subject knowledge than the other translators. H. Kim (2006) divided translation students into two equal

groups. One group was asked to collect background information before translating while the other group was not. She reported that the students from the first group produced significantly better TTs. Besides, she found that only the quality of background information, but not the quantity, significantly improved the translation quality. However, the experimental design of her study had two major limitations. First, the participants were required by the researcher, not out of their personal needs, to consult external resources. Second, it is not an accurate method to calculate the quantity of background information by counting the word number. These two limitations can be avoided by providing participants an autonomous translation environment and using the amount of attention to measure the quantity of extralinguistic information consulted in the task.

In conclusion, the existing studies on the effect of translators' attribute on consultation cover two research avenues: their translation experience and their domain knowledge. Regarding the first avenue, four major findings are reported: firstly, the studies on translators' reliance on consultation reveal a consistent finding that translators with more experience rely less on consultation; secondly, the investigation into translators' preferences concerning resource types does not reveal consistent findings, with Jääskeläinen (1989a, 1989b) reporting that the professional translators preferred to use monolingual dictionaries over bilingual dictionaries but Zheng (2014) and Gough (2016) reported no such observation; thirdly, the studies on translators' consultation aim report that translators with less experience tend to consult lexical information to solve comprehension problems, while experienced translators are inclined to use external information to optimise the TL solutions; and fourthly, the investigation into the effect of translators' experience on their consultation results shows that only translation training experience, but not translation work experience, improves translators' consultation success rate. Regarding the second research avenue, the studies confirm that translators with domain knowledge produce better translation quality than translators who do not have domain knowledge. However, due to the methodological limitations in the existing studies, they have not provided reliable findings on which aspect of domain knowledge benefits the production of translation products.

In addition to these research topics on the effect of user attribute on consultation, the

cognitive aspect should also be taken into consideration. For example, although it was proven that professional translators rely less on external resources, this finding was observed on the basis of the frequency of consultations and would be more reliable with cognitive data collected from empirical studies. However, there have not been any studies conducted to compare the effect of translation experience on the allocation of cognitive resources on consultation. Hvelplund's (2016) study reported significant differences in cognitive efficiency between experienced and less experienced translators in the translation process: experienced translators allocated cognitive resources more flexibly than less experienced translators and they engaged in automated translation processing to a greater extent than those with less translation experience. The findings from his study show that translators' experience is an influential factor in allocating cognitive resources in translation, which suggests that it might also be an influential factor in allocating cognitive resources during consultation.

In the literature on web searching, the effect of user attributes has been widely explored not only from the perspective of users' experience but also from the perspective of users' domain knowledge. In relation to users' experience, it is a common phenomenon to equate search experience with search expertise in the study of web searching (Aula, 2005; Lazonder et al., 2000; Palmquist & Kim, 2000). These studies found that web users with more experience tended to be more sophisticated than the novices. As Aula (2005) pointed out:

> experts use longer and more complex queries, are better aware of the features of the system they are using, and sometimes employ imaginative strategies for searching. Novices, on the other hand, are known to have several misconceptions as to how search engines work. They believe that the authors of Web pages need to register their pages with search engines, they believe that search engines can extract semantic meaning from the pages, they use natural language in their queries, they try to express several searches at the same time, and they over-or under- specify their search requests. In their search performance, these misconceptions typically result in longer task completion times, a smaller number of tasks being completed and less efficient search strategies (pp. 25-26).

In order to identify the variables involving in the web searching process, Navarro-Prieto et al. (1999) defined two different task scenarios: the specific fact-finding task (e.g., to look for database algorithms in Java) and the exploratory task (e.g., to find all the available jobs for a specific profession). They also identified two different web searching scenarios: the information is dispersed throughout the Web (e.g., to find all the information available about the 1997 Nobel Prize for Literature) and the information is structured in categories (e.g., to look for definitions of several words). Based on a combination of these two task scenarios and these two web searching scenarios, Navarro-Prieto et al. (1999) proposed four web searching tasks and identified three web searching strategies: (1) top-down strategy, which is when users search in a general area and then narrow down their search from the links provided until they find what they are looking for; (2) bottom-up strategy, which is when users look for a specific keyword that they are provided with in the instructions; and (3) mixed strategy, which refers to a parallel use of both strategies. They reported several observations concerning the effect of users' experience on their web searching strategies in different tasks. Firstly, in the specific fact-finding task with information in a dispersed structure, experienced users developed a plan about how they were going to search and were flexible in choosing the more successful strategy while novice users started with general queries and gradually narrowed down their searches. Secondly, in the exploratory task with information in a dispersed structure, experienced users conducted more complex and diverse searching behaviours in a more structured way than novice users. Thirdly, in both the specific fact-finding task and exploratory task with structured information, the effect of users' experience was not significant. These results suggest that the difference between experienced and inexperienced users is especially significant when searching with dispersed information. In the case of consultation in translation, when translators are searching for more than lexical information, they are faced with a wide range of online information from various kinds of resources, which is a searching condition with dispersed information. Based on the findings summarised by Navarro-Prieto et al. (1999), it is assumed that consultation strategies will also be affected by translators' experience.

In addition to web searching experience, domain knowledge (or subject expertise) was also proven to have an impact on web searching. Foltz (1996) argued that domain knowledge

is critical to comprehension, especially when dealing with hypertext as opposed to linear text. Aula (2005) also confirmed this argument by stating that “domain experts have been claimed to plan their search beforehand, to use more sophisticated queries, and to be more efficient and effective in performing search tasks” (p. 26). In their empirical study, Desjarlais and Willoughby (2007) asked students with different educational backgrounds to search for information on different topics online and found students who had a rich knowledge base performed significantly better, used more efficient and elaborate processes, and had a better memory for new information.

In conclusion, existing studies on both consultation in translation and general web searching behaviours have proven that user attributes, including users’ experience and users’ domain knowledge, are both influential factors in information-seeking behaviours. It is found that users with more experience tend to conduct more complex and structured information-seeking behaviours than inexperienced users and this difference is more significant in searching tasks with dispersed information.

3.4 Consultation and Translation Solution

Information use behaviour is defined as “the physical and mental acts involved in incorporating the information found into the person's existing knowledge base” (Wilson, 2000a, p. 50). During translation process, information use behaviour refers to the production of translation products with the support of both internal knowledge and the results of external consultation. A list of the studies that are reviewed in this section is presented in Table 8.

Table 8. Studies on the effect of consultation on information use

Author(s)	Year	Variables
Laukkanen	1996	With or without consultation
Dancette	1997	Consultation frequency
Livbjerg & Mees	1999	With or without consultation
House	2000	With or without consultation
Livbjerg & Mees	2003	With or without consultation
H.Kim	2006	Consultation quantity Consultation quality
Daems et al.	2016	Consultation length

The effect of consultation on the production of translation solutions is mainly investigated from two perspectives: efficiency and effectiveness. In relation to efficiency, Laukkanen (1996) was one of the earliest translation process researchers who compared translation processes with and without the use of reference materials. She collected the translation process data from two first-year and two fourth-year translation students to investigate whether dictionary use would slow down the translation process, have a certain restrictive effect on a translator's creativity, or result in poor translation quality. Like Krings (1986), Laukkanen (1996) also asked her participants to bring along their own reference materials. This is considered to be a drawback in her research design, because the participants, who were translation students, had a limited familiarity with the reference materials that could be helpful and did not bring adequate materials. She found that the experienced translators' translation processes and creativity were not largely affected by accessing reference materials, but the inexperienced translators' preliminary processing were omitted since they had a greater reliance on dictionaries. In addition, her original hypothesis that the use of reference materials would slow down translation processes and restrict translators' creativity was supported in the case of the fourth-year students. She suggested that these students had a "mistrustful" attitude towards reference materials and tended to spend too much time checking and crosschecking these materials (Laukkanen, 1996, p. 71). Based on these findings, she suggested that translation students "might be able to develop a more effective translation process by relying more on creativity and the context rather than on reference material" (Laukkanen, 1996, p. 71). Her findings were somewhat akin to those obtained by House (2000), who carried out two think-aloud experiments on the use of

reference materials with 10 advanced translation students. These students were only allowed to use reference materials in the first experiment but not in the second experiment. By comparing the process data collected from two experiments, he yielded a number of significant findings. Firstly, he distinguished two groups of participants based on their consultation patterns: high-risk-takers, who were confident in their own translation capabilities with and without access to reference material, and low-risk-takers, who seemed to "intensely miss the 'islands of reliability' (Dechert, 1983) provided by the possibility of using a dictionary or a grammar" (House, 2000, p. 155). Secondly, he found that when translating without the help of reference materials, although all participants felt insecure, they displayed more confidence in their own translation abilities "because they were free to creatively delve into their competence reservoir" (House, 2000, p. 155). This finding is consistent with Laukkanen's (1996) finding that accessing reference materials affects translators' confidence towards their own translation competence and might negatively influence their creativity. Livbjerg and Mees (2003) also reported that the use of external resources would slow down the translation process. They compared the average time spent on the same translation assignment by students who had access to dictionaries and students who did not. They found that the students who had access to dictionaries spent a larger amount of time on the assignment compared to the students who did not have access to dictionaries (80 m. compared to 54 m.).

Regarding the effect of consultation on translation effectiveness, Dancette (1997) examined the translation process of three postgraduate translation students and counted the frequencies that each participant used the reference materials. She found that "the number of consultations does not correlate with the quality of the translation" (p. 101). Livbjerg and Mees (1999) designed a TAP experiment to investigate the influence of dictionary use on the quality of L2 translations produced by five postgraduate translation students and reported a similar finding. They divided the experiment into two sessions: in the first session, students were asked to translate a non-domain-specific text into their L2 without any external consultation; and in the second session, they were asked to revise and correct their translations with the help of reference materials (including one usage book, one monolingual dictionary, and one bilingual dictionary). Translation quality was assessed at three points in the process: (1) the first

spontaneous solution, which was produced without any external consultation; (2) the solution produced at the end of the first session; and (3) the solution revised with the help of external resources. They found that after external consultation, a large proportion of translation solutions (74.3%) was retained, and a much smaller proportion of solutions (12.2%) was revised. Furthermore, an error was corrected in only seven cases (one of them without the use of dictionaries) and in three cases "the possibility of consulting dictionaries led to a correct solution being turned into an error" (Livbjerg & Mees, 1999, p. 142). The results showed that in 86.5% of the cases, the consultation of external resources did not result in any improvements. Furthermore, the correlation between consultation and the quality of post-editing products has also been investigated. Daems et al. (2016) used key-logging and eye-tracking to compare translation students' consultation behaviours in translation and post-editing. They found that less time was spent on consultation during post-editing than during translation, and using consultation significantly reduced the overall productivity. This research also found that longer searches did not lead to a better translation.

The findings concluded from these studies suggest that the consultation of external resources might be of limited help in translation, which seems to contradict the commonly agreed upon argument that consultation is an inevitable part of translation. However, there are two reasons why the results from these studies should be interpreted with caution. Firstly, translation is a complex process that might be affected by various factors, including psychological and demographic factors. Psychological factors refer to "translators' beliefs and translators' mental activities and translators' ideology" and demographic factors refer to "characteristics such as gender, age" (Araghizade & Jadidi, 2016, p. 24). Previous studies show that translation quality could not be improved with increased consultation length, which is only one feature of consultation. As illustrated in section 3.1, studies on consultation can be conducted from multiple perspectives, among which length is only one aspect. The effect of other aspects of consultation, such as complexity, style, and allocation of cognitive resources, on translation quality still requires further investigation. Secondly, some of the existing studies have methodological drawbacks. For example, in Livbjerg and Mees' (1999) study, the reference materials were brought along by the participants. This might lead to two issues: (1)

due to a lack of familiarity with which types of reference materials could be helpful, the participants' need for consultation could not be fulfilled by the materials they had; (2) different participants might choose to bring different types of materials, which meant that the information accessed by the participants was not equal from the beginning. Therefore, although the existing studies that explore the effect of consultation on information use questioned the usefulness of consulting external resources in translation, it is believed that the results summarised from these studies are questionable due to their methodological drawbacks. The present study improves on the research design and proposes further empirical evidence to investigate the effect of different features of consultation on translation performance.

3.5 Existing Research Gaps

Previous studies on consulting online resources in translation have left five research gaps:

First, most of the existing studies predominantly focused on paper-based reference materials whose importance has been gradually replaced by online reference materials. Based on the results obtained from the existing studies on paper-based materials, the present study will focus on the use of online reference materials. This new avenue of investigation on consultation in translation is more closely connected with the actual translation process, in which online materials are widely used.

Second, the descriptive analysis of consultation in translation tends to focus on the behavioural aspect and ignore the cognitive aspect. The present study will further investigate the cognitive aspect of consultation in translation, such as the allocation of cognitive resources between translating and consultation and cognitive load on consultation. It is believed that this aspect can provide further insight into consultation efficiency in translation. In addition to this issue, translators' information evaluation behaviours also remain unclear and will be explored in the present study. The descriptive investigation will not be considered as an individual research topic in the present study but will be used to investigate the following correlations.

Third, the correlation between information needs and consultation has not been thoroughly investigated. From a theoretical perspective, based on the models of information-seeking

behaviours, consultation in translation will be affected by information needs. From an empirical perspective, the existing studies in general information-seeking behaviours and Web searching also suggest that differences in information needs, including task complexity and problem structures, affect information-seeking behaviours. However, existing studies fail to provide a convincing finding regarding the correlation between information needs and consultation in translation. The investigation of this topic will be carried out on two levels: the larger translation task and the individual translation problems. The difference in the information need for the larger translation task will be defined by perceived translation difficulty while the individual translation problems will be defined by translation problem type.

Fourth, the existing studies on the effect of user attribute on consultation in translation propose controversial findings in the resource types preferred by professional translators. Some studies find that professional translators prefer to use monolingual dictionaries while some other studies do not report such a finding and this issue will be investigated further in the present study.

Fifth, previous studies that investigated the effect of consultation on translation performance include some methodological drawbacks which affect the reliability of their findings on this topic. The present study aims to assess translation quality in order to evaluate the effectiveness of consultation behaviours and compare the differences between the successful and unsuccessful consultation behaviours.

In order to address these research gaps, the present study aims to answer the following research questions. (1) What is the effect of information need (perceived translation difficulty or translation problem type) on consultation behaviour? (2) What is the effect of translation experience on consultation behaviour? (3) What is the effect of consultation behaviour on translation quality? Each research question covers several subsequent aspects of the investigation. As the present study is explorative in nature, it only aims to examine one independent variable (perceived translation difficulty, information need type, or translation experience) and several dependent variables (attention distribution, cognitive load, consultation style, etc.) with each research question. In order to answer these three research questions, an empirical experiment was designed. The details of the research design will be explored in the

next Chapter.

Chapter 4: Research Design

A series of translation experiments were carried out, including two pilot studies and one formal experiment. 15 participants took part in the first pilot study, four participants in the second pilot study, and 68 participants in the formal experiment. The participants' eye movements activities were registered with a Tobii eye-tracker. The entire translation and consultation process was recorded with the screen-recording function integrated into the eye-tracking software. The first pilot study was carried out at Durham University from August to September 2018. Based on the experimental process and preliminary results of the pilot study, the experimental design was improved by adding a new ST, and then the second pilot study was conducted in May 2019. As the second pilot study went smoothly, the final experimental design was determined and the formal experiment was carried out from June 2019 to November 2020 in several different locations, including Durham University, Ningbo University, Wuhan University of Technology, Nanjing University of Posts and Telecommunications, Nanjing Normal University, and Nanjing University of Finance and Economics.

It was deemed appropriate to conduct the formal experiments in different locations for two reasons. Firstly, carrying out the experiments in different locations offered greater opportunities to recruit more participants, especially more professional translators. As one of the key research questions the present study aims to answer is the differences across three groups of participants with different levels of translation experience, it was essential to recruit a sufficient number of professional translators. Secondly, the outbreak of the Covid-19 pandemic in March 2020 in the UK made it impossible to conduct eye-tracking experiments in the eye-tracking lab at Durham University while maintaining social distancing measures. In order to follow the research schedule, conducting the experiments in other locations was considered to be the most sensible choice. However, it was noted that conducting the experiments in different locations might affect the eye-tracking data quality. In order to avoid bias as much as possible, the experimental setting remained the same in the different locations (see section 4.2 for a detailed description).

Another potential drawback of this research design is that the process data collected in the laboratory experiments are not comparable to the data collected in a more familiar environment. In addition, the use of an eye-tracker might affect the participants' state of mind. In order to

minimise the negative effect of this drawback, the participants were asked to translate a warm-up text prior to translating the experimental texts. In translating the warm-up text, they would have the opportunity to acclimatise to the translating interface, the consultation interface, and the input method.

Another issue that might affect the ecological validity of the experiment is that the participants were aware that their translations would be used and evaluated. For language learners and translation students, this might potentially be less of an issue, as they are used to translating for the purpose of having their translations evaluated by a teacher (Dragsted, 2004, p. 126). However, professional translators might feel less responsibility to produce high-quality translations, which might have affected their consultation behaviours to some degree. For instance, if a professional translator did not find it necessary to provide the best translation solutions, he/she might not be fully motivated to use optimal searching strategies. By providing remuneration for all participants and stressing the importance of producing a high-quality translation in the present study prior to the translation task, this issue is considered to have minimal effect on the process data.

Pilot studies

Two pilot studies were carried out prior to the formal experiment. In the first pilot study that was carried out from August to September 2018, 15 translation students were recruited to conduct the translation experiments. They were asked to translate the warm-up text and two experimental texts (Text A and B, see Appendix I). Their translating and consultation processes were recorded using the eye-tracker and in-depth retrospective interviews were performed. This pilot study was conducted for the following three reasons. Firstly, it was used to determine whether there were any issues with the experimental setting. Each participant in this pilot study was asked if they had experienced any discomfort that might disrupt their translation process and if they had any suggestions to improve the experimental design after completing the task. No complaints or suggested changes were reported in the first pilot study. However, it was found that many participants became impatient during the retrospective interviews and tried to

answer the questions as briefly as possible. Some of the participants reported that they found the interview to be too long. Therefore, in the formal experiment, the in-depth retrospective interviews were replaced with structured retrospective interviews, which were only used to define the types of translation problems encountered by the participants. Secondly, the participants were asked to assess the perceived translation difficulty levels of Text A and B using the NASA Task Load Index. The assessed results, combined with their psychological metrics during translation, were used as the post-translation assessments for the perceived translation difficulty of the two STs. Thirdly, the participants were asked to separate the STs into individual segments, which were used to examine the correlation between translation problem type and consultation behaviours. After the first pilot study, it was noticed that the two STs did not trigger much consultation of extralinguistic information, which was considered to be a neglected topic for translation research. Therefore, three other texts that were assumed to have an unfamiliar background for the participants were used to select a third ST. In order to determine which text would be the most appropriate ST, the second pilot study was conducted during May 2019 with four translation students, who were asked to translate the three experimental texts in the same experimental setting. The three texts were ranked based on the need for extralinguistic information, the texts were separated into individual segments, and the segments that required the consultation of extralinguistic information were annotated. Based on the results from the second pilot study, Text C was eventually selected as the third ST for the formal experiment.

4.1 Participants

In the formal experiment, with the aim of investigating the effect of training experience and professional work experience on consultation, the participants were divided into three categories, including participants without either translation training or professional work experience, participants with only training experience but no work experience, and participants with both training and work experience. The naming of these three groups followed R. Kim's (2006) study, who also used the same division of participants. These three groups were named

language learners, translation students, and professional translators. It was worth mentioning that in contrast to R. Kim's (2006) study, the present study did not conduct the group comparisons based on the differences across all three groups of participants, but based on the difference between language learners and translation students, and the difference between translation students and professional translators, respectively.

Overall, 68 participants were recruited on a voluntary basis (see Appendix II for the details about all participants). The group of language learners consisted of 22 participants (20 females and 2 males), with an average age of 21.5 years (range 20-22 years, *SD*=0.72 years). This group of participants was made up of undergraduate students in their third or fourth year in humanities and social science subjects other than English. None of them had any training experience in translation theory or practice and did not have any professional translation experience. The participants in this group were numbered L01 to L22. The group of translation students consisted of 23 participants (20 females and 3 males), with an average age of 23.43 years (range 22-28 years, *SD*=1.31 years). They all had a bachelor's degree in English and had finished a one-year MA programme in Translation Studies at a UK university. None of them had any professional translation experience. The participants in this group were numbered S01 to S23. The group of professional translators consisted of 23 participants (13 females and 10 males), with an average age of 43.87 years (range 39-55 years, *SD*=5.14 years). They all had more than 12 years' experience lecturing in written translation at a university and had been working as a freelance translator for more than five years. The participants in this group were numbered P01 to P23.

All participants had the same language background. They were all native Mandarin Chinese speakers with English as their second language and were not brought up in a bilingual environment. They were all touch-typists and had normal or corrected-to-normal vision. There was no attempt to recruit an equal number of male and female participants for two reasons. Firstly, existing studies do not suggest that gender is an influential factor on translation or information-seeking behaviour, so there was no need to consider gender as a potentially influential factor in the present study. Secondly, it is much easier to recruit female participants than male participants in empirical studies on translation. For example, in the empirical study

on the allocation of cognitive resources in translation, Hvelplund (2011) recruited 20 female and four male translators. He also pointed out that recruiting an equal number of female and male translators is difficult in practice. Therefore, with the aim of recruiting as many participants as possible, the effect of gender was not considered in the present study.

4.2 Tasks

4.2.1 Experimental Setting

All the experiments were carried out in a room with a ceiling light as the only light source. The equipment included a computer connected to two monitors, one was connected to the eye-tracker and was the presentation monitor for the participants, and the other monitor was used by the researcher to oversee the experiment. The light source was placed behind the two monitors to avoid any lighting influence on the experiment. Both monitors were placed on one long table side by side, so the participant could not see the researcher's face and an appropriate distance was maintained between the participants and the researcher during the experiments.

All the experiments were prepared and carried out using an eye-tracker connected to a 23" LCD monitor that functioned as the presentation screen. The screen resolution was set to 1920*1080 pixels and the fixation radius was the default setting for the Tobii system, 35 pixels per inch. The eye movement data from eight language learners (L01 to L08), all the translation students (S01 to S23), and two professional translators (P07 and P08) were recorded with a Tobii TX300 eye-tracker. The eye data from six professional translators (P01 to P06) were recorded with a Tobii Pro Spectrum eye-tracker. The other participants' eye movement data (L09 to L22 and P09 to P23) were recorded with a Tobii Pro Fusion eye-tracker.

To suit the eye-tracker based design, the screen was purposely separated into two equal areas (shown in Figure 6), with the Translog II user interface on the left for translating and the web browser (Internet Explorer 11) on the right for consultation. The English ST was displayed in the upper window of the Translog interface, with a Microsoft Sans Serif typeface set at 18 points using double-line spacing. The Chinese TT was produced in the lower window, with a

SimSun typeface set at 18 points, also with double-line spacing. The web browser was set on a blank page before the translation task began. After each task, the search history was erased in order to avoid any potential influence on the next participant.

Figure 6. Interface design for the experiment

4.2.2 Experimental Procedure

The day before the experiments, the participants were instructed not to drink any coffee or alcoholic beverages before the experiment, and not to wear heavy make-up or coloured contact lenses during the experiment to minimise any negative influences on data quality. Participants who did not have normal vision were told to wear their glasses to correct their vision.

After the participants arrived at the laboratory, they were given a translation brief about the experiment, told that anonymity and confidentiality would be ensured, and informed that the data would only be used for research purposes. Once they had agreed to participate in the experiment, they were asked to sign a consent form and started the experiment.

In the formal experiment, the participants were asked to translate four texts from English to Chinese, including one warm-up text and three experimental texts. The warm-up text was always the first text presented to the participants, followed by three experimental texts. They

were informed that the process data and the translations of all four texts would be used for further analysis. However, only the data retrieved from the translations of the three experimental texts were used. The sequence in which the experimental texts were presented was semi-randomised in order to minimise the influence of task order on their consultation behaviours (see section 4.4). No time constraint was given in the present study. The participants were allowed to use any online resources apart from machine translation and CAT tools. The restriction on using machine translation and CAT tools was put in place because the focus of the present study was the consultation behaviour in translating-from-scratch, not in post-editing. Nevertheless, it was observed that some participants still used machine translation websites as a type of bilingual dictionary. Being tested individually, the participants were firstly asked to sit approximately 60cm away from the monitor; then a five-point calibration and validation procedure was carried out. After an acceptable calibration had been saved, each participant started to translate the warm-up text and then the three experimental texts. They could take a break between tasks if necessary. Each translation segment that triggered consulting online resources was recorded by the researcher.

After translating the texts, all participants were asked to take part in a retrospective interview, in which they would confirm whether the recorded translation problems that required online consultation were segmented correctly and categorise the segments into three translation problem types as instructed in the translation brief. Finally, they were asked to complete a questionnaire about their educational background and how familiar their background knowledge of Text C was (see Appendix III for the questionnaire). All participants were rewarded with a supermarket gift card. The experiment was approved by the research ethics committee at Durham University. The session for each participant lasted roughly 60-75 minutes.

4.3 Source Texts

Three STs were used in the present study (Text A, B, and C, see Appendix I). These texts were of a similar length in terms of the total number of words and were all from the same genre: popular science. Text A was an excerpt from an article published in *New Scientist*, a weekly

English-language magazine that covers all aspects of science and technology. Text B was an excerpt from *Coral Reef and Global Climate Change*, a popular science book introducing the negative effects of global climate change on coral reefs. Text C was an excerpt from an article published in *LiveScience*, a science news website.

4.3.1 Text A and B

One of the research questions in the present study is to examine the effect of perceived translation difficulty on consultation behaviours. In order to answer this question, Text A and B were selected to present different levels of perceived translation difficulty for the participants.

How to measure perceived translation difficulty has always been a controversial and challenging task in Translation Studies. Borrowing from reading studies, Pavlović and Jensen (2009) used readability (the relative ease with which a text can be read) alone as an indicator of translation difficulty for texts of a similar length and genre. Later, Jensen (2009) improved this method by using a combination of readability, word frequency, and non-literalness as the indicator of text complexity. Although text complexity and translation difficulty cannot be equated, she argued that these indicators of text complexity could be used to help select texts for experimental purposes. Using text complexity to measure translation difficulty was further questioned since that apart from text complexity, translation difficulty can be affected by "translation-specific difficulty" and "translator factors (i.e., the individual's cognitive capabilities, and past experience and training)" (Sun & Shreve, 2014, p. 100). In this regard, apart from the features of texts, certain characteristics of translators' performance can also be used to indicate the perceived translation difficulty. Sun and Shreve (2014) used participants' mental workload as an indicator of translation difficulty. They asked participants to predict the translation difficulty level with a Likert scale before translating, and then applied NASA Task Load Index (TLX) as a multidimensional scale for measuring participants' workload to assess translation difficulty. NASA-TLS was developed by Hart and Staveland (1988) based on a multi-year research project and is used to evaluate subjective experiences of workload across a variety of activities. This index contains six workload-related subscales, as follows:

> 1. Mental Demand (Low/High): How much mental and perceptual activity was required (e.g., thinking, deciding, remembering, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
>
> 2. Physical Demand (Low/High): How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
>
> 3. Temporal Demand (Low/High): How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
>
> 4. Performance (Good/Poor): How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
>
> 5. Effort (Low/High): How hard did you have to work (mentally and physically) to accomplish your level of performance?
>
> 6. Frustration Level (Low/High): How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task? (Hart & Staveland, 1988, p. 170)

Sun and Shreve (2014) confirmed that NASA-TLX is a reliable subjective metric for measuring translation difficulty. In addition, Liu et al. (2019) measured perceived translation difficulty with cognitive load indicated by physiological indices including fixation and saccade duration and pupil dilation. They found that the perceived translation difficulty had a strong correlation with fixation and saccade duration but had no correlation with pupil size.

Based on previous studies, a two-phase rating procedure was conducted in the present study to compare the perceived translation difficulty of Text A and B. In the pre-translation phase, the complexity of STs was tested by using a combination of readability indices,

percentage of complex words, and non-literalness (Jensen, 2009). Moreover, 12 freelance translators were recruited to rate the perceived translation difficulty using a rating scale. The pre-translation phase was conducted as part of the experimental design before the first pilot study. The data for the post-translation phase were collected from the first pilot study with 15 translation students. In this phase, the participants' mental workload when translating was measured using two methods and served to further support the pre-translation assessment. Firstly, the participants' post-translation rating was determined using NASA-TLX to estimate the mental effort they exerted. Secondly, their fixation duration was used as a physiological measurement of cognitive load. Although pupil size is "often taken as an indicator of the working load placed on the cognitive system" (Hvelplund, 2014, p. 214), it was not used to assess the cognitive load in the present study. As Liu et al. (2019) argued, pupil size during translating might be influenced by various factors including ambient illumination, task complexity, and gaze angle, and it is difficult to control all the factors in an eye-tracking experiment while also simulating a real translation scenario. Furthermore, pupil size is also found to be largely affected by emotional arousal (Bradley et al., 2008). During consultation for translation, participants' emotions might be affected by the information they find and thus could impact their pupil size. Based on the above discussion, only fixation duration was used as an indicator of cognitive load.

4.3.1.1 Pre-translation rating

Text complexity

Following Jensen's (2009) experiment design, readability indices, percentage of complex words, and non-literalness were used to measure the text complexity. The readability indices included the Automated Readability Index (ARI), the Flesch-Kincaid index, the Coleman-Liau index, the Gunning Fog index, the SMOG index, and the Flesch Reading Ease Score index and LIX. The first five indices returned the U.S. grade level that the reader must have completed in order to fully understand the text. The results from the five indices showed that Text A was less

complex than Text B, with 8.68 years and 18.02 years of schooling required, respectively, to successfully comprehend the texts (see Figure 7).

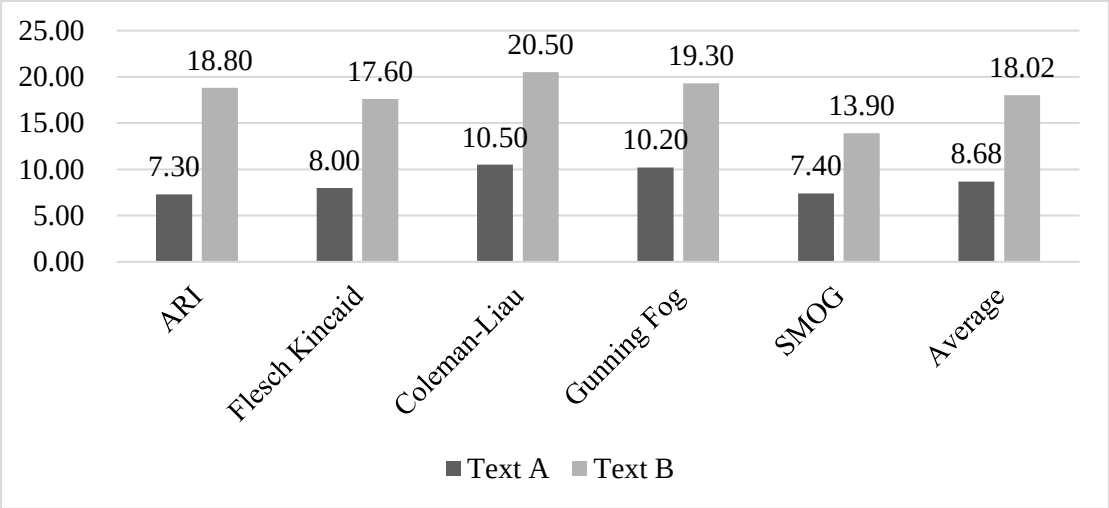

Figure 7. U.S. grade level indices scores for Text A and B

The Flesch Reading Ease Score index and LIX return numerical scores. In the Flesch Reading Ease Score index, higher scores (up to 100) indicate that the text is easier to read, while lower scores (as low as 0) indicate that the text is more difficult to read. The LIX-scale is divided into five categories of difficulty: very easy texts (<25), easy texts (25- 35), average texts (35-45), difficult texts (45-55), very difficult texts (>55). According to these two standards, Text A was evaluated as an easy text while Text B was evaluated as a very difficult text (see Figure 8).

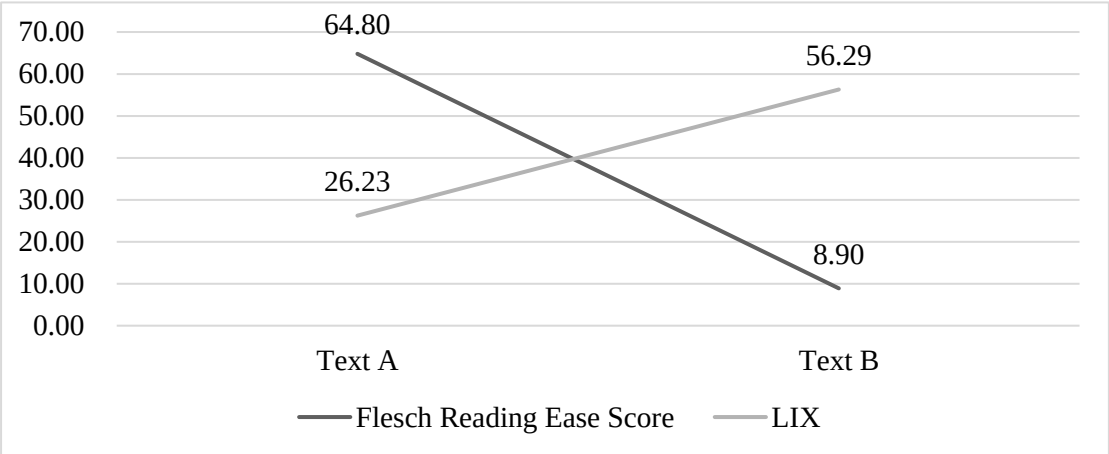

Figure 8. Flesch Reading Ease Scores and LIX for Text A and B

The percentage of complex words and the amount of non-literalness were also used to indicate text complexity. Figure 9 shows that Text B had a larger proportion of complex words than Text A, and both texts contained the same amount of non-literalness.

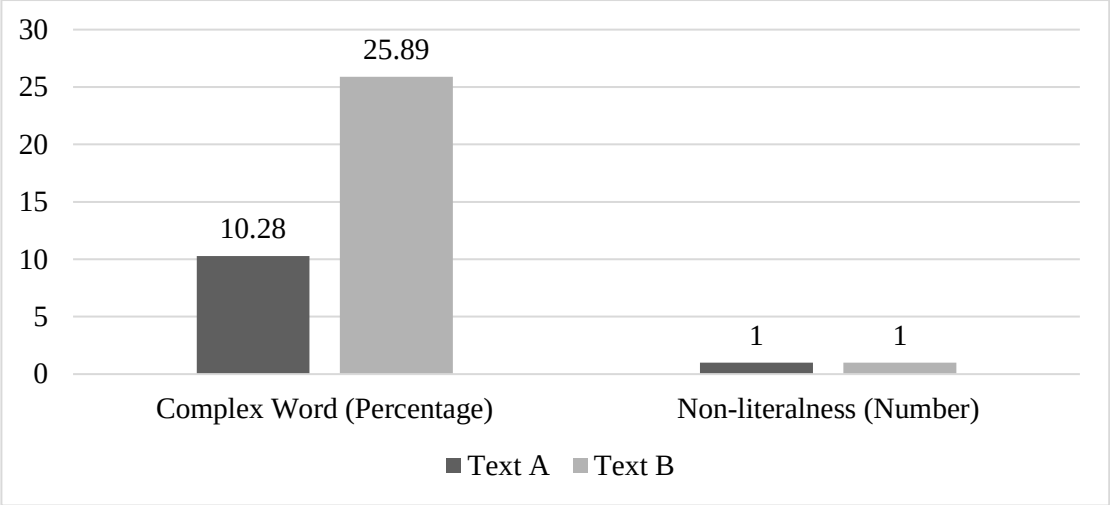

Figure 9. Complex word percentage and non-literalness number for Text A and B

Evaluation from experts

Twelve freelance translators were recruited to rate the perceived translation difficulty of Text A and B using the five-point Likert scale, with 1 being "very easy" and 5 being "very difficult". The statistical results are presented in Table 9, indicating that Text B was perceived to be significantly more difficult to translate than Text A.

Table 9. Descriptive statistics and Wilcoxon's result for the experts' rating of perceived translation difficulty

Text	N	Mean	SD	Wilcoxon's *Z*	Sig.
A	12	2.18	.72	3.111	< .05
B	12	4.27	.58		

To summarise, in the pre-translation evaluation of perceived translation difficulty, Text B was found to be more difficult to comprehend and was considered to be more difficult to translate by the experts. Therefore, these two texts were used in the first pilot study to confirm

whether the difference in the assessed translation difficulty was perceived by translation students.

4.3.1.2 Post-translation rating

NASA-TLX

Following Sun and Shreve's (2014) experiment design, four out of the six NASA-TLX subscales were adopted as a post-translation rating on the perceived translation difficulty, namely: Mental Demand, Effort, Frustration, and Performance. In the first pilot study, 15 translation students were asked to rate the post-translation difficulty using NASA-TLX. The statistical results are presented in Table 10, showing that the participants experienced significantly higher mental demand, exerted more effort, felt much more frustrated, and performed slightly worse when translating Text B than Text A. The results indicated that the participants perceived that a higher workload was necessary when translating Text B than when translating Text A based on their subjective evaluation.

Table 10. Descriptive statistics and Wilcoxon's results for post-translation rating of perceived translation difficulty

Subscale	Text	N	Mean	SD	Wilcoxon's *Z*	Sig.
Mental Demand	A	15	4.09	1.31	3.865	< .001
	B	15	5.96	1.43		
Effort	A	15	4.48	1.81	3.884	< .001
	B	15	6.04	1.69		
Frustration	A	15	3.13	1.60	2.336	< .05
	B	15	3.89	2.28		
Performance	A	15	6.04	1.15	-1.006	> .05
	B	15	5.80	1.37		

Physiological measurement

As presented in section 4.2.1, the experimental interface was divided into the translating and the consultation areas. Overall, 147,692 fixations with valid fixation duration data on the

translating area were collected. Since the data from the two groups have unequal variances (Levene's test, F=99.033, p< .001) and are not normally distributed (the Kolmogorov-Smirnov normal distribution test, Z= .168 for Text A, Z= .171 for Text B, p< .001), the Welch's t-test on the rank transformation of the raw data was conducted (Mellinger & Hanson, 2017; Ruxton, 2006; Zimmerman & Zumbo, 1993). The result shows that the difference is statistically significant, indicating that the participants allocated greater cognitive load when translating Text B than Text A (see Table 11).

Table 11. Statistic results of fixation duration (milliseconds) on the translation area

Text	N	Mean	SD	*df*	*t*	Sig.	Cohen's *d*
A	59325	241.97	181.86	147690	-130.897	< .001	1.50
B	88367	251.89	191.94				

In conclusion, the results from both the pre-translation and post-translation phases showed that Text B was perceived to be more difficult to translate than Text A.

4.3.2 Text C

In the translation process, two types of information can be consulted with online resources: linguistic information, such as entries in dictionaries, and extralinguistic information, such as background information on the text. In the translation competence model proposed by PACTE (2003), extralinguistic sub-competence, which refers to the use of declarative knowledge, is listed as one of the five sub-competences. Given that translators often have to deal with texts in various domains, it is unlikely that they will always have sufficient extralinguistic knowledge for translation. Therefore, the consultation of extralinguistic information seems to be an inevitable part of translation.

During the first pilot study, it was observed that Text A and B could not effectively trigger the consultation of extralinguistic information. To address this issue, three texts that potentially required extralinguistic consultation were used in the second pilot study. These three texts were similar in length but were on different topics. Four translation students participated in the

second pilot study with the same experimental setting as the first pilot study. They were asked to select the text that was most likely to require background information in order to translate it and all of them selected Text C. This text was about a Jewish holiday, which was highly likely to be unfamiliar to the participants, who were all Chinese, and might trigger the need to consult extralinguistic information. Since Text C was in a different domain to Text A and B, it would be biased to compare the perceived translation difficulty across all three texts. Therefore, the difficulty level of Text C was not assessed.

4.3.3 Summary of Source Text Selection

The complexity of Text A and Text B was first assessed with a combination of readability, percentage of complex words, and the amount of non-literalness. The results showed that Text B was more complex than Text A. However, a complex text is not necessarily difficult to translate for everyone (Jensen, 2009). Therefore, a pre-translation assessment based on experts' evaluation and a post-translation assessment based on participants' subjective mental workload and physiological cognitive load were performed. In conclusion, as shown in the above assessments on text complexity and participants' mental workload, Text B was perceived to be more difficult to translate than Text A.

4.4 Presentation Sequences

In the present study, semi-randomised presentation sequences were used for the three STs for two reasons. Firstly, since Text A and B were used to investigate the effect of perceived translation difficulty on consultation, the semi-randomised presentation sequence was used to make sure that each text was presented an equal number of times in a different order. Secondly, the effect of fatigue was minimised in case the participants gave up easily after failing to perform a successful consultation. In order to account for the effect that fatigue may have had on the results, the presentation sequences for the three STs were rotated. Since 68 participants were recruited in the formal experiment, the presentation sequence was repeated 11 times plus

two additional sequences (see Table 12 for the presentation sequence).

Table 12. Presentation sequence of STs in the formal experiment

Sequence	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**…**	**P67**	**P68**
Sequence one	A	A	B	B	C	C	…	A	A
Sequence two	B	C	A	C	A	B	…	B	C
Sequence three	C	B	C	A	B	A	…	C	B

Chapter 5: Data Collection, Preparation, Annotation, and Analysis

5.1 Data Collection

Three types of data were collected in the experiments: eye-tracking data, screen-recording data, and translation product data. Eye-tracking data were collected with Tobii eye-trackers and Tobii's eye collection/analysis software Tobii Studio and Tobii Pro Lab. The screen-recording data were retrieved using the integrated screen-recording function of Tobii's eye collection/analysis software, which recorded the participants' screen automatically during the translation task. The product data were based on the produced TTs, which were manually typed into a separate Word file based on the screen-recording data.

5.1.1 Eye-tracking Data

Three types of eye-trackers were used in the present study: Tobii TX-300 with Tobii Studio (version 3.4.8) as the data collection/analysis software, Tobii Pro Spectrum, and Tobii Pro Fusion both with Tobii Pro Lab (version 1.152) as the data collection/analysis software. Both Tobii Studio and Tobii Pro Lab are able to record the position of the participant's gaze on the screen, the size of the pupils, the participant's distance from the monitor, and the participant's gaze angle relative to the monitor. They can also record the key and mouse events when the participants press a key on the keyboard or press the left or right mouse buttons. Although Tobii Studio and Tobii Pro Lab have different interfaces, as they are developed by the same company, they work very similarly: both software contain a working environment which is divided into three modules: Design, Record, and Analyze. Since Tobii Pro Lab was used to collect the data from the majority of participants, the functionalities of these three modules are explained based on the interface of Tobii Pro Lab rather than Tobii Studio in the subsections below.

Design

The Design module of Tobii Pro Lab contains various types of stimuli, including Image, in which an image is presented on the screen for a predefined period of time; Web, in which a

webpage is presented; Instructions, in which texts in a chosen colour, font, and size are presented on the screen; and Screen Recording, in which any changes to the screen image are recorded in an .mp4 video file while all eye movements, pupillary movements, typing and mouse events are stored in separate data files. The Screen Recording stimulus is the only one that allows other software to be used, such as Translog and the Internet Explorer, and can record the screen during the experiments. In this case, the use of a screen-recording software is unnecessary, which eliminates the interference to the participants. Therefore, the Screen Recording was added as the only stimulus in the timeline

Record

The Record module is used to record and perform the entire eye-tracking experiment. In the Record module, a mandatory calibration was performed at the start of each eye-tracking task. Throughout the translation tasks, including translating the warm-up text and three experimental texts, the calibration was conducted four times. During calibration, the participants were asked to look at a calibration object, which moved between five calibration points; four points were located near the corners of the screen, and one was located in the centre. When the calibration session was completed, a calibration plot was displayed, which can be used as an indicator of the quality of the calibration and thus as an indicator of the eye-tracking data quality for the pending experiment. Once an acceptable calibration was saved, the recording was started. The user interface of Tobii Pro Lab was automatically minimised and ran in the background while the participant translated the warm-up text and three experimental texts. The recording was terminated by pressing Esc.

Analyze

The Analyze module in Tobii Pro Lab enables users to define Times of Interest (TOIs) and Areas of Interest (AOIs) and analyse data after the eye-tracking experiments are recorded. As this module is not used in the data collection phase, a detailed description of using this module

will be presented in section 5.2.

5.1.2 Screen-recording Data

Both Tobii Studio and Tobii Pro Lab have an internal function that can record the screen automatically during the experiment and generate video files with a resolution of 1920*1080. The videos contained all the movements on the screen, including the visited webpages, searched keywords, and online information. Figure 10 shows a screenshot from the screen-recording of the translation of Text A by S02.

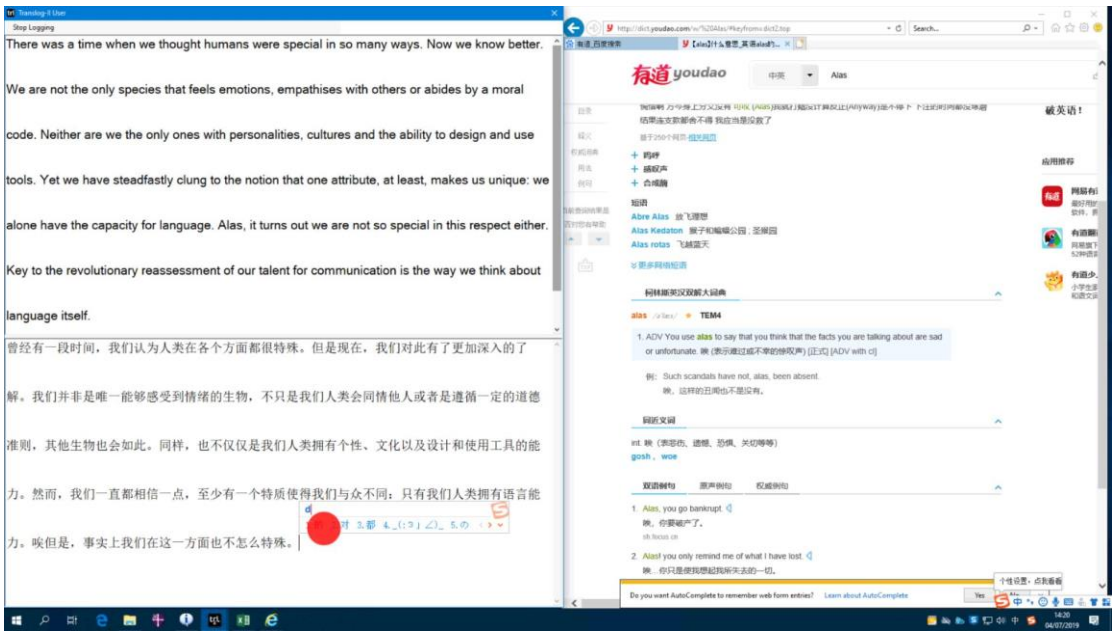

Figure 10. An screen-shot example of screen-recording data

5.1.3 TTs

The TTs were manually typed into a separate .doc file based on the screen-recording data. Each TT was numbered with a combination of the participants' assigned number and the task order. For example, the translation of Text A conducted by L01 was named L01_T01. Figure 11 shows an example of the three STs produced by Participant S01.

S01_T01

曾经我们认为人类在某种程度上是特殊的。现在我们了解的更多了。我们不是唯一有情绪、有同理心或者遵守道德的物种。我们不是唯一拥有个性、文化、设计和使用工具能力的生物。我们坚定地认为至少有一个特质可以让我们变得不同：只有我们有自己的语言。哎，这样看来我们在这方面也不是那么特殊。革命性的重新评估我们交流才能的关键，是我们思考语言本身的方式。

S01_T02

珊瑚礁拥有海洋生态系统中最高的生物多样性，它们为沿海地区大量增长中的人口提供重要的生态系统服务和直接的经济利益。尽管珊瑚礁的自然生长环境压力很大，最近全球珊瑚礁生态系统降解和死亡率的上升暗示着最近环境变化的速度和种类通常超越了珊瑚礁的适应能力，这一危机机会就是多重压力间相互作用的结果。其中包括数量上升的营养物和输沙量、直接破坏、污染、过度捕杀、疾病和掠夺。上升的海洋温度已经包括长期的压力、流行病的蔓延、大量珊瑚漂白事件和钙化的减少。

S01_T03

光明节是一个持续八天八夜的犹太节日，通常在深秋或初冬庆祝。每天傍晚太阳落山后，都会点燃九枝灯台的一枝灯盏。第一天晚上点燃第一枝，第二天点第二枝，一直到第八天。点燃灯盏的传统顺序是从右到左。第九支蜡烛（又名"attendant candle"）是专门用来点燃另外 8 支蜡烛的，往往插在最高的灯台上。食物在许多犹太传统当中扮演着重要角色，光明节也不例外。最受喜爱的光明节食物是油炸食物，尤其是油炸土豆丝饼（latkes），配合苹果酱和酸奶油食用，以及油炸圈饼（sufganiyot）。

Figure 11. TTs produced by Participant S01

In addition to the whole TTs, the translation solutions for individual segments were also collected. These solutions were typed in a separate .xls file. Figure 12 presents the translation solutions produced by Participant S02 when translating Text B. Column A and B presents the code for the participant and text. Column C and D shows the ST and TT segments, respectively. Both files were prepared for translation quality assessment and were sent to the assessors.

A	B	C	D
Participant	Text	ST	TT
S02	B	coral reef	珊瑚礁
S02	B	ecosystem services	生态系统服务
S02	B	degradation	退化
S02	B	mortality	死亡率
S02	B	nutrient and sediment loading	累积的营养物质与沉淀物
S02	B	direct destruction	直接破坏
S02	B	overharvesting	过度捕捞
S02	B	predation	捕食
S02	B	be implicated in	致使了
S02	B	coral bleaching episode	珊瑚白化

Figure 12. Translation solutions in S02_T02

5.2 Data Preparation and Export

5.2.1 Source Text Segmentation

Translation segments

In order to investigate individual web search tasks, Enríquez Raído (2014) selected ST segments that were perceived to be problematic by the participants from their online search reports. She named these segments "information needs". Among these information needs, those that were only pointed out by one participant were defined as individual or subjective information needs while those that were common to at least two participants were defined as common needs. In the present study, the activity of noting down each translation segment that involved external consultation was conducted by the researcher when observing the experiment. These segments were recorded in a separate spreadsheet. During the retrospective interview, the participants were asked to confirm whether the segment that required external consultation was recorded correctly and to categorise the translation problem type for each written segment. This categorisation method is based on Angelone's (2010) study. Considering translation as a problem-solving process, he categorised translation problems into three types: (1) source language comprehension, which refers to the inability to understand the ST; (2) source

language-target language transfer of meaning, which refers to difficulty in finding a satisfactory equivalent in the target language; and (3) target language text production, which is connected to the style of, or cultural references in the ST. These three translation problem types were named Type 1, Type 2, and Type 3, respectively, in the spreadsheet and in this thesis. An example of the spreadsheet for the problematic translation segments is shown in Figure 13. The problematic translation segments are presented in column C and the translation problem type is shown in column D.

	A	B	C	D
1	Participant	Text	ST	TP
2	S02	B	coral reef	2
3	S02	B	ecosystem services	2
4	S02	B	degradation	2
5	S02	B	mortality	2
6	S02	B	nutrient and sediment loading	1
7	S02	B	direct destruction	2
8	S02	B	overharvesting	2
9	S02	B	predation	3
10	S02	B	be implicated in	1
11	S02	B	coral bleaching episode	2

Figure 13. An example of ST segmentation (S02_T02)

The spreadsheets for all participants were merged together in order to list the translation segments that were seen to be problematic by at least two participants in three STs (see Table 13). Overall, Text A, B, and C contained 14, 25, and 7 common problematic translation segments, respectively.

Table 13. Problematic translation segments identified by at least two participants

Text	Index	Translation segment
A	1	know better
	2	species
	3	empathise with
	4	abide by
	5	moral code
	6	personality
	7	steadfastly
	8	cling to

Text	Index	Translation segment
	9	notion
	10	attribute
	11	capacity
	12	in this respect
	13	alas
	14	revolutionary reassessment
	1	coral reef
	2	biodiversity
	3	marine ecosystem
	4	ecosystem services
	5	economic benefits
	6	large and growing
	7	coastal zones
	8	the natural habitat
	9	a stressful environment
	10	degradation
	11	mortality
	12	nature
B	13	exceed
	14	adaptive capacity
	15	stress
	16	nutrient and sediment loading
	17	direct destruction
	18	contamination
	19	overharvesting
	20	predation
	21	be implicated in
	22	chronic stress
	23	disease epidemics
	24	coral bleaching episode
	25	reduced calcification
	1	Hanukkah
	2	branch
	3	menorah
C	4	so forth
	5	the “attendant” candle
	6	latke
	7	sufganiyot

Rich Points

PACTE (2009) proposed the concept of "Rich Points", which is defined as "specific source-text segments that contained translation problems" (p. 214). Based on a series of pilot studies, they selected five Rich Points from the STs covering five types of translation problems (linguistic problems, textual problems, extralinguistic problems, problems of intentionality, and problems relating to the translation brief and/or the target-text reader) to investigate the resolution of translation problems. PACTE (2009) pointed out five methodological advantages of conducing data collection and analysis based on Rich Points:

> 1. Data may be collected on a range of different types of translation problems representative of those commonly found when translating.
>
> 2. In-depth analysis of the same Rich Point can be carried out using the results obtained from several indicators.
>
> 3. The triangulation of data obtained from multiple sources is facilitated.
>
> 4. The same methods of data analysis can be used for direct translation and inverse translation in all language combinations involved in the experiment.
>
> 5. Greater economy is guaranteed in the experiment, and, as a result, data analysis [is] made easier. (p. 214)

In the investigation of the optimisation of consultation in translation, Shih (2019) followed PACTE's (2009) research method by selecting nine Rich Points from three STs. She summarised and compared the characteristics of successful and unsuccessful web search episodes. In the present study, one of the research aims is to compare the differences in the consultation style among language learners, translation students, and professional translators. Consultation style is a qualitative metric based on the transcription of screen-recording data (see section 5.2.3 for an explanation of the transcription system). The transcription of screen-

recording videos is an extremely time-consuming process. Enríquez Raído (2014) only transcribed 10 screen-recording videos and she claimed that this process was "the most arduous and labor-intensive phase" (p. 103). the present study collected 204 screen-recording videos with over 1,000 individual web search tasks, which means that it would be challenging and time-consuming to summarise the characteristics of every task or to make a systematic comparison. By selecting Rich Points from the STs and focusing the qualitative analysis on them, the depth of investigation and the economy of performing data analysis are guaranteed. PACTE (2005) demonstrated three essential criteria for selecting Rich Points: (1) they should provide variety in the types of translation problems studied; (2) they would not lead to immediate and acceptable solutions; and (3) they should be homogeneous in all the languages (so comparisons can be made) (p. 614). Following these criteria, five Rich Points were selected in the present study (see Table 14).

Table 14. Rich Points selected from the STs

Text	Identified Rich Points	Translation problem type
A	steadfastly	Type 1
	alas	Type 2
B	a stressful environment	Type 3
C	latke	Linguistic problem
	the "attendant" candle	Extralinguistic problem

In order to meet the first criterion, three Rich Points from Text A and B that cover the three types of translation problems were selected. It is worth mentioning that the participants' categorisation of translation problem types for these Rich Points might differ, which is reasonable given that the perception of information need is subjective. Only the web search tasks for translating these three Rich Points that are triggered by the same type of translation problem were used for data analysis. The two Rich Points from Text C were selected to examine the consultation of extralinguistic information. "Latke" is a type of Jewish food and an acceptable TL equivalent can be easily found in online dictionaries, so translating this term was considered to have a relatively higher need for linguistic knowledge and a lower need for extralinguistic knowledge. "The 'attendant' candle" is the tallest candle on a Jewish menorah,

which is used to light the other candles and an acceptable TL equivalent is not available in bilingual dictionaries. It is supposed that the translation of this Rich Point does not require much linguistic knowledge, as its linguistic meaning should be easily understood by the participants but would require a relatively higher need for extralinguistic knowledge. Since these Rich Points were all selected from the translation segments that required online consultation and were all in the same language, their selection naturally met the second and third criteria proposed by PACTE (2005).

5.2.2 Eye-tracking Data

In Tobii Pro Lab, two data analytic tools are used to define the spatial segments of the recordings: TOI and AOI. Both tools are configured in the Analysis module of Tobii Pro Lab. TOIs are intervals which refer to spans of time on the recording timeline and have a start and end event. They are used to define the interval selection rules and the gaze data sources and to specify internals for visualisation, metric calculation, or data export. AOIs refer to the defined areas in the stimulus or Snapshot. They facilitate numerical and statistical analysis based on regions or objects of interest in the stimuli. Generally, the design of TOIs and AOIs should be performed as the first step of eye-tracking data preparation.

5.2.2.1 TOI and AOI design

In the present study, two types of TOIs were defined for each translation task: the holistic translation task and the translation of individual segments. Firstly, for each translation task, one TOI was created and named in the following way: “Full_ParicipantCode_TaskCode”. For example, when recording the translation of Text A by L01, this TOI was named “Full_L01_T01”. The TOI started at the end of the calibration and ended at when the recording stopped. Both time events were created automatically in the software. Secondly, within the Full TOI, each individual consultation behaviour was segmented into individual TOIs, which started from the first keystroke when searching for a keyword and ended when the last keystroke of

the searched keyword was entered into the next translation segment. The keystroke was used to indicate the starting and ending of each TOI because it could provide a precise timestamp, which was required in creating TOIs in eye-tracking software. These TOIs were named in the following way: "ParticipantCode_TaskCode_Consulted ST segment". For example, "L01_T01_alas".

For the TOIs covering the holistic translation tasks, four AOIs were drawn: (1) the entire screen, named "Full"; (2) the ST area in the Translog interface, named "ST"; (3) the TT area, named "TT"; and (4) the entire web browser, named "Web" (see Figure 14 for a sample AOI design). The first AOI was defined only for eye-tracking data quality assessment, which will be explained in the next section. The second and the third AOIs were defined to calculate the amount of attention allocated to translating, while the fourth AOI was used to calculate the fixation data allocated to consultation.

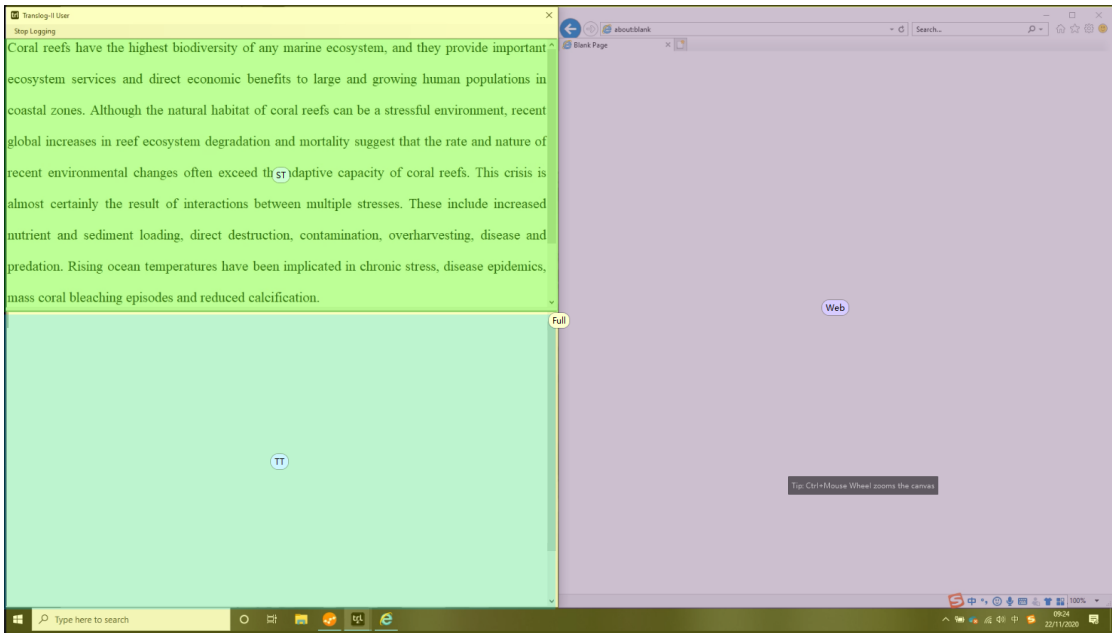

Figure 14. Sample AOI design: within the Full TOI

For the TOIs representing individual web search tasks, the AOIs were drawn based on the type of information presented on the webpages: (1) lexical information, which contains information related to the meaning of words (i.e., definitions and translations provided in dictionaries); (2) extra-lexical information, which contains all other linguistic-related

information (i.e., grammatical information and synonyms); and (3) extra-linguistic information, which contains non-linguistic related information (i.e., background information). Figure 15 presents a sample of an AOI design for an individual web search task containing linguistic and extra-lexical information.

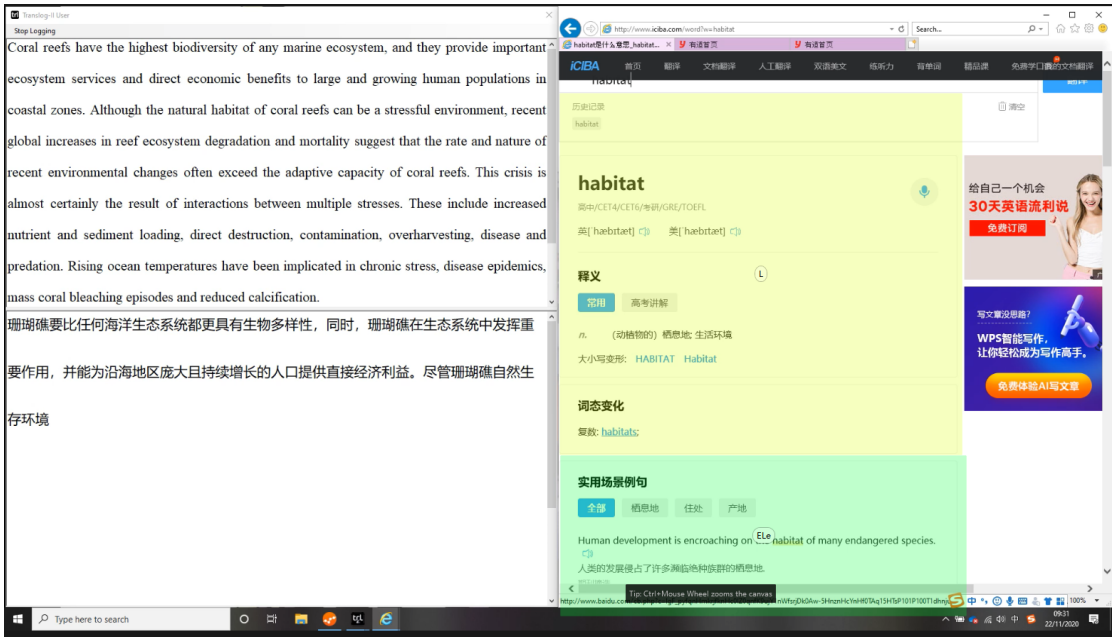

Figure 15. Sample AOI design: an individual web search task

5.2.2.2 Data quality assessment

In the post-task questionnaire, the participants were asked to rank their familiarity with the source texts using a five-point Likert scale (1 = “not familiar at all”; 5 = “very familiar”). A ranking of 5 meant that the participant’s extralinguistic consultation might be influenced by their being “very familiar” with the subject matter and the data would be eliminated. In the present study, P23 was highly familiar with Text C since he/she had learnt Hebrew as the third language and had translated two books about Jewish culture, so his/her data were eliminated. With reference to Hvelplund (2011), the following three criteria were adopted in the present study to assess the eye-tracking data quality: (1) Gaze Time on the Screen as a percentage of total production time (GTS); (2) Gaze sample to Fixation Percentage (GFP); and (3) Mean Fixation Duration (MFD). Data that satisfied at least two out of the three criteria were included

for further analysis.

GTS

As eye-tracking data were used as the main data source for the calculation of attention and cognitive load, there is a need for "a sufficient amount of data" (Hvelplund, 2011, p. 104). Also, in order to comprehend the online information and transfer it into internal knowledge used for translating, participants need to look at the screen for a sufficient amount of time. Therefore, GTS, which is a calculation of TFD as a percentage of total task time [(TFD/total task time)*100%], was used as the first standard of eye-tracking quality assessment. TFD refers to the sum of the durations of all fixations on the "Full" AOI within the TOI, named "Full_ParicipantNumber_TaskNumber". Total task time refers to the length of the same TOI. For example, Participant S02 spent 1023.05 seconds on the translation of Text A, during which he/she spent 801.77 seconds gazing at the screen, which produced a GTS of 78.51%. Another example was Participant S01, who spent 1043.22 seconds on the translation of Text A, which was very close to the time spent by S02, but Participant S01 only spent 383.59 seconds gazing at the screen, equalling a GTS score of 36.77%, which was dramatically lower than the GTS produced by Participant S02. In the present study, the mean value of GTS was 59.66% and the SD was 18.39%. Therefore, GTS data below 41.27% (one SD below the mean) were considered as invalid data (see Table 15 for a list of the recordings which contained flagged GTS scores). Among the 68 participants, 15 participants (including six language learners, six translation students, and three professional translators) had GTS scores that were below the standard, which accounted for 22.06% of all participants.

Table 15. Recordings with flagged GTS scores as a percentage (grey cells)

Participant	Text A	Text B	Text C
L01	49.52	32.67	39.16
L16	20.80	34.38	30.15
L17	34.54	48.61	42.65
L19	44.18	38.58	24.36
L20	40.60	36.79	33.16
L21	13.25	13.49	8.81
S01	36.77	40.71	38.78
S04	34.02	75.27	73.59
S06	44.50	38.16	51.10
S10	11.67	16.12	13.54
S15	47.46	33.93	10.26
S23	41.40	26.02	60.18
P06	6.97	6.77	5.45
P14	31.94	43.29	44.82
P16	54.83	16.69	58.66

GFP

Hvelplund (2011) suggested that GFP is "a criterion for evaluating eye-tracking data quality as it reflects how much of a participant's gaze activity actually belongs to fixations and how much does not" (p. 105). Although Tobii Studio and Tobii Pro Lab do not provide the number of gaze samples that form fixations and saccades, they do provide a list of all the gaze samples that are categorised into fixations, saccades, unclassified, or eyes not found. Figure 16 below shows an example from the eye-tracking data produced by Participant L09 during the translation of Text A. Each row of the .xlsx file represents a gaze sample: the eye movement type is presented in Column D, the gaze event duration is presented in Column E, and the eye movement type index is presented in Column F. These gaze samples are raw gaze events before being filtered by the Tobii fixation filter.

D	E	F
Eye movement type	Gaze event duration [ms]	Eye movement type index
Saccade	36	329
Saccade	36	329
Saccade	36	329
Saccade	36	329
Saccade	36	329
Saccade	36	329
Saccade	36	329
Saccade	36	329
Saccade	36	329
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
Fixation	80	109
EyesNotFound	4	365
Unclassified	12	355
Unclassified	12	355
Unclassified	12	355
EyesNotFound	4	366

Figure 16. An example of the gaze samples produced by Participant L09 when translating Text A

GFP is calculated by comparing the total number of gaze samples with the total number of gaze samples that formed part of a fixation [(number of gaze samples/number of fixation gaze samples)*100%]. For example, in Participant L09's translation of Text A, 68,103 gaze samples

were recorded with 57,454 samples belonging to fixations, so the GFP score was 84.36%, which is acceptable. The translation of Text A by Participant L21 provides an unacceptable example of a GFP, in which 167,940 gaze samples were recorded with 22,998 samples belonging to fixations, so the GFP score for this task was only 13.69%. Ideally, the data with a GFP lower than 85% should be discarded. However, as the tasks in the present study involved both translating and consultation activities, the GFP may be affected. Therefore, in line with Liu et al. (2019), the present study adopts a threshold of 67.20% (one SD below the mean). Among the 68 participants, seven participants (including four language learners, two translation students, and one professional translator) had GFP scores that were below the standard, which accounted for 10.29% of participants. The list of these seven participants is presented in Table 16.

Table 16. Recordings with flagged GFP scores (grey cells)

Participant	Text A	Text B	Text C
L16	41.87	57.54	53.97
L19	61.40	55.65	43.67
L20	57.88	53.71	59.76
L21	13.69	57.88	42.00
S06	66.74	65.05	74.73
S10	68.33	72.84	67.07
P06	6.99	6.78	5.51

MFD

MFD is the TFD divided by the number of fixations. Fixations when reading English texts usually last between 200 and 225 ms (Rayner, 1998, p. 375). Following the standard used by Hvelplund (2011), MFDs below 200 ms were considered as invalid data in the present study. Table 17 presents the list of participants that had a MFD lower than 200 ms. Overall, 13 participants (including six language learners, six translation students, and one professional translator) had MFDs below 200 ms, which accounted for 19.12% of participants.

Table 17. Recordings with flagged MFD scores (grey cells)

Participant	Text A	Text B	Text C
L16	136.18	165.53	159.95
L17	162.47	187.95	191.61
L18	176.34	224.65	192.02
L19	168.68	159.88	157.09
L20	174.94	159.76	168.86
L21	146.95	179.36	136.45
S01	198.15	210.44	181.26
S06	185.66	203.32	230.68
S10	148.17	165.39	152.71
S11	198.09	225.98	217.06
S15	204.03	195.19	169.27
S23	234.33	193.53	210.10
P14	186.13	199.49	209.90

Summary

Table 18 summarises the results from the eye-tracking data quality assessment. Overall, data obtained from 11 participants, including five language learners, five translation students and one professional translator, were deemed invalid. For comparability, the data obtained from one participant would only be considered as valid if the quality of all three translation tasks fell within the range of acceptability by the quality criteria. For example, since Participant L17's translation of Text A failed to meet the requirements of two criteria, this participant's translations of Text B and Text C were also excluded. To conclude, the discard rate in the present study is 16.18%.

Table 18. Summary of eye-tracking quality assessment with invalid data (marked as ×)

Participant	Text A			Text B			Text C		
	GTS	**GFP**	**MFD**	**GTS**	**GFP**	**MFD**	**GTS**	**GFP**	**MFD**
L16	×	×	×	×	×	×	×	×	×
L17	×		×			×			×
L19		×	×	×	×	×	×	×	×
L20	×	×	×	×	×	×	×	×	×
L21	×	×	×	×	×	×	×	×	×
S01	×		×	×			×		×
S06		×	×	×	×				
S10	×		×	×		×	×	×	×
S15				×		×	×		×
S23				×		×			
P06	×	×		×	×		×	×	

5.2.2.3 Data export

Tobii software provides two sets of data: one exported from the Metrics function, which was based on the AOIs, and one exported from the Data Export function, which was based on the raw gaze samples. In the Metrics function, the relevant parameters include: Recording, Participant, TOI, AOI, Total_duration_of_fixations, and Number_of_fixations (see Figure 17 for a sample). The first two columns, Recording and Participant, refer to the code of the task and the participant. Column C and D refer to the name of the defined TOIs and AOIs. It was possible for multiple AOIs to be identified within one TOI. Column E and F, Total_duration_of_fixations and Number_of_fixations, refer to the sum of fixations in milliseconds and the number of fixations on the specific AOI.

	A	B	C	D	E	F
1	Recording	Participant	TOI	AOI	Total_duration_of_fixations	Number_of_fixations
2	P77_T01	P77	P77_alas	ELe	492	4
3	P77_T01	P77	P77_alas	L	8992	44
4	P77_T01	P77	P77_empathise	L	9012	40
5	P77_T01	P77	P77_steadfastly	ELe	0	0
6	P77_T01	P77	P77_steadfastly	L	3960	23
7	P77_T01	P77	P77_T01	Full	597002	2675
8	P77_T01	P77	P77_T01	ST	211047	1029
9	P77_T01	P77	P77_T01	TT	317452	1358
10	P77_T01	P77	P77_T01	Web	65236	270
11	P77_T01	P77	P77_T02	Full	597002	2675
12	P77_T01	P77	P77_T02	ST	247199	1182
13	P77_T01	P77	P77_T02	TT	278636	1190
14	P77_T01	P77	P77_T02	Web	65236	270
15	P77_T01	P77	P77_T03	Full	597002	2675
16	P77_T01	P77	P77_T03	ST	222563	1080
17	P77_T01	P77	P77_T03	TT	308896	1319
18	P77_T01	P77	P77_T03	Web	65236	270

Figure 17. A sample data set exported from the Metrics function

In the Data Export function, the relevant parameters include: Recording timestamp [ms], Eye movement type, Gaze event duration [ms], Eye movement type index, and AOI hit (see Figure 18 for a sample). Column A (Recording timestamp [ms]) refers to the timestamp of all the gaze and key events and is accurate to milliseconds. This parameter does not directly provide data for analysis, but it is included to confirm that fixations are listed following the right sequence. Column B (Eye movement type) indicates the type of each gaze sample. It includes Fixation, Saccade, Unclassified, and Eyes not found. Column C (Gaze event duration [ms]) refers to the total duration in milliseconds of each filtered eye movement rather than each gaze. For instance, in the sample data set, the gaze event duration for all the gaze events was the same, because these events formed the same fixation with a duration of 793 milliseconds. Column D (Eye movement type index) provides a sequence of all the fixations and saccades. Column E (AOI hit) represents whether the gaze is located in the selected AOI, with “1” being positive and “0” being negative. One .xlsx file was exported using the Data Export function for each TOI. Since several AOIs can exist within one TOI, there could be several AOI hit columns.

	A	B	C	D	E
1	Recording timestamp [ms]	Eye movement type	Gaze event duration [ms]	Eye movement type index	AOI hit [P53_T01 - Web]
2	53597	Fixation	793	122	0
3	53601	Fixation	793	122	0
4	53605	Fixation	793	122	0
5	53609	Fixation	793	122	0
6	53613	Fixation	793	122	0
7	53617	Fixation	793	122	0
8	53621	Fixation	793	122	0
9	53625	Fixation	793	122	0
10	53629	Fixation	793	122	0
11	53633	Fixation	793	122	0
12	53637	Fixation	793	122	0
13	53641	Fixation	793	122	0
14	53645	Fixation	793	122	0
15	53649	Fixation	793	122	0

Figure 18. A sample data set exported from the Data Export function

5.2.3 Transcription of Screen-recording Data

Although the quality of the screen-recording data was not affected by the quality of the eye-tracking data, in order to use the data for between-task comparison, only the recordings that met the eye-tracking quality assessment were used for further analysis.

The aim of transcribing the screen-data was to create a script "resembling 'stage directions'" (Pavlović, 2007, p. 76) detailing every information search behaviour within the translation process. In order to do so, a coherent transcription method was developed, which should also be used to pool and exchange the same type of data in other research projects. Only the consultation activities were transcribed, such as typing a search query, modifying a query, clicking a link or a button, and typing a URL.

Hargittai (2004) developed a transcription method for "coding and classifying users' online information-seeking behaviour". She argued that this method "makes it possible to understand many details about users' sequence of actions simply by looking at the spreadsheet that contains the information" (p. 210). Her method contains three key components: (1) an online action, such as accessing a uniform resource locator (URL), clicking on a button or a link, or searching; (2) specific details of the action, such as the URL, the timestamp, and the search query; and (3) a search result. She provided an extremely detailed coding and classification method, in which each action was given a numeric code. The method was divided into 10 categories including (1) directly accessing a URL (Web address) including default Home, (2) browser buttons, (3) search engines, (4) search engine results, (5) particular search engine

results, (6) directory categories, (7) advertisements, (8) links, (9) miscellaneous, and (10) scrolling. Table 19 presents the actions listed in the first category.

Table 19. An excerpt from Hargittai's (2004) list of web search actions (p. 223)

Code	Descriptive of action
	Directly accessing a URL (Web address) including default Home
10	Type in URL in location bar
101	Type in URL without .com extension and press Ctrl-Enter
11	File → Open
12	America Online (AOL) Internet www.
13	URL truncation
14	Pull down location bar for URL
15	Back button pull-down for URL
16	Go menu (Netscape) for previous URL
17	Home button
171	Default move to homepage
18	Favourites button/Bookmark
181	Favourites button/Bookmark with Favourites/Bookmark directory

It can be seen from Table 18 that Hargittai's (2004) method was extremely detailed. She also suggested that "not all projects may require the level of detail the classification scheme makes possible" (p. 211). Some of the listed items or even entire categories are not necessary for the present study. For instance, the participants were only allowed to use the web browser for external consultation, so they would not conduct Action 11 (File → Open). In addition to this, one of the categories, "particular search engine results", includes the search actions with specific search engines, including AOL, Google, Yahoo!, and MSN. Taking the actions on AOL search engines as an example (see Table 20), these actions cover almost all the functions of AOL as a search engine. This detailed list of actions might be helpful in a study about the use of search engines, but it is not necessary in an investigation about the use of consultation in translation.

Table 20. Actions listed under the category "particular search engine results" (Hargittai, 2004, p. 224)

Code	Descriptive of action
	Particular search engine results
500	AOL search results link
501	AOL Recommended Sites link
502	AOL Sponsored Links link
503	AOL Matching Sites link
504	AOL Narrow Your Search link
505	AOL "Search for 'x' on:" link
506	AOL Other Searches
507	AOL "Show me more like this" link

Based on the previous description of Hargittai's (2004) transcription method of web search actions, it can be seen that her categorisation is not entirely appropriate for the present study. Nevertheless, further suggestions can be seen in existing studies on consultation in translation that transcribed screen-recording data. Enríquez Raído (2014) also noticed that Hargittai's (2004) transcription method is too detailed, so she made some modifications. Her transcription method covered three sub-tasks within the translation process: translating, web searching, and problem-solving reporting with online search report (OSR). It contained the time, actions, URL, actions on the webpage, and a new metric "task environment", which was to report how participants switched between sub-tasks (translating, problem-solving reporting, and web searching). By adding this metric, she developed the transcription method by providing "a contextualized analysis of web-searching behaviors from a multitasking perspective" (p. 103).

Shih (2019) also transcribed the web search behaviours in translation based on the screen-recording videos. She did not provide a detailed explanation of the transcription method; instead, she presented several searching examples (see Table 21). This example shows that her transcription method contained four main parts: time frames, queries, URLs, and notes. The first three parts provide a specific description of the action, and the fourth part presents the details of the actions.

Table 21. An example of web search episode presented by Shih (2019, p. 9)

Time frames	Queries	URLs	Notes
13:40	Station 0	Zh.wikipedia	
14:00	Station 0 胎位 (LT: foetus position)	Zh.wikipedia	
14:20	Station 0 胎位 (LT: foetus position)	Baidu	
14:28	Station 0 婴儿头部位置 (LT: baby's head position)	Baidu	
14:59	Station 0 胎儿头部位置 (LT: foetus head position)	Baidu	
15:02	Station 0 胎儿位置 (LT: foetus position)	Baidu	
15:19	胎儿位置 (LT: foetus position)	Baidu	
15:38	产前胎儿位置 (LT: foetus position before birth)	Baidu	Click 1st result: Baidu Baike 胎位 Dwell time: 11 sec
15:49			Open zh.wikipedia.org
15:56	胎位 (LT: foetus position)	Zh.wikipedia	Click 难产 in Wiki Dwell time: 40 sec
16:36			Backtrack to Baidu Baike 胎位 (previously clicked webpage)
17:26	胎儿头部朝上 临盆 (LT: foetus head facing upwards right before birth)	Baidu	
17:55	胎儿头部位置 (LT: foetus head position)	Zh.wikipedia	No results found in Wiki
18:05	胎儿头部朝上 (LT: foetus head facing upwards)	Zh.wikipedia	No results found in Wiki
18:40	胎位 (LT: foetus position)	Baidu	Reading Baidu content about 'occipital'
20:11	STOP		Start to self-translate 'station 0' into TL.

The advantage of these two transcription methods is that they are both specially designed for consultation in translation, so the actions included in these methods are not too detailed or redundant. In addition, Enríquez Raído (2014) emphasised the multitasking perspective of translation with consultation and included the between-task switches in her transcription

method. However, these two methods also have the same disadvantage: they do not provide a systematic coding system for the web search actions. This issue is not significant for small-scale experiments, in which narrative descriptions can also be used to conduct cross-comparisons. However, this disadvantage means that these two methods are not appropriate for the present study as it used screen-recording videos from 57 participants. The larger amount of data required a systematic coding system for the web search actions. In addition, the transcription method proposed in the present study can also be used in further experiments on consultation in translation. With this aim in mind, a unified coding method should be developed.

Based on the existing methods, the transcription method for consultation in translation used in the present study is presented and illustrated as follows. It consists of seven items:

(1) Time frame, which refers to the time when the corresponding action took place.

(2) Action, which is categorised into five types and each action was given a numeric code following Hargittai's (2004) transcription scheme (see Table 22). The five categorisations cover the entire process of a web search task, including the beginning, information-searching behaviours, evaluating search results, moving to other webpages, and the ending. Inspired by Enríquez Raído's (2014) study, the ending includes both the ending of the web search task and the start of translating.

Table 22. Coding method for actions used in the present study

Code	Actions
	Accessing a URL
10	Type in new URL in location bar
11	Type in visited URL in location bar
111	Use back button to access a visited URL
112	Select an open website
	Information-searching behaviour
20	Search with unmodified ST segment as the query
201	Search with modified ST segment (in SL)
21	Search with TL query
22	Search with both SL and TL query
	Information evaluation
30	Read the search result
31	Read the search result with highlight
	Subsequent action
40	Click link - to offsite
41	Click link - to within site
42	Click link - to within page
43	Click on multimedia link
	Miscellaneous action
50	Close window
60	Translate
61	Re-translate

(3) Sequence, which refers to the sequence of the corresponding query within one web search task.

(4) URL, which refers to the address of website consulted in the query.

(5) Resource type, which is based on PACTE's categorisation of online resources (Kuznik, 2017; Kuznik & Olalla-Soler, 2018). The list contains 8 items: (a) search engines, such as Google or Baidu; (b) bilingual dictionaries, such as Youdao Dictionary or Bing Dictionary; (c) monolingual dictionaries, such as Oxford English Dictionary; (d) dictionaries of synonyms, such as WordReference; (e) encyclopaedias, such as Wikipedia; (f) databases, such as UNTERM; (g) online corpora, such as Collins; and (h) online or field-specific portals, such as information related to the subject of the STs.

(6) Query, which refers to the search queries used by the participant.

(7) TT, which refers to the produced translation solution. It should be noted that the

presented TT is not always the final solution. In some cases, the translator may revise their translation solution.

For a better illustration of the proposed transcription method, Table 23 presents a transcription example of the web search task conducted for translating “coral reef” by Participant S02. In this example, the participant started the web search task by directly typing in a new URL “youdao.com” in the location bar. This was the first query to a bilingual dictionary in this web search task. The participant then conducted the search with “coral reef” as the key word. After reading the search result with no other actions, the participant went back to the translating section and produced the translation solution.

Table 23. A transcription example of web search task

Time frame	**Action**	**Sequence**	**URL**	**Resource type**	**Query**	**TT**
00:13	10	1	youdao.com			
00:37	20			Bilingual dictionary	coral reef	
00:39	30					
00:50	60					珊瑚礁

5.2.4 Target Text Quality Assessment

The assessment of translation quality was conducted from two perspectives: the quality of all the TTs and the acceptability of the individual translation solutions.

To assess the quality of the TTs, the Multidimensional Quality Metrics (MQM) framework, developed as part of the EU-funded QTLaunchPad project (http://www.qt21.eu/launchpad), was used (Burchardt & Lommel, 2014). This framework provides a flexible vocabulary of quality issue types and a mechanism for applying them to generate quality scores (Klubička et al., 2017). It does not impose a single metric for all uses, but includes a comprehensive catalogue including 108 quality issue types that can be categorised into five subdivisions: fluency, accuracy, verity, design, and internationalisation (Lommel et al., 2013).

In the present study, the MQM framework was chosen to assess the quality of TTs because

of its flexibility in the issue types and their granularity — it provided a reliable assessment methodology and still allowed researchers to pick and choose which error tags they wished to use. To fit the task which was from-scratch translation without using any CATs, 10 metrics from three subdivisions that are suitable for translation quality evaluation were selected (see Figure 19).

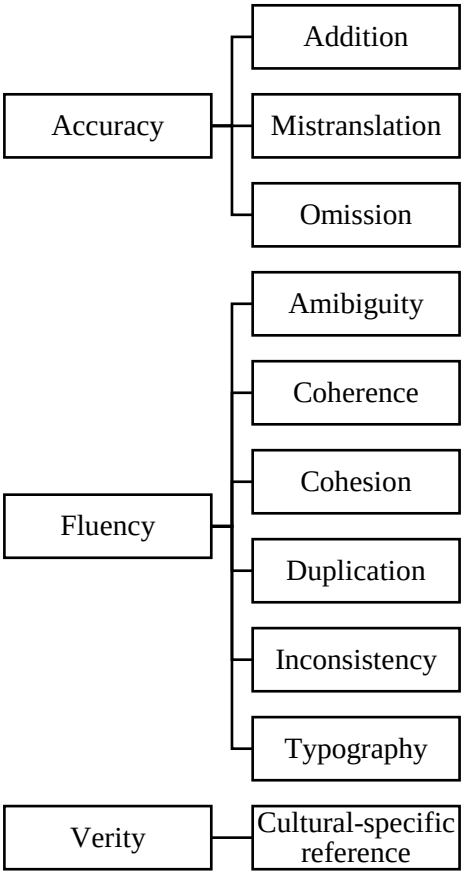

Figure 19. MQM metrics used in the present study

Two professional translators were invited to assess the holistic quality of 174 translated texts using the MQM system individually. They had prior experience of using the MQM framework and the same education background: PhD degrees in Translation Studies. They were thoroughly familiarised with the official guidelines and the process prior to assessing (see "http://www.qt21.eu/mqm-definition/definition-2015-12-30.html#issue-list" for the guideline). The assessors were provided with the STs, the reference translation texts, and the TTs for assessment at the same time. They were asked to identity the existing translation problems in

the TTs, categorised them into accuracy penalty (AP), fluency penalty (FP), or verity penalty (VP) and annotated them as minor, major, and critical.

After receiving all the evaluation reports, the penalty points and subsequently the scores of translation quality (TQ) were calculated using the following formulae (Lommel et al., 2013, p. 6):

$$\text{Penalty} = \left(\text{Issue}_{\text{minor}} + \text{Issue}_{\text{major}} \times 5 + \text{Issue}_{\text{critical}} \times 10\right) \div \text{Word Count}$$

$$\text{TQ} = 100 - \text{AP} - \text{FP} - \text{VP}$$

The mean value of the two evaluation results was used as the final score for each TT.

For the assessment of individual translation solutions, PACTE's (2009) acceptability criteria were applied in the present study. Translation acceptability is related to the quality of the translation product and is defined "in terms of whether or not the solution effectively communicates (1) the meaning of the ST, (2) the function of the translation (within the context of the translation brief, the readers' expectations, genre conventions in the target culture), and (3) makes use of appropriate language" (Kuznik & Olalla-Soler, 2018, p. 20). The acceptability criteria are grouped into three main categories: meaning (i.e., the extent to which source-text meaning is reproduced), function (i.e., how adequately the function of the translation and the translation brief have been achieved), and language (i.e., how appropriate the use of the target language is). An assessment result is given for each category, and the operational definitions are presented in Table 24.

Table 24. Operational definitions for the three assessment results (PACTE, 2009)

Result	Value	Operational Definition
Acceptable solution (A)	1	The solution activates all the relevant connotations of the ST in the TT.
Semi-**A**cceptable solution(SA)	0.5	The solution activates some of the relevant connotations of the ST in the TT, and maintains the coherence of the TT.
Non-**A**cceptable solution (NA)	0	The solution activates none of the relevant connotations of the ST in the TT, or introduces connotations that are incoherent

27 possible permutations existed for each solution, which were considered to be: acceptable (A), semi-acceptable (SA), or non-acceptable (NA) according to the method presented in Table 25, with each category being given a numeric value.

Table 25. Permutations of acceptability (PACTE, 2009, p. 218)

Meaning	Function	Language	Assessment	Numerical Value
A	A	A		
A	A	SA		
A	SA	A	A	1
A	SA	SA		
SA	A	A		
A	A	NA		
A	SA	NA		
A	NA	A		
A	NA	SA	SA	0.5
SA	SA	A		
SA	SA	SA		
SA	A	SA		
A	NA	NA		
SA	SA	NA		
SA	A	NA		
SA	NA	A		
SA	NA	SA		
SA	NA	NA		
NA	A	A	NA	0
NA	SA	A		
NA	SA	SA		
NA	SA	NA		
NA	A	SA		
NA	A	NA		
NA	NA	A		
NA	NA	SA		

The two assessors who scored the holistic translation quality were invited to assess the acceptability of translation solutions. Where doubts arose, both assessors were consulted so that they could agree on a result.

5.3 Data Annotation

This section explains the definitions and annotation methods of the metrics used in the present study. The list of the metrics is presented in Table 26. This list is divided into two parts: metrics used to explore the holistic consultation tasks and for individual web search tasks.

Table 26. List of metrics used in the present study

Consultation task	Metric	Data source
Holistic consultation	Amount of attention	Eye-tracking
	Proportion of attention	Eye-tracking
	Cognitive load	Eye-tracking
	Resource type variety	Screen recording
	Number of transitions	Eye-tracking
Web search tasks	Amount of attention	Eye-tracking
	Proportion of attention	Eye-tracking
	Cognitive load	Eye-tracking
	Consultation style	Screen-recording

Amount and proportion of attention

Attention refers to focusing the conscious awareness on a certain object while filtering out information, but suppressing and ignoring non-relevant information (Hvelplund, 2021). James (1890) proposed a definition of attention:

> [Attention] is the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others. (p. 403)

Attention can be constructed as a behavioural and sometimes observable cognitive process, but it is different from cognition. It is "a type of cognitive process by which the mind engages cognitive resources on a specific object" while cognition refers to "the mental processing of sensory information and information already held in a person's memory" (Hvelplund, 2021, p. 279). In empirical studies, three methods can be used to measure attention in translation: eye-tracking, key-logging, and TAP. The advantages and disadvantages of using these three methods in empirical studies have been discussed in the previous sections and eye-tracking proved to the most suitable method for the present study. Among these three methods, eye-tracking is the newest method, dating back to O'Brien's (2006) study on translation memory matches using pupillary data. In the last decade, eye-tracking has become a popular method to investigate

translators' visual attention and the underlying cognitive processes. Attention involves focusing on a specific environmental stimulus while ignoring other stimuli. For example, if a person is reading a book in a noisy environment, he/she would ignore the noise in order to pay attention to the contents of the book. In the translation process involving consulting external resources, when a translator focuses on consultation, he/she is not able to pay attention to translating and thus needs to consider the distribution of attention.

Distribution of attention during translation has been examined with eye-tracking data. For example, Jakobsen and Jensen (2008) calculated the amount of visual attention indicated with total gaze time and found that professional translators looked at the TT nearly twice as much as they looked at the ST. In a study of 24 translators (12 professionals and 12 students), K. T. Jensen (2011) also used the proportion of gaze time as an indicator of attention distribution. He found that around 71% of the professionals' gaze time and 63% of the students' gaze time were allocated to the target-text area on the screen. The remainder (29% and 37%, respectively) was allocated to the ST (with and without concurrent typing). The same calculation method was also used by Pavlović and Jensen (2009) in their investigation of translation directionality. They reported the same distribution pattern irrespective of translation direction: source-text/target-text processing in L1 translation, 36%/64%, respectively, and in L2 translation, 31.5%/68.5%, respectively. Going beyond the binary division of the translation task into ST and TT processing, Hvelplund (2017) compared the amount of attention distribution allocated to translation drafting, translation revision, and digital resource consultation in translating literary texts and LSP texts. He reported that digital resource consultation accounted for roughly 19.4% of the overall translation task time with 62.6% allocated to translation drafting and 18.0% allocated to translation revision.

In the present study, the amount of attention was measured with the total amount of gaze time allocated to the selected AOI within the selected TOI. For example, the amount of attention distributed to consultation in translating a ST was calculated as the amount of total gaze time (in second) distributed to the AOI named "Web" within the TOI named "Full_Paricipant number_Task number". This metric was used in both the examination of holistic consultation and individual web search tasks. The proportion of attention was also used in both perspectives

of the investigation, but the calculation methods for this metric were different. In investigating the holistic consultation, the proportion of attention was calculated as the proportion of attention allocated to consultation over the holistic translation task. In investigating the individual web search tasks, the proportion of attention was used to indicate translators' evaluation of different types of information and was calculated as the proportion of the amount of gaze time allocated to specific information sections over the entire web search tasks.

Cognitive load

Two types of eye movement data have been commonly used to assess cognitive load: behavioural (voluntary) eye movements like fixation duration, and physiological (involuntary) eye movements like pupil size. Various studies have used fixation duration to indicate cognitive load in reading studies. Longer fixation durations have been found when processing long words (Just & Carpenter, 1980), unfamiliar words (Chaffin et al., 2001), ambiguous words (Rayner & Duffy, 1986; Sereno et al., 2006), and comprehending metonymic referential descriptions and metaphorical expressions (Gibbs, 1990). Fixation duration is also used to indicate cognitive load in Translation Studies. Hvelplund (2017) used MFD to compare the cognitive load allocated to translation drafting, revision, and consultation. He found that MFD on consultation was longer than on translation and suggested that consultation was more cognitively demanding than translating.

Pupillary response, as an involuntary reflex, is "often taken as an indicator of the working load placed on the cognitive system" (Hvelplund, 2014, p. 214). Hess and Polt (1964) first found a positive correlation between pupil size and task difficulty, suggesting that an increase in task complexity elicited a strong pupillary response and arguing that pupil size is a valuable tool in the study of problem-solving and other mental processes. In reading experiments, Just and Carpenter (1993) examined the intensity of processing during sentence comprehension by measuring pupil size and found that more complex sentences required a larger amount of processing time and triggered larger pupil dilations. However, existing studies have found that using pupillary response to indicate cognitive load in complex tasks is not reliable, since it may

be influenced by a variety of factors. For example, Hess and Polt (1960) stated that emotion has a bi-directional effect on pupil change: the pupils constrict when people view unpleasant images and dilate when they view pleasant images. Libby et al. (1973) later conducted a more extensive analysis of pupillary changes during affective picture viewing and also confirmed that pupillary response is influenced by emotion. Another factor that affects the reliability of pupillary response is task length. Schultheis and Jameson (2004) found that reading more difficulty texts leads lower reading speed, higher subjective load ratings, and a reduced P300 amplitude, but has no effect on pupil size. They proposed that pupil size may not be suitable as an indicator of cognitive load in long tasks involving hypertexts. Liu et al. (2019) reported a strong correlation between fixation and saccade duration and translation difficulty, but no correlation between pupil dilation and translation difficulty. They suggested that "pupil size may not be a suitable indicator of cognitive load for translation tasks lasting for a relatively long period" (p. 141).

Translation with consultation is a complex activity that involves multiple actions and participants' emotions could be influenced by the information-seeking results. Schultheis and Jameson (2004) proposed that pupil size could be utilised as an indicator of cognitive load with at least three of the following five conditions being applied: (1) constant lighting; (2) avoidance of eye movements; (3) use of nonvisual (e. g., acoustic) stimuli; (4) use of many similar, short tasks; and (5) evaluating only mean values averaged across tasks and subjects (p. 227). Conditions (1) and (5) are possible to apply in the present study, but not the rest. Therefore, pupiliary measurements would not be a reliable measure of cognitive load and only fixation duration would be used as the indicator of cognitive load in the present study. Fixation duration was retrieved from the Metric function in the Tobii software (see section 5.2.2) and was calculated for consultation in translating both holistic texts and individual segments.

Resource type variety

The variety of resource types was retrieved from the transcription of the screen-recording data. As illustrated in section 5.2.3, PACTE's categorisation of online resources is used to indicate

the online resource types (Kuznik & Olalla-Soler, 2018, pp. 31-32), which includes eight items: (1) search engines, (2) bilingual dictionaries, (3) monolingual dictionaries, (4) dictionaries of synonyms, (5) encyclopaedias, (6) databases, (7) online corpora, and (8) online or field-specific portals. In the present study, six types of online resources [excluding (4) dictionaries of synonyms and (6) databases] were consulted by the participants.

Number of transitions

In the translation process with consultation, participants have to frequently make transitions between translating and consultation, which leads to a *switch cost* in time and cognitive resources. The basis for switch costs is still a controversial topic (Arrington & Logan, 2004). Some researchers argue that these costs reflect active processes, which include updating working memory, retrieving information from long-term memory, or activating the production rules associated with a particular task (Logan & Gordon, 2001; Mayr & Kliegl, 2000; Rubinstein et al., 2001); while others suggest that these costs reflect passive interference from memories of past task sets or interference from associations between the current stimulus and its interpretation from the last task set (Allport & Wylie, 2000; Wylie & Allport, 2000). Nevertheless, both interpretations confirm that task switching leads to a cost in cognitive resources. Hvelplund (2019) categorised three attention-demanding areas [ST, TT, and digital resources (DR)] and divided the transitions between these areas into four types: ST-DR-ST, ST-DR-TT, TT-DR-ST, TT-DR-TT. He compared the number of occurrences of the four patterns and found that ST-DR-TT was the most frequently occurring pattern. Therefore, instead of calculating the precise amount of time and cognitive resource cost in each task switching, the difference in the numbers of transitions was used as an indicator of the cost.

In the present study, when eye fixations moved from translating to consultation and moved back, this movement was defined as one transition. A sample of transition calculation is presented in Figure 20. Firstly, only gaze events that were categorised as fixations were included in the analysis. Secondly, each gaze was annotated as “ST”, “TT”, or “Web” based on the AOI hit parameter from the datasets exported with the Data Export function in the eye-

tracking software. This annotation work was conducted with the Excel “if” function: E2=IF(B2="1","ST", IF(C2="1","TT","Web")). Thirdly, from the second gaze event, the types of transition were annotated with the function: F3=E2&"-"&E3. Fourthly, the number of transitions was calculated as the total number of “ST-Web” and “TT-Web” transitions. However, the number of transitions might be affected by the frequency of consultations, as they were triggered by the need for external information. For each translation segment that required consultation, at least one transition was involved. Since Text B was perceived to be more difficult to translate, the number of translation problems that required external information was naturally higher, which inevitably led to more between-task transitions. Therefore, in order to eliminate this effect, the number of transitions was calculated based on the number of redundant transitions, which equalled the total number of transitions subtracted by the number of translation problems with consultation.

	A	B	C	D	E	F
1	AOI hit [P	AOI hit [P	AOI hit [P	AOI hit [P	Code	Transition
2	1	1	0	0	ST	
3	1	1	0	0	ST	ST-ST
4	1	1	0	0	ST	ST-ST
5	1	1	0	0	ST	ST-ST
6	1	1	0	0	ST	ST-ST
7	1	1	0	0	ST	ST-ST
8	1	1	0	0	ST	ST-ST
9	1	1	0	0	ST	ST-ST
10	1	1	0	0	ST	ST-ST
11	1	1	0	0	ST	ST-ST
12	1	1	0	0	ST	ST-ST
13	1	1	0	0	ST	ST-ST
14	1	1	0	0	ST	ST-ST
15	1	1	0	0	ST	ST-ST

Figure 20. An example of the calculation of between-task transitions

5.4 Data Analysis

Student's *t*-test

Gossert (1908) initially published the classic parametric test for comparing two groups under the pseudonym "Student", which led this test being referred to as Student's *t*-test. This test is utilised to compare two groups to each other in respect to a particular measurement. It is widely adopted as a data analysis method in Translation and Interpreting Studies. For example, O'Brien (2007) compared two groups of English-to-German translators, one set of participants translating the text and the other post-editing a machine-translated text. Carl et al. (2011) compared human translation and post-editing of machine translation output and used independent *t*-tests to indicate a statistically significant difference between the two tasks. In both studies, two distinct groups of participants performed a task under different conditions. A variation of this research design is to use the same group of participants and compare their behaviours under different conditions. For instance, Roziner and Shlesinger (2010) compared the differences in the working conditions of remote and on-site conference interpreters. They asked the same group of interpreters to work under two different conditions. Similarly, Braun (2013) compared the performance of the same group of French-English legal interpreters in remote and face-to-face settings. Both studies used *t*-tests to determine the statistical significance of the data sets.

Three assumptions should be met to conduct the *t*-test: (1) the observations are independent; (2) the variance of the two groups are identical, known as homogeneity of variance or homoscedasticity; and (3) the underlying population must be normally distributed (Mellinger & Hanson, 2017, p. 91). When the assumptions are violated, alternative procedures are recommended. Welch's *t*-test is designed to counteract the effects of unequal variances, and the Mann-Whitney *U*-test is preferable when the underlying populations are not normally distributed. When both assumptions are not met, conducting Welch's *t*-test on the rank transformation of the raw data (Ruxton, 2006; Zimmerman & Zumbo, 1993) would be a straightforward method.

In the present study, perceived translation difficulty and translation experience were used as two independent variables to conduct the comparisons between two groups. For perceived translation difficulty, the same group of participants was asked to translate under two conditions; for translation experience, two different groups of participants were asked to translate under the same condition. Both cases were suitable for the use of Student's *t*-tests to evaluate between-group comparisons.

Analysis of variance (ANOVA)

ANOVA is a powerful statistical procedure that can be used to determine whether there are statistically significant differences in the means of three or more independent groups (Mellinger & Hanson, 2017). The comparison across three or more groups is a commonly used research method in Translation and Interpreting Studies. For instance, Yudes et al. (2011) explored differences among simultaneous interpreters, bilinguals without training in simultaneous interpreting, and monolinguals in their performance on the Wisconsion Card Sorting Test, which was a measure of executive process. They analysed the data with a one-way ANOVA with participants' language experience as the independent variable and the task performance as the dependent variable. In a broad study of mediation effects in translated and edited texts, Kruger (2012) utilised ANOVA with three levels of text types as the independent variable and the ratio of contracted to non-contracted forms as the dependent variable. With a similar ANOVA design, Redelinghuys and Kruger (2015) compared the differences among three types of texts: (1) texts translated by experienced translators, (2) texts translated by inexperienced translators, and (3) non-translated texts. They used the three levels of text types as the independent variable and the readability of the texts as the dependent variable.

Three assumptions should be met to conduct the ANOVA: (1) the observations are independent; (2) the variance of each group must be identical (homoscedasticity); and (3) the residual errors must be normally distributed (Mellinger & Hanson, 2017, p. 115). For cases where these three assumptions cannot be met, the Kruskal-Wallis test is the most common nonparametric alternative.

In the present study, the categorisation of individual translation problems was used as the independent variable in investigating the effect of information need on consultation. Since the categorisation covered three types, the differences across them were investigated with ANOVA.

Correlation

Correlation is used to measure the strength of the linear relationship between two variables. It is useful for describing and establishing the statistical significance of the co-movement of two variables. For instance, PACTE (2011) reported a correlation between the Dynamic Translation Index and the translation acceptability score with Pearson's *r*. Sun and Shreve (2014) examined the correlation of translation difficulty score with a number of variables, such as the time spent on a translation and the translation quality score.

The classic parametric statistic measure of correlation is Pearson's product-moment correlation, which can be shortened to Pearson's correlation or Pearson's *r*. This test requires five assumptions: (1) the data should follow a bivariate normal distribution; (2) the data do not exhibit any significant outliers; (3) the data should be homoscedastic, meaning that the variance of one variable does not change based on the level of the other variable; (4) there must be a linear relationship between the two variables, which means the rate of change is constant across the sample; and (5) the data are independent. In the case that these assumptions could not be met, a nonparametric procedure called Spearman's ρ is recommended (Mellinger & Hanson, 2017, p. 192).

In the present study, the correlation between translation problem type and consultation, and the correlation between consultation and translation quality were investigated. Pearson's r correlation or Spearman's ρ was used based on whether the data were normally distributed and homoscedastic.

Effect size

Effect size provides "an understanding of the strength and practical impact of a difference or

relationship" (Mellinger & Hanson, 2017, p. 77). The Publication Manual of the APA emphasises the importance and need to report effect sizes to convey the full results of a study. Standardised effect sizes come in two primary types, known as the *d* family and the *r* family. The *d* family measures the standardised difference between groups, such as Student's *t*-test, and the *r* family focuses on the strength of relationships.

Chapter 6: Information Need and Consultation

This Chapter aims to answer the first research question: what is the effect of information need on consultation in translation? As illustrated in section 3.2, information need is defined and investigated from two perspectives: the level of information need triggered by translating the entire ST and information needs triggered by translating individual segments.

6.1 Perceived Translation Difficulty and Consultation

In the holistic translation task, the perceived translation difficulty was considered as the task attribute which affected consultation behaviours. As the perceived translation difficulty increased, the translator needed more information to produce the TT. For the same translator, his/her internal knowledge remained at the same level. When more knowledge was required, the gap between the translator's internal knowledge and the required knowledge widened. Therefore, the following hypotheses were proposed: the increase in the perceived translation difficulty would (1) lead to an increase in the amount of attention allocated to consultation and in the proportion of attention distributed to consultation over the entire translation process, (2) require participants to use more types of online resources, (3) lead to an increase in the cognitive load allocated to consultation, and (4) result in a decrease in cognitive efficiency.

In this section, only one independent variable was involved: perceived translation difficulty. Since the level of translation experience was considered to be another independent variable, the present study collected data from three groups of participants with different levels of translation experience. This variable was not considered to be relevant in answering the first research question, so the between-group comparison was not performed. Several process-oriented indicators were used as the dependent variables to test each hypothesis and a conclusion for each hypothesis is presented at the end of this section. The dependent variables included: (1) the amount of attention, which was indicated by gaze time allocated to consultation; (2) the proportion of attention distributed to consultation, which was indicated by the proportion of gaze time allocated to consultation over the entire translation process; (3) the use of online resources, which was reflected in the number and preference of online resources; (4) cognitive load, which was indicated by MFD allocated to consultation; and (5) cognitive

efficiency, which was indicated by the number of transitions between translating and consultation. The data used in this section were collected from the consultation behaviours of translating Text A and B conducted by 56 participants (including 17 language learners, 18 translation students, and 21 professional translators).

6.1.1 Amount and Proportion of Attention

The amount of attention allocated to consultation when translating the entire text was calculated by the amount of gaze time, an eye-tracking metric calculated based on the methods illustrated in Chapter 5. Table 27 presents the mean values of the amount of gaze time allocated to consultation when translating Text A and B by three groups of participants. The results show that all participants allocated a greater amount of attention to consultation when translating Text B than Text A.

Table 27. Amount of gaze time (seconds) on consultation when translating Text A and B by three groups of participants

Group	N	Text A		Text B	
		Mean	SD	Mean	SD
Language learners	17	60.74	39.86	207.67	154.53
Translation students	18	78.92	96.23	251.33	156.23
Professional translators	21	47.45	46.86	175.29	128.19

Additional statistical analyses were performed to determine whether the differences were significant. Tables 28 and 29 show that the group variances were homogeneous, but not all the groups of data were normally distributed. Therefore, Wilcoxon matched-pairs signed-ranks tests were performed, and the results confirm the differences are all statistically significant (see Table 30).

Table 28. Test of homogeneity of variances (amount of gaze time on consultation when translating Text A and B by three groups of participants)

Group	Statistic	*df1*	*df2*	Sig.
Language learners	10.488	1	32	> .05
Translation students	4.911	1	34	> .05
Professional translators	5.776	1	40	> .05

Table 29. Shapiro-Wilk normal distribution test (amount of gaze time on consultation when translating Text A and B by three groups of participants)

Group	Text A			Text B		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
Language learners	.958	17	> .05	.884	17	< .05
Translation students	.650	18	< .05	.810	18	< .05
Professional translators	.856	21	< .05	.821	21	< .05

Table 30. Wilcoxon matched-paired signed ranks tests (amount of gaze time on consultation when translating Text A and B by three groups of participants)

Group	Statistic	Sig	Hedge's *g*
Language learners	3.309	< .05	.96
Translation students	3.783	< .05	1.10
Professional translators	3.989	< .05	1.00

In the experimental design of the present study, there were no time constraints, which meant that the amount of gaze time allocated to consultation could vary depending on the participants' personal processing behaviours, and the raw data could not reveal the actual proportion of attention allocated to these areas. A greater amount of attention allocated to consultation might be the result of a longer translation process, but not the result of a greater proportion of allocated attention. In some previous studies, the proportion of consultation was calculated using the length of consultation in time (Daems et al, 2016; Kuznik & Olalla-Soler, 2018). However, the observation of the translation process revealed that the participants' attention flitted frequently between translation and resource consultation, which made it difficult to accurately assess the length of the consultation. Hvelplund (2017, 2019) used the percentage of gaze time to investigate the attention distribution on consultation in the translation process. His calculation method was followed in the present study, by using the percentage of gaze time allocated to consultation over the entire translation process as an

indicator of the proportion of attention. The mean values of the proportion of gaze time allocated to consultation over the entire process of translating Text A and B by three groups of participants are presented in Table 31. The results show a similar trend compared to the differences in the amount of attention: when translating the more difficult ST, Text B, all groups of participants allocated a greater proportion of attention to consultation.

Table 31. Proportion of gaze time allocated to consultation over the holistic translation task when translating Text A and B by three groups of participants

Group	N	Text A		Text B	
		Mean	SD	Mean	SD
Language learners	17	11.22%	4.81%	23.14%	11.63%
Translation students	18	12.94%	9.17%	26.69%	7.83%
Professional translators	21	9.04%	7.13%	20.58%	11.14%

Since not all the datasets had homogeneous variances or were normally distributed (see Table 32 and 33), Wilcoxon matched-pairs signed-ranks tests were performed to determine the differences in the proportions of attention allocated to consultation between translating Text A and B, and the differences are all statistically significant (see Table 34).

Table 32. Test of homogeneity of variances (proportion of gaze time allocated to consultation over the holistic translation task when translating Text A and B by three groups of participants)

Group	Statistic	*df1*	*df2*	Sig.
Language learners	11.023	1	32	< .05
Translation students	.013	1	34	> .05
Professional translators	7.706	1	40	< .05

Table 33. Shapiro-Wilk normal distribution test (proportion of gaze time allocated to consultation over the holistic translation task when translating Text A and B by three groups of participants)

Group	Text A			Text B		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
Language learners	.929	17	> .05	.951	17	> .05
Translation students	.866	18	< .05	.938	18	< .05
Professional translators	.902	21	< .05	.950	21	< .05

Table 34. Wilcoxon matched-paired signed ranks tests (proportion of gaze time allocated to consultation over the holistic translation task when translating Text A and B by three groups of participants)

Group	Statistic	Sig.	Hedge's *g*
Language learners	2.947	< .05	1.01
Translation students	3.783	< .001	1.76
Professional translators	3.841	< .001	1.04

In summary, the results show that as the perceived translation difficulty increased, all participants allocated a significantly greater amount of attention to consultation, which also accounted for a significantly larger proportion over the holistic translation process. This finding partly echoes the results presented by Hvelplund (2017, 2019), who found that translators allocated a larger proportion of attention to consultation when translating LSP texts than when translating literary texts. He justified this finding by pointing out that "the translation of LSP texts, as a case in point, implies more frequent dictionary lookups to solve a higher number of terminological problems" (Hvelplund, 2017, p. 76). In the present study, as Text B was perceived to be more difficult to translate, it contained a higher number of translation problems, which included more terminological problems. The increase in the terminological problems lead to the increase in the perceived translation difficulty to some extent, which eventually lead to a greater amount of attention being allocated to consultation when translating Text B compared to Text A.

Translation is an activity that "constantly requires information" (Pinto & Sales, 2007, p. 532). When translators are aware that their internal knowledge is insufficient to reach the intended goal, they try to obtain more information, with consulting online resources being one of the methods employed. Consulting online resources to obtain more information bridges the gap between the translators' existing knowledge and the knowledge required to produce the translation solutions. In the present study, compared to translating Text A, translating the more difficult ST, Text B was a task that required more knowledge to complete. Therefore, there was a larger gap between the translators' internal knowledge and the required knowledge. When the only accessible resource for obtaining external knowledge was consulting online resources, it would not be surprising to see that all participants allocated a greater amount of attention to

consultation.

The relationship between task complexity and information behaviour is also helpful in supporting the present study's finding. Vakkari's study (1999) indicated that task complexity is defined by "the degree of predeterminability of task performance" (p. 826) and is influenced by the amount of knowledge the actor completing the task has. He illustrated this relationship as follows:

> The more the actor knows about the dimensions of the task, the less complex it becomes, and the easier it is to accomplish. Thus, we can connect the degree of predeterminability of a task to the structuredness of the knowledge or conceptual space of the performer about the task. The structure of the conceptual space depends on a person's prior knowledge of the dimensions of the task. If there is a severe lack of knowledge about the task, we can say that the person is in a problematic situation and has an anomalous state of knowledge. (p. 826)

Based on his understanding of the relationship between task complexity and performance, Vakkari (1999) proposed a model of task complexity and information actions (see Figure 21). This model summarises the relationship between task complexity and other aspects as follows: the more complex the task, the more ill-structured it is, and the less prior knowledge the user has. The user's prior knowledge and the problem structure can inversely affect the task complexity. The combined influence of prior knowledge, task complexity, and problem structure could then affect the information actions.

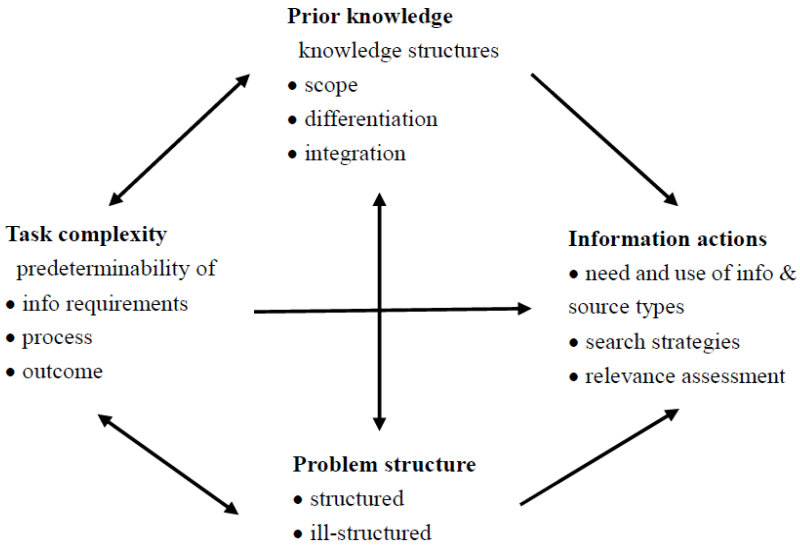

Figure 21. Vakkari's model on task complexity and information behaviours (Vakkari, 1999, p. 830)

Since the nature of the task and the participants' prior knowledge remained the same when translating Text A and B, the only variable was the perceived translation difficulty of these two STs. As the perceived translation difficulty increased, a greater amount of information was needed, which resulted in a wider gap between the participants' prior knowledge and the required knowledge. In order to successfully complete the task, the participants had to consult external resources to fill the knowledge gap.

The fact that consultation also accounted for a larger proportion of the entire translation process when translating a more difficult text is another interesting finding. Since the two subtasks, translating and consultation, cannot be conducted simultaneously, when a greater proportion of attention is allocated to consultation, there would inevitably be a smaller proportion of attention allocated to translating. Shih (2019) found that, if translation students ignored the importance of consultation and only conducted superficial searches, they might spend a shorter amount of time on a translation task but obtain an undesirable quality, which was called "a false economy in efficiency" (p. 920). She argued that "it was not necessarily the amount of time spent overall, but how and where it was spent that seemed to offer optimum return in web search" (p. 920). Therefore, in order to follow the "minimax principle" in translation proposed by Levý (1967), that is, producing maximised translation products with

minimised effort, translation students should be trained how to balance the cost of using resources for translating and consultation. Otherwise, consultation could cause interference in the translation process rather than being a beneficial exercise.

The finding of the present study suggests that the allocation of attention between translating and consultation might present more challenges when translating difficult texts. Few studies have provided practical suggestions for how to improve translation students' efficiency in resource allocation, but the existing studies on driving tasks can be utilised since they also involve various secondary tasks and require attention to "be divided between the primary driving task and the secondary task" (Metz et al., 2011, p. 369). Metz et al. (2011) found that, if drivers allocate too much attention to the secondary tasks, they are more likely to be distracted when driving, since "the amount of attentional resources used for the driving task is reduced compared to undistracted driving" (p. 379). They suggested that the efficiency of attention distribution in driving tasks could be improved by designing new in-vehicle information systems. Based on these considerations, the following practical suggestions for translator training are proposed. Firstly, translation students should be taught about the helpfulness of external resources but also about the interference these resources could cause. By so doing, they can be more conscious of potential distractions during consultation in their translation process. Secondly, the use of external resources, especially the use of general information resources, should receive more attention in translation pedagogy. Dictionaries and bilingual corpora are specially designed for translators, so they are more convenient and targeted when providing information for translators. However, the other types of online resources, such as search engines and encyclopaedias, do not provide systematic linguistic information for translators, so the use of these types of resources should receive more attention from translators.

6.1.2 Use of Online Resources

The use of online resources was reflected in two metrics retrieved from screen-recording data: (1) the number of online resource types, and (2) the preferred types of online resources. As illustrated in section 5.2.3, PACTE's categorisation of online resources was used to indicate the

online resource types (Kuznik & Olalla-Soler, 2018, pp. 31-32), which includes eight items. In the present study, six types of resources from this list were used by the participants: (1) search engines, such as Google or Baidu; (2) bilingual dictionaries, such as Youdao Dictionary or Bing Dictionary; (3) monolingual dictionaries, such as Oxford English Dictionary; (4) encyclopaedias, such as Wikipedia; (5) online corpora, such as Collins; and (6) online or field-specific portals, such as information related to the subject of the STs. Table 35 shows the mean values of the number of resource types consulted when translating Texts A and B by three groups of participants. The results show that all participants tended to consult more types of online resources when translating the more difficult text.

Table 35. Number of resource types consulted when translating Text A and B by three groups of participants

Group	N	Text A		Text B	
		Mean	SD	Mean	SD
Language learners	17	1.19	.54	1.81	.98
Translation students	18	1.32	.89	2.26	1.20
Professional translators	21	.90	.70	1.38	1.02

Since not all the datasets had homogeneous variances or were normally distributed (see Table 36 and 37), Wilcoxon matched-pairs signed-ranks tests were conducted (see Table 38). The results show that the three groups of participants consulted significantly more types of online resources when translating the more difficult text.

Table 36. Test of homogeneity of variances (number of resource types consulted when translating Text A and B by three groups of participants)

Group	Resource type number			
	Statistic	*df1*	*df2*	Sig.
Language learners	6.983	1	32	< .05
Translation students	2.110	1	34	> .05
Professional translators	1.458	1	40	> .05

Table 37. Shapiro-Wilk normal distribution test (number of resource types consulted when translating Text A and B by three groups of participants)

Group	Text	Resource type number		
		Statistic	*df*	Sig.
Language learners	A	.719	17	< .05
	B	.796	17	< .05
Translation students	A	.769	18	< .05
	B	.878	18	< .05
Professional translators	A	.731	21	< .05
	B	.622	21	< .05

Table 38. Wilcoxon matched-paired signed ranks tests (number of resource types consulted when translating Text A and B by three groups of participants)

Group	Statistic	Sig.	Hedge's *g*
Language learners	2.153	< .05	0.78
Translation students	2.429	< .05	0.89
Professional translators	1.513	< .05	0.80

Figure 22 presents the number of participants that consulted each type of online resource when translating Texts A and B. Among the six types of online resources, search engines and bilingual dictionaries proved to be the most commonly used types of resources in both the translations of Text A and B. These findings are consistent with results presented in previous studies. Olalla-Soler (2018) reported that for both translation students and professional translators, the most frequently used resources were general search engines, bilingual dictionaries, and encyclopaedias. Except online corpora, the other five types of online resources were consulted by more participants when translating Text B compared to Text A. The increase was particularly noticeable for encyclopaedias, which were consulted by only two participants when translating Text A but 14 participants when translating Text B.

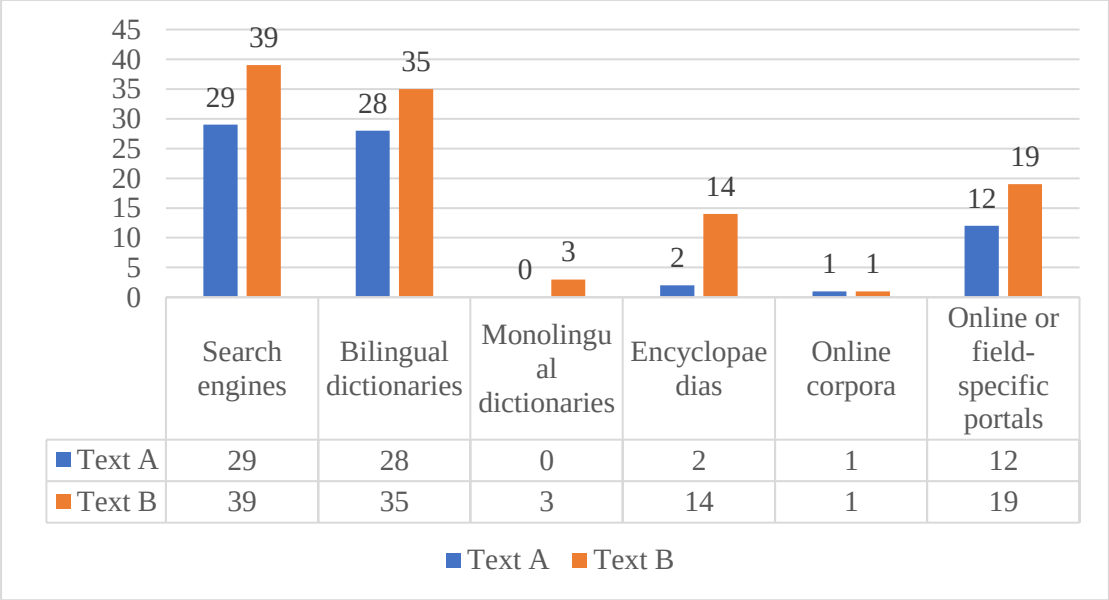

Figure 22. Number of participants that consulted each type of online resources when translating Text A and B

The investigation of the effect of perceived translation difficulty on the use of online resources presents two main findings. Firstly, participants used significantly more types of online resources when translating the more difficult text. Secondly, as their reliance on bilingual dictionaries remained high, participants' tendency to use general-purposed resources, such as search engines and encyclopaedias, increased when translating the more difficult text. Enríquez Raído (2014) reported a similar finding by indicating that when translating a relatively more difficult text, participants conducted a wider range of search behaviours, including using more types of resources.

These two findings indicate that an increase in the perceived translation difficulty was not only triggered by an increase in lexical problems. Byströml and Järvelin (1995) defined the different types of information required in general problem-solving processes: problem information (PI), which describes the structure, properties, and requirements of the problem; domain information (DI), which consists of known facts, concepts, laws, and theories in the domain of the problem; and problem-solving information (PSI), which covers the methods of problem treatment. According to their research, an increase in task complexity results in a greater need for DI and PSI, which leads to an increase in the number of sources used and the proportion of general-purpose sources, but a decrease in the proportion of problem and fact-

oriented sources. Angelone (2010) defined the translation process as "a chain of decision-making behavior relying on multiple, interconnected sequences of problem solving behavior for successful task completion" (p. 17). In the present study, when participants were translating the more difficult text, their need for DI and PSI increased as their information need could not be fulfilled by fact-oriented sources alone. In fact, the participants extended their consultation scope to more general-purpose sources, such as search engines and encyclopaedias.

The finding that translators tend to use more types of online resources when translating the more difficult text suggests that in translation training, an appropriate level of challenge could motivate translators to take more diverse problem-solving approaches. Several existing studies observed that translation students rely heavily on dictionaries and try to solve extralinguistic problems with online dictionaries. For instance, Varantola (1998) reported that translation students "try to find non-dictionary type information in dictionaries because it is not readily or systematically available in other sources" (p. 189). Massey and Ehrensberger-Dow (2011) also found that undergraduate students tend to consult online dictionaries for extralinguistic problems requiring expert or specialised knowledge. Similarly, Sales et al. (2018) reported that first-year translation students often do not select the most appropriate information sources in relation to their information need (such as contextualising the text they are translating and searching for specific information). However, in the present study, the language learners and translation students were capable of consulting multiple online resources, especially when translating a more difficult text. It is believed that the challenge triggered by the increase in perceived translation difficulty motivates participants to conduct more complicated consultation behaviour. Betts (1946) first proposed that the instruction level, or an appropriate level of challenge, would change readers' behaviours. A number of studies have then been conducted to demonstrate that providing students with an optimal level of challenge can improve their learning outcomes, since they are more actively and productively engaged in the learning task (Burns, 2002; Gettinger & Seibert, 2002; Gickling & Thompson, 1985). In the present study, as the increase in perceived translation difficulty led to a higher requirement for consulting more types of resources, the language learners and translation students changed their consultation method by increasing the variety of online resources and showed a higher

preference towards resources providing general information. It is believed that the increase in perceived translation difficulty serves as the motivation for the translators to conduct such consultation behaviours. Therefore, in translation training, using STs with higher difficulty levels might be more effective in triggering students' development in their consultation behaviours.

6.1.3 Cognitive load

Cognitive load allocated to consultation was indicated by fixation duration, using the calculation method illustrated in section 5.3. Table 39 presents the mean values of fixation duration on consultation when translating Texts A and B by three groups of participants. The results show that when translating the more difficult text, all participants allocated slightly higher cognitive load to consultation.

Table 39. Fixation duration (milliseconds) on consultation when translating Text A and B by three groups of participants

Group	N	Text A		Text B	
		Mean	SD	Mean	SD
Language learners	17	246.00	28.56	250.27	24.55
Translation students	18	255.57	32.02	267.35	43.57
Professional translators	21	255.02	45.42	270.67	34.70

Since not all the datasets had homogeneous variances or were normally distributed (see Table 40 and 41), Wilcoxon matched-pairs signed-ranks tests were conducted. The results showed that the differences in cognitive load allocated to consultation for all participants were not statistically significant (see Table 42).

Table 40. Test of homogeneity of variances (fixation duration on consultation when translating Text A and B by three groups of participants)

Group	Levene statistic	*df1*	*df2*	Sig.
Language learners	.464	1	32	> .05
Translation students	.644	1	34	> .05
Professional translators	1.083	1	40	> .05

Table 41. Shapiro-Wilk normal distribution test (fixation duration on consultation when translating Text A and B by three groups of participants)

Group	Text A			Text B		
	Statistic	***df***	**Sig.**	**Statistic**	***df***	**Sig.**
Language learners	.979	16	> .05	.960	16	> .05
Translation students	.972	19	> .05	.946	19	> .05
Professional translators	.895	21	< .05	.832	21	< .05

Table 42. Wilcoxon matched-paired signed ranks tests (fixation duration on consultation when translating Text A and B by three groups of participants)

Group	Statistic	Sig.
Language learners	.683	> .05
Translation students	1.505	> .05
Professional translators	1.787	> .05

The insignificant effect of perceived translation difficulty on cognitive load in consultation supports the conflicting relationship between translating and consultation. As the model of consultation in translation proposed in the present study (see section 2.3), translating and consultation are two embedded tasks of the translation process. In the present study, since the two STs are of the same domain, their intrinsic text complexity is the major cause for the difference in their perceived translation difficulty. The increase in perceived translation difficulty results in the increase in the amount of knowledge being required to produce the TT, which is indicated by the amount of attention, but does not lead to more complex information-seeking tasks, which is indicated by resource variety.

6.1.4 Number of Transitions

Number of transitions was calculated as the frequency of fixation movements from translating to consultation and back. A larger number of transitions indicated a greater amount of switch cost and a lower cognitive efficiency. The mean values of the number of transitions when translating Texts A and B conducted by three groups of participants are presented in Table 43.

Table 43. Number of transitions when translating Text A and B by three groups of participants

Group	N	Text A		Text B	
		Mean	SD	Mean	SD
Language learners	17	47.88	6.98	79.88	15.23
Translation students	18	42.68	7.74	78.95	12.56
Professional translators	21	56.48	8.26	96.33	10.95

Since not all the datasets had homogeneous variances or were normally distributed (see Table 44 and 45), Wilcoxon matched-pairs signed-ranks tests were conducted and showed that the differences in the number of between-task transitions conducted by three groups of participants were all statistically significant (see Table 46).

Table 44. Test of homogeneity of variances (number of transitions when translating Text A and B by three groups of participants)

Group	Statistic	*df1*	*df2*	Sig.
Language learners	6.480	1	30	< .05
Translation students	1.903	1	36	> .05
Professional translators	.609	1	40	> .05

Table 45. Shapiro-Wilk normal distribution test (number of transitions when translating Text A and B by three groups of participants)

Group	Text A			Text B		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
Language learners	.855	16	< .05	.875	16	< .05
Translation students	.862	19	< .05	.845	19	< .05
Professional translators	.899	21	< .05	.934	21	> .05

Table 46. Wilcoxon matched-pairs signed-ranks tests (number of transitions when translating Text A and B by three groups of participants)

Group	Statistic	Sig.	Hedge's *d*
Language learners	2.158	< .05	2.70
Translation students	3.704	< .001	3.48
Professional translators	3.112	< .05	4.11

The results can be attributed to the following two reasons. Firstly, the entire consultation process consists of multiple smaller segments which are defined as individual web search tasks. In the present study, as Text B triggered more translation problems than Text A, the translation

process of Text B automatically involved more web search tasks, which consequently resulted in more between-task transitions. In this situation, working memory capacity should have an impact on the number of transitions. According to Baddeley (2007), "working memory is a temporary storage system under attentional control that underpins our capacity for complex thought" (p. 1). When participants conduct consultation in translation, the obtained information from external resources is stored in their working memory ready for solving translation problems. If the stored information is too complex, participants will have to revisit the consultation area and repeat the previous consultation procedure, leading to more between-task transitions and using more cognitive resources. As discussed in section 5.1, the increase in perceived translation difficulty could lead to an increase in information need. Hence, participants had to search for a greater amount of information (including complex information) in the translation of Text B, which requires a greater demand on their working memory capacity, and results in more transitions between translating and consultation. This finding can provide some pedagogical suggestions for teaching students instrumental sub-competence. In order to reduce the amount of cognitive resources needed by switching between tasks, translation students should be given designated training on how to improve their working memory capacity.

6.1.5 Conclusion

Section 6.1 aims to answer the first part of the research question: what the effect of information need on consultation is. The investigation was conducted from the perspective of considering translating the entire text as the task and taking perceived translation difficulty as the variable indicating information needs. Four measurements were proposed to cover both the behavioural and cognitive aspects of consultation: (1) the amount and proportion of attention allocated to consultation, (2) resource type variety, (3) cognitive load indicated by fixation duration, and (4) the number of transitions

The findings of the present study can be summarised as follows. Firstly, an increase in perceived translation difficulty leads to a significant increase in the amount of attention allocated to consultation, which also accounts for a larger proportion over the entire translation

process. Secondly, an increase in perceived translation difficulty motivates participants to use more diverse types of online resources and encourages them to consult more general-purpose resources like search engines. Thirdly, the increase in perceived translation difficulty does not affect participants' cognitive load allocated to consultation. Fourthly, an increase in perceived translation difficulty leads to a decrease in cognitive efficiency, which is indicated by an increase in the number of between-task transitions.

Based on these findings, several suggestions for translation training are proposed. Firstly, translators should be trained to maintain a balanced allocation of attention between translating and consultation, especially when translating difficult texts. Secondly, they should be aware of the influential factors on cognitive efficiency in translation with consultation. Thirdly, an appropriate level of translation difficulty could be both challenging and motivational for translation students.

6.2 Translation Problem Type and Consultation

The effect of information need on consultation, triggered by different types of translation problems, is explored in this section. As described in section 2.2, the individual translation problems were categorised into three types: comprehension problems, transfer problems, and production problems (hereafter referred to as Type 1, Type 2, and Type 3, respectively). The data used in this section were from the translations of three STs produced by three groups of participants. Since the analytical unit used in this section is translation segments, the perceived translation difficulty is not considered to be an influential factor. Overall, 978 individual translation problems involving consulting online resources with valid eye-tracking data are used for further analysis in this section, including 531 Type 1 (accounting for 54.29%), 154 Type 2 (accounting for 15.75%), and 293 Type 3 (accounting for 29.96%) translation problems (see Table 47).

Table 47. Three types of translation problems encountered by three groups of participants

Group	Type 1		Type 2		Type 3	
	Amount	**Proportion**	**Amount**	**Proportion**	**Amount**	**Proportion**
Language learners	177	60.20%	41	13.95%	76	25.85%
Translation students	177	48.76%	74	20.39%	112	30.85%
Professional translators	177	55.14%	39	12.15%	105	32.71%
Total	531	54.29%	154	15.75%	293	29.96%

The effect of translation problem type on consultation will be considered from the following four aspects: (1) the amount of attention, which is indicated by the total amount of gaze time allocated to consultation when translating individual ST segments; (2) consultation complexity, which is reflected in the number of online resource types and the number of consulted webpages; (3) cognitive load, which is indicated by fixation duration; and (4) information evaluation, which is indicated by the proportion of attention allocated to three information sections.

6.2.1 Amount of Attention and Consultation Complexity

Table 48 presents the mean values of gaze time (in seconds) allocated to online resources when translating each type of problem by three groups of participants. The results show that all participants allocated an increasing amount of attention from Type 1 to Type 3 translation problems.

Table 48. Amount of gaze time (seconds) allocated to consultation when translating each type of problem

Group	Translation problem type	N	Mean	SD
Language learners	Type 1	177	8.64	12.04
	Type 2	41	12.31	13.72
	Type 3	76	36.08	60.63
Translation students	Type 1	177	5.95	8.45
	Type 2	74	8.46	11.23
	Type 3	112	37.31	54.41
Professional translators	Type 1	177	9.02	13.05
	Type 2	39	10.91	7.35
	Type 3	105	29.79	40.39

Additional statistical analyses were performed to determine whether the differences were significant. Tables 49 and 50 show that the group variances were homogeneous but not all the groups of data were normally distributed. The results of Kruskal-Wallis tests confirm that for three groups of participants, the differences in the amount of gaze time allocated to consultation across three types of translation problems were statistically significant (see Table 51).

Table 49. Test of homogeneity of variances (gaze time allocated to consultation in individual web search tasks by three groups of participants)

Group	Levene statistic	*df1*	*df2*	Sig.
Language learners	36.081	2	291	< .05
Translation students	56.082	2	360	< .05
Professional translators	36.148	2	318	< .05

Table 50. Shapiro-Wilk normality test (gaze time allocated to consultation in individual web search tasks by three groups of participants)

Group	Translation problem type	Shapiro-Wilk		
		Statistic	*df*	Sig.
Language learners	Type 1	.559	177	< .05
	Type 2	.766	41	< .05
	Type 3	.571	76	< .05
Translation students	Type 1	.570	177	< .05
	Type 2	.616	74	< .05
	Type 3	.625	112	< .05
Professional translators	Type 1	.648	177	< .05
	Type 2	.820	39	< .05
	Type 3	.655	105	< .05

Table 51. Kruskal-Wallis tests (gaze time allocated to consultation in individual web search tasks by three groups of participants)

Group	Statistic	*df*	Sig.
Language learners	32.846	2	< .001
Translation students	110.407	2	< .001
Professional translators	35.638	2	< .001

The complexity of individual web search tasks was reflected in two metrics: the number of consulted online resource types and webpages. The mean values of these two metrics when translating each type of problem are presented in Table 52. The results show that from Type 1 to Type 3 translation problems, the number of resource types and webpages consulted by three groups of participants show an upward trend.

Table 52. Number of resource types and webpages consulted when translating each type of problem by three groups of participants

Group	Translation problem type	Resource type number		Webpage number	
		Mean	SD	Mean	SD
Language learners	Type 1	1.08	.32	1.14	.40
	Type 2	1.02	.16	1.12	.40
	Type 3	1.39	.66	1.75	1.16
Translation students	Type 1	1.04	.20	1.11	.37
	Type 2	1.16	.50	1.34	.88
	Type 3	1.55	.68	2.13	1.20
Professional translators	Type 1	1.09	.33	1.12	.44
	Type 2	1.05	.32	1.08	.48
	Type 3	1.21	.51	1.38	.84

Additional statistical analyses were performed to determine whether the differences were significant. Tables 53 and 54 show that the group variances were not homogeneous, and all sets of data were not normally distributed. Therefore, Kruskal-Wallis tests were performed, and the results confirm that the differences in the two metrics when translating the three types of problems were statistically significant (see Table 55).

Table 53. Test of homogeneity of variances (number of resource types and webpages consulted when translating each type of problem by three groups of participants)

Group	Metric	Levene statistic	*df1*	*df2*	Sig.
Language learners	Resource type number	62.652	2	291	< .05
	Webpage number	75.402	2	291	< .05
Translation students	Resource type number	110.708	2	360	< .05
	Webpage number	71.535	2	360	< .05
Professional translators	Resource type number	14.473	2	318	< .05
	Webpage number	24.735	2	318	< .05

Table 54. Shapiro-Wilk normality test (number of resource types and webpages consulted when translating each type of problem by three groups of participants)

Group	Translation problem type	Resource type number			Webpage number		
		Statistic	*df*	Sig.	Statistic	*df*	Sig.
Language learners	Type 1	.286	177	< .05	.371	177	< .05
	Type 2	.144	41	< .05	.344	41	< .05
	Type 3	.625	76	< .05	.694	76	< .05
Translation students	Type 1	.192	177	< .05	.337	177	< .05
	Type 2	.359	74	< .05	.449	74	< .05
	Type 3	.725	112	< .05	.836	112	< .05
Professional translators	Type 1	.300	177	< .05	.318	177	< .05
	Type 2	.150	39	< .05	.150	39	< .05
	Type 3	.455	105	< .05	.522	105	< .05

Table 55. Kruskal-Wallis tests (number of resource types and webpages consulted when translating each type of problem by three groups of participants)

Group	Metric	Statistic	*df*	Sig.
Language learners	Resource type number	30.408	2	< .001
	Webpage number	29.877	2	< .001
Translation students	Resource type number	84.268	2	< .001
	Webpage number	97.096	2	< .001
Professional translators	Resource type number	7.760	2	< .05
	Webpage number	14.233	2	< .05

Two major findings are summarised as follows. Firstly, translation problem type is an influential factor on consultation in both the amount of allocated attention and complexity. Secondly, from Type 1 to Type 3 translation problems, both the amount of attention and complexity show significant upward trends.

As mentioned in Chapter 3, little research has been conducted on the effect of translation

problem type on consultation. With a limited number of participants, Enríquez Raído (2014) categorised three types of translation problems, including comprehension, production, and both, and compared participants' consultation behaviours under these types of translation problems. She found that:

> [N]ot only did most of the participants use one and the same initial search action in all situations, they also chose the same source of information regardless of the type of question asked (or search goal pursued). In other words, question characteristics seemed to have no impact on either the participants' initial choice of search actions or their selection of information sources – the latter phenomenon, however, does not apply to Bob. (p. 124)

In Enríquez Raído's (2014) study, translation problem type was generally not an influential factor on consultation behaviours. The findings reported in the present study are not consistent with Enríquez Raído's findings. The most likely reason for this difference is the methodological drawback of her study. She only recruited six participants, with four of them having no translation training experience. It is possible that the lack of training experience is the reason why the participants did not perceive the need for different types of consultation behaviours when facing different types of translation problems. There was one exception in her study, identified as Bob, who changed his consultation behaviours when facing different types of translation problems. This participant was the only translation lecturer recruited in her study, which meant that he was the only participant who had sufficient experience in translation. This exception in her findings supports the assumption that the lack of experience is the main reason that no significant correlation was found between translation problem type and consultation in her study.

Several studies on web searching have been conducted on the effect of problem type on searching behaviours. However, in order to compare the present study with them, it is necessary to make the defined problem types comparable. Since the focus of the present study is on consultation in translation, the categorisation of translation problems is based on translation intentions, which also reveal the problem structure of consultations. On the one hand, the

consultation of lexical information is usually required when solving Type 1 problems. One example of a typical Type 1 problem is the segment “steadfastly” in Text A. Regardless of their experience, participants who perceived this segment as a translation problem that required the consultation of online resources all categorised it as a Type 1 problem. The participants perceived this word to be difficult because they were unfamiliar with the lexical meaning of the word. In general, the purpose of consulting online information for Type 1 problems are only for lexical information, like a definition from a dictionary. On the other hand, the consultation for the other two types of translation problems requires more than lexical information. For instance, in translating “a stressful environment”, which is considered to be a Type 3 problem, most participants not only searched for the lexical meaning of this term, but also looked for background information about the living environment of coral reef. Therefore, the consultation behaviours triggered by different types of translation problems can be further defined as specific fact-finding tasks, extended fact-finding tasks, and exploratory tasks, respectively (see Table 56).

Table 56. Categorisation of three types of translation problems

	Definition	**Information Task Type**
Type 1	Comprehension of the source language	Specific fact-finding task
Type 2	Production of satisfactory equivalence	Extended fact-finding task
Type 3	Production of target language	Exploratory task

This categorisation was first used by Shneiderman (1997) and has been used in various web searching studies. For instance, Navarro-Prieto et al. (1999) proposed an Interactive Framework, which can be used to indicate the correlation between task types and web users' searching strategies. According to this framework, web users’ searching strategy is purpose-driven. For fact-finding tasks, users perform a search with a specific keyword (bottom-up strategy), while for exploratory tasks they first search in a general area and then narrow down the search results (top-down strategy). A similar correlation was found between translation problem type and consultation behaviour in this research. As the information need became less specific, both the length and the complexity of the participants’ information-searching behaviour increased. This correlation could also be indicated by the attention allocated to

different types of information. For Type 1 problems, the information-seeking behaviour tended to focus on answering a specific question; this type of problem produced the lowest number of queries of the three types of problems, and the number of resource types consulted was also lower than for the other two types of problem. Similarly, when evaluating information relevance for Type 1 problems, the participants allocated a large proportion of their attention to one type of information – lexical information (accounting for 79.57% on average). For Type 2 and Type 3 problems, information-seeking behaviour became more general, with no specific target being set, which can be indicated by the increased number of queries and the increased number of resource types used. Athukorala et al. (2016) investigated the web searching behaviours with six tasks, among which three were exploratory tasks and three were look-up tasks. Look-up tasks refer to "the most basic kind of search, which returns discrete and well-structured objects" (p. 2639). This type of task has the same characteristics of fact-finding tasks. The researchers found that in exploratory tasks, users tend to scroll significantly more and take a much longer amount of time to complete the task than in look-up tasks. Both metrics indicate that exploratory tasks require a larger amount of information. In the present study, it was also found that the consultation for Type 3 translation problems leads to a greater amount of attention being allocated to consultation with more types of resources and webpages being consulted. These three metrics also indicate that more information is required in consultation for this type of translation problem, not only in the amount of information required, but also in the types of information required.

6.2.2 Cognitive load

Cognitive load allocated to consultation in translating individual segments was indicated by fixation duration (see Table 57 for the mean values). Compared to the trends shown in the amount of attention and consultation complexity, the effect of translation problem type on cognitive load shows different trends across three groups of participants. Compared with the translation students, both the language learners and professional translators allocated lower cognitive load to the consultation for Type 2 translation problems. The difference among the

three groups of participants will be presented and discussed in Chapter 7.

Table 57. Fixation duration allocated to consultation when translating each type of problem by three groups of participants

Group	Translation problem type	N	Mean	SD
Language learners	Type 1	177	243.36	58.09
	Type 2	41	239.96	36.43
	Type 3	76	252.77	77.69
Translation students	Type 1	177	233.43	59.53
	Type 2	74	247.64	53.67
	Type 3	112	229.74	30.65
Professional translators	Type 1	177	256.46	56.54
	Type 2	39	245.17	48.65
	Type 3	105	252.41	53.06

In order to explore whether there was a concealed variance among the three datasets, an additional statistical analysis was performed. The results of the homogeneity test of variance showed that not all three datasets have a homogeneous group variance (see Table 58) and the normal distribution test (see Table 59) showed that the data for the three translation problem types are not normally distributed. Therefore, the Kruskal-Wallis tests were performed (see Table 60). The results show that the differences in the mean values of fixation duration allocated to consultation across three types of translation problems were statistically significant for the translation students only.

Table 58. Test of homogeneity of variances (fixation duration allocated to consultation when translating each type of problem by three groups of participants)

Group	Levene statistic	*df1*	*df2*	Sig.
Language learners	1.130	2	291	> .05
Translation students	10.348	2	360	< .05
Professional translators	2.635	2	318	> .05

Table 59. Shapiro-Wilk normality test (fixation duration allocated to consultation when translating each type of problem by three groups of participants)

Group	Translation problem type	Shapiro-Wilk		
		Statistic	*df*	Sig.
Language learners	Type 1	.908	177	< .05
	Type 2	.982	41	> .05
	Type 3	.580	76	< .05
Translation students	Type 1	.939	177	< .05
	Type 2	.928	74	< .05
	Type 3	.975	112	< .05
Professional translators	Type 1	.912	177	< .05
	Type 2	.869	39	< .05
	Type 3	.738	105	< .05

Table 60. Kruskal-Wallis tests (fixation duration allocated to consultation when translating each type of problem by three groups of participants)

Group	Statistic	*df*	Sig.
Language learners	.691	2	> .05
Translation students	6.590	2	< .05
Professional translators	1.835	2	> .05

The results indicate that translation problem type does not have a significant effect on cognitive load allocated to consultation for all participants. Evidence from empirical studies also show web searching task types might not affect fixation duration significantly. Wang and Zhang (2014) reported no significant difference in the average fixation duration between fact finding and exploratory search tasks. With 21 children aged 11-13 as participants, Bilal and Gwizdka (2016) also found no significant difference in the average fixation duration when reading search engine results in factual and informational tasks. The results of the existing studies regarding the effect of task types on cognitive load were somewhat unclear since they could be "heavily influenced by the concrete topics, by participants' familiarity with these topics, and last but not least by the concrete individual search results provided by the search engine" (Lewandowski & Kammerer, 2020, p. 23).

In the present study, individual translation problems were embedded in the entire text, which meant that participants' emotional status when translating the entire text might be an influential factor in cognitive load allocated to individual web search tasks. For a more accurate and unbiased study of the effect of translation problem type on cognitive load allocated to

consultation, more restrictive conditions could yield more reliable results, such as asking participants to translate separate sentences with pre-set translation problems.

6.2.3 Information Evaluation

As previously illustrated in section 5.2.2, with the function of drawing AOIs, all the online information was divided into three types: lexical, extra-lexical, and extralinguistic information. The investigation of how translators evaluated different types of information was explored from three aspects: (1) the proportion of attention, which was indicated by the percentage of gaze time allocated to consulting each type of information in each individual web search tasks; (2) cognitive load, which was indicated by fixation duration; and (3) information processing patterns, which was summarised based on the screen-recording videos.

Table 61 shows the mean values of the proportions of attention allocated to each information section in individual web search tasks. This metric shows the perceived relevance of each information section by three groups of participants. A greater proportion indicates that the participant pays a greater amount of attention to this type of information than to the other types and perceives it to be more relevant for solving the translation problem. The percentages of gaze time allocated to lexical information shows a downward tendency from Type 1 to Type 3 translation problems, while the percentages of extralinguistic information shows an upward tendency.

Table 61. Percentages of attention allocated to each type of information section when translating three types of problems by three groups of participants

Group	Translation problem type	N	Lexical		Extra-lexical		Extralinguistic	
			Mean	SD	Mean	SD	Mean	SD
Language learners	Type 1	177	83.09	30.98	6.06	17.34	10.85	28.03
	Type 2	41	74.51	37.86	17.70	33.16	7.79	24.83
	Type 3	76	48.04	41.70	5.89	16.14	46.07	43.07
Translation students	Type 1	177	78.40	34.10	10.24	20.94	11.37	30.44
	Type 2	74	67.96	36.65	18.56	27.73	13.48	30.71
	Type 3	112	34.27	35.28	18.45	29.82	47.28	44.59
Professional translators	Type 1	177	84.82	30.04	6.82	17.82	8.36	26.25
	Type 2	39	71.45	37.48	20.02	31.82	8.54	27.26
	Type 3	105	57.83	41.45	6.27	16.18	35.90	43.07

In order to explore whether there was a potentially concealed variance among the three datasets, an additional statistical analysis was performed. The results of the homogeneity tests of variance and the normal distribution tests show that the datasets did not have homogeneous group variances and were not normally distributed (see Table 62 and 63).

Table 62. Test of homogeneity of variances (percentages of attention allocated to each type of information section when translating three types of problems by three groups of participants)

Group	Information section	Levene statistic	*df1*	*df2*	Sig.
Language learners	Lexical	16.515	2	291	< .05
	Extra-lexical	20.325	2	291	< .05
	Extralinguistic	36.979	2	291	< .05
Translation students	Lexical	1.542	2	360	< .05
	Extra-lexical	14.193	2	360	< .05
	Extralinguistic	47.663	2	360	< .05
Professional translators	Lexical	23.738	2	318	< .05
	Extra-lexical	24.336	2	318	< .05
	Extra-linguistic	52.736	2	318	< .05

Table 63. Shapiro-Wilk normality test (percentages of attention allocated to each type of information section when translating three types of problems)

Group	Translation problem type	Information section	Shapiro-Wilk		
			Statistic	*df*	Sig.
Language learners	Type 1	Lexical	.602	177	< .05
		Extra-lexical	.406	177	< .05
		Extralinguistic	.430	177	< .05
	Type 2	Lexical	.681	41	< .05
		Extra-lexical	.585	41	< .05
		Extralinguistic	.348	41	< .05
	Type 3	Lexical	.815	76	< .05
		Extra-lexical	.423	76	< .05
		Extralinguistic	.788	76	< .05
Translation students	Type 1	Lexical	.667	177	< .05
		Extra-lexica	.564	177	< .05
		Extra-linguistic	.399	177	< .05
	Type 2	Lexical	.802	74	< .05
		Extra-lexical	.716	74	< .05
		Extralinguistic	.487	74	< .05
	Type 3	Lexical	.840	112	< .05
		Extra-lexical	.670	112	< .05
		Extralinguistic	.755	112	< .05
Professional translators	Type 1	Lexical	.563	177	< .05
		Extra-lexical	.449	177	< .05
		Extra-linguistic	.342	177	< .05
	Type 2	Lexical	.739	39	< .05
		Extra-lexical	.664	39	< .05
		Extra-linguistic	.338	39	< .05
	Type 3	Lexical	.803	105	< .05
		Extra-lexical	.451	105	< .05
		Extra-linguistic	.725	105	< .05

Spearman correlation coefficients were conducted to further assess the correlations between translation problem type and the proportion of attention allocated to three information sections. The results show statistically significant correlations between translation problem type and the proportion of attention allocated to lexical and extralinguistic information sections for all groups of participants, but no significant correlation between translation problem type and the proportion of attention allocated to extra-lexical information for professional translators (see Table 64).

Table 64. Spearman correlation coefficients between translation problem type and attention allocation to three types of information

Group	Information section	Statistic	Sig.
Language learners	Lexical	- .353	< .001
	Extra-lexical	.348	< .05
	Extralinguistic	.380	< .001
Translation students	Lexical	- .473	< .001
	Extra-lexical	.164	< .05
	Extralinguistic	.391	< .001
Professional translators	Lexical	- .332	< .001
	Extra-lexical	- .001	> .05
	Extralinguistic	.375	< .001

In summary, the results suggest that participants look for different types of information and conduct different searching strategies when they perform consultation for different types of translation problems. Moreover, regardless of their levels of training or professional work experience, the participants in the present study were capable of adjusting their consultation strategies. For Type 1 problems, the information-seeking behaviour tended to focus on answering a specific question; this type of problem produced the lowest number of queries among the three types, and the number of resource types consulted was also lower than for the other two types of problem. Similarly, when evaluating information relevance for Type 1 problems, the participants allocated a large proportion of their attention to one type of information – lexical information (accounting for 79.57% on average). For Type 2 and Type 3 problems, information-seeking behaviour became more general, with no specific target being set, which can be indicated by the increased number of queries and the increased number of resource types used.

The second perspective of the investigation on how participants evaluated different types of information focused on the difference in cognitive load allocated to linguistic (including lexical and extra-lexical) and extralinguistic information. The mean values of fixation duration allocated to linguistic and extralinguistic information in individual web search tasks by three groups of participants are presented in Table 65. The results show that all participants allocated higher cognitive load to linguistic information than to extralinguistic information. Paired *t*-tests were conducted, indicating that the differences were statistically significant (t= 1.283, p< .05,

t=4.210, p <.001, and t=4.402, p< .001, respectively).

Table 65. Fixation duration (in milliseconds) allocated to linguistic and extralinguistic information by three groups of participants

Group	N	Linguistic		Extralinguistic	
		Mean	SD	Mean	SD
Language learners	294	245.98	71.09	230.98	39.54
Translation students	363	264.00	37.73	218.52	27.38
Professional translators	321	275.85	36.10	226.94	27.62

The differences in cognitive load allocation between the consultations of linguistic and extralinguistic information suggest that these two types of consultations involve different information processing patterns. When translators consult linguistic information, they are normally driven by a specific information need, such as the meaning of a particular term; while when they consult extralinguistic information, they would read a collection of information. Therefore, the consultation of linguistic information can be defined as a fact-finding task, which refers to "a task in which you are looking for specific facts or pieces of information" (Kellar et al., 2007, p. 1005), and the consultation of extralinguistic information can be considered to be an information-gathering task.

Previous studies have reported inconsistent findings regarding the difference in cognitive load between fact-finding and information-gathering tasks in general information tasks. Wang and Zhang (2014) asked participants to conduct one fact-finding task and two information-gathering tasks. They found no significant difference in cognitive load between these two types of tasks. Bilal and Gwizdka (2016) studied 21 children aged 11-13 reading search engine results pages (SERPs) and found no difference in cognitive load between factual tasks (answering a specific question) and research tasks (finding information on a given topic). However, Lu and Jia (2014) suggested that, during image search, participants invested a significantly higher cognitive load in general tasks (searching for broader categories) than in specific tasks (searching for specific objects). Lewandowski and Kammerer (2020) proposed an explanation for these inconsistencies, that investigations of cognitive load might be "heavily influenced by the concrete topics, by participants' familiarity with these topics, and last but not least by the

concrete individual search results provided by the search engine" (p. 23). Considering these potentially confounding factors, in this present study, the participants were asked to translate the same STs with their familiarity to the text background being controlled.

Brand-Gruwel et al. (2009) proposed the Information Problem Solving on the Internet model (IPS-I) to identify five main information processes when using the Internet: problem definition, searching, scanning information, deep processing, and presentation. In linguistic consultations, the relevant information is usually placed compactly and is easier to be processed without much scanning. While in extralinguistic consultations, the pertinent information is normally included in a lengthy webpage and requires scanning to be located. In order to confirm this deduction, the heat maps and gaze plots involving linguistic and extralinguistic consultations were further examined. In general, for linguistic information, the participants consulted results pages from online dictionaries or the lexical information sections from search engines, such as the dictionary pages automatically recommended by the algorisms of search engines; while for extralinguistic consultations, they tended to read SERPs, contents from encyclopaedias, or relevant information portals. The former type of search results contained shorter and more compact information than the latter one. Regardless of their experience levels, the participants focused on the relevant information, which was located in a small area of the webpage in linguistic consultations. On the other hand, they read through a larger amount of information and sometimes scrolled down the webpages in extralinguistic consultations. A typical example revealing the difference in the processing patterns between linguistic and extralinguistic consultations is presented in Figure 23. It shows the heat map and gaze plot of the fixations in the web search task when translating "menorah" by P22. This participant consulted both linguistic information (the entry from the bilingual dictionary) and extralinguistic information (the encyclopaedical and pictorial contents). When consulting linguistic information, his/her fixations formed a horizontal path, with which indicated little scanning but much deep processing; while in extralinguistic consultation, the fixations followed a vertical path, which indicated more scanning and less deep processing.

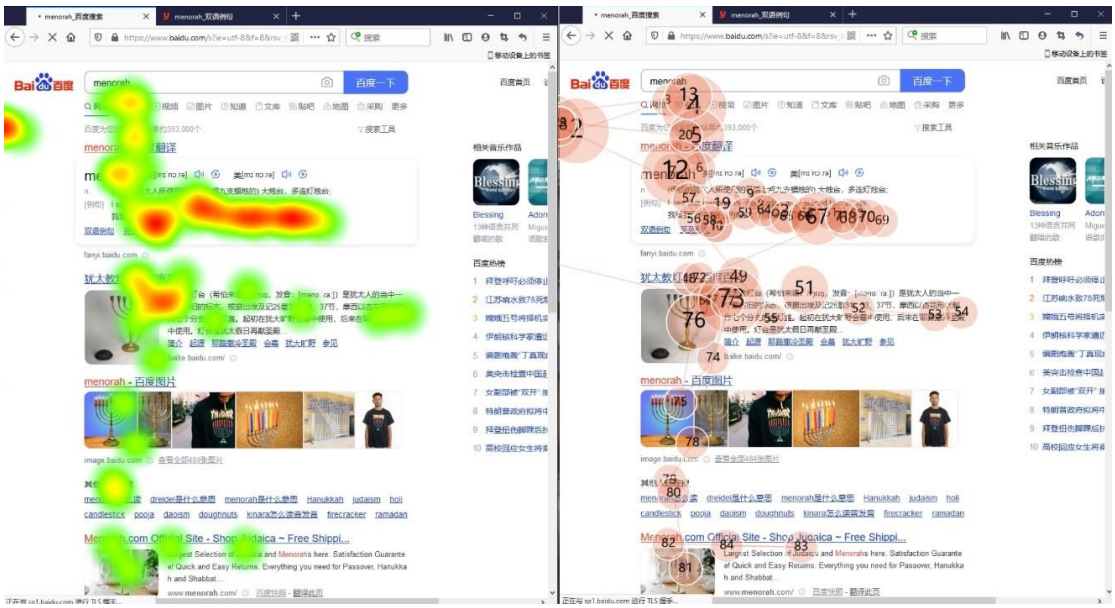

Figure 23. Heat map and gaze plot of web search task when translating “menorah” by Participant P22

Translators performed differently when consulting linguistic and extralinguistic information, which was revealed in cognitive load as well as information processing patterns. Based on the results, two implications for translation pedagogy and further research are proposed. Firstly, considering that the total amount of cognitive resources is limited (Galy et al., 2012), translation teachers should take more consideration in improving the efficiency of extralinguistic consultations. For example, they could teach about the use of built-in search functions, which would highlight the keywords on the SERPs and speed up the scanning process. Secondly, more studies considering extralinguistic consultation as a sole research object or taking it as an independent part of consultation should be conducted. The results from the present study indicate that linguistic and extralinguistic consultations trigger different search techniques that should be investigated separately for an optimal result.

6.2.4 Conclusion

Section 6.2 aims to provide the answer to the second half of the research question: what is the effect of information need on translation consultation? The investigation was conducted with web search tasks that were carried out to translate individual segments as information tasks,

and the three types of translation problems were the variable indicating information needs. The investigation was developed from four aspects: (1) the amount of attention allocated to individual web search tasks; (2) consultation complexity, which is indicated by the number of consulted resources and webpages; (3) cognitive load indicated by fixation duration; and (4) the information evaluation behaviours, which is reflected in the proportion of attention allocated to three information sections, cognitive load individuated by fixation duration, and participants' information processing patterns.

The findings of the present study can be summarised as follows. Firstly, translation problem type significantly influences the amount of gaze time allocated to online resources and the complexity of consultation. As the information need becomes more general and less linguistic-related, both metrics of consultation behaviours present an upward trend, showing that participants allocated a greater amount of attention and used more types of online resources and webpages in consultation. Secondly, cognitive load allocated to consultation was not affected by translation problem type for language learners and professional translators. This finding suggests that using fixation duration as an indicator of cognitive load might be biased in complex tasks like consultation in translation. Thirdly, in translating all three types of problems, participants allocated the largest proportion of attention to lexical information sections. Moreover, from Type 1 to Type 3 translation problems, the proportion of attention allocated to lexical information sections presented a downward trend while the proportion to extralinguistic information presented an upward trend.

Chapter 7: Translation Experience and Consultation

This Chapter aims to answer the second research question: what is the effect of translation experience on consultation? Translation experience consists of two elements: training experience and professional work experience. This research question is answered with the data collected from three groups of participants with different levels of translation experience: language learners, translation students, and professional translators. As stated in section 4.1, the language learners have no experience in either translation training or professional translation work, the translation students have training experience but no work experience, and the professional translators have both training and work experience. It is important to note that a comparison of the language learners and translation students, and a comparison of the translation students and professional translators was carried out separately. The comparison between language learners and professional translators was not considered in the present study. Since translation experience consists of two parts, the effect of experience on consultation should be investigated separately. The major difference between language learners and translation students is their translation training experience, so the between-group comparison is used to examine the effect of training experience on consultation. Similarly, the major difference between professional translators and translation students is their work experience, so the comparison between these two groups is used to investigate the effect of work experience on consultation. However, language learners and professional translators are different in both training and work experience. The comparison between these two groups is therefore considered to be less reliable.

Similar to the previous Chapters, the effect of translation experience on consultation is explored when translating both the holistic STs and individual segments. A different method will be used to investigate individual tasks. In this Chapter, instead of using all the individual tasks, only the data from translating selected Rich Points will be used. A detailed explanation of this rationale is presented in section 7.2.

7.1 Translation Experience and Holistic Consultation

This section presents the results on the effect of translation experience on consultation when

translating the entire text. In Chapter 6, it was proven that perceived translation difficulty of STs is a significantly influential factor on consultation behaviours. In order to avoid any interference, only the data from translating Texts B and C are used in this section. The data from these two translation tasks are not used to compare each other. The data from translating Text B are used to examine the descriptive aspects of consultation, including the amount of attention allocated to consultation and the participants' resource preferences. Based on the findings in Chapter 6, Text B is perceived to be more difficult to translate and triggers more diverse consultation behaviours than Text A, so the consultation undertaken when translating Text B is assumed to be challenging and can reveal more differences across the three groups of participants. As illustrated in section 4.3, Text C was specially selected as a ST since the participants were unlikely to be familiar with the topic. The data from translating it are used to explore the differences in searching for background information. Therefore, it had a high potential to trigger participants' consultation behaviours for background information.

The data analysis in this section is conducted using both quantitative and qualitative methods. For the quantitative analysis, training and work experience are considered to be two independent variables. Several eye-tracking measurements were used as dependent variables: (1) the amount of attention, which is indicated by gaze time allocated to consultation; (2) the proportion of attention, which is indicated by the proportion of gaze time allocated to consultation over the entire translation process; (3) cognitive load, which is indicated by fixation duration allocated to consultation; and (4) cognitive efficiency, which is indicated by the number of transitions between translating and consultation. These metrics were retrieved from the eye-tracking data when translating Text B by 56 participants (including 17 language learners, 18 translation students, and 21 professional translators). For the qualitative analysis, participants' preference to resource type and their search style for background information are investigated based on the screen-recording data.

7.1.1 Quantitative Metrics

Table 66 shows the descriptive data of four process-oriented indicators in the translation of Text

B performed by three groups of participants. Compared to both the language learners and professional translators, the translation students allocated a greater amount of attention to consultation, which also accounted for a larger proportion over the entire translation process. The translation students also allocated slightly higher cognitive load to consultation than the language learners and slightly less than the professional translators. Furthermore, they conducted fewer between-task transitions than both the language learners and professional translators.

Table 66. Descriptive data when translating Text B by three groups of participants

Group	Amount of attention (seconds)		Proportion of attention (percentage)		Fixation duration (milliseconds)		Number of transitions	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Language learners	207.67	154.53	23.14	11.63	250.27	24.55	79.88	15.23
Translation students	251.33	156.23	26.79	7.83	267.35	43.57	78.95	12.56
Professional translators	175.29	128.19	20.58	11.14	270.67	34.70	96.33	10.95

Statistical analysis was conducted to determine whether the differences were significant. Table 67 and 68 show that the group variances were homogeneous, but some sets of the data were not normally distributed.

Table 67. Test of homogeneity of variances (quantitative metrics of consultation when translating Text B by three groups of participants)

Metrics	Statistic	*df1*	*df2*	Sig.
Amount of attention	.673	2	53	> .05
Proportion of attention	.447	2	53	> .05
MFD	.540	2	53	> .05
Number of transitions	.527	2	53	> .05

Table 68. Shapiro-Wilk normal distribution test (quantitative metrics of consultation when translating Text B by three groups of participants)

Metrics	Language learners			Translation students			Professional translators		
	Statistic	***df***	**Sig.**	**Statistic**	***df***	**Sig.**	**Statistic**	***df***	**Sig.**
Amount of attention	.897	16	> .05	.810	19	< .05	.821	21	< .05
Proportion of attention	.951	16	> .05	.886	19	< .05	.950	21	> .05
MFD	.960	16	> .05	.946	19	> .05	.832	21	< .05
Number of transitions	.875	16	< .05	.845	19	< .05	.934	21	> .05

Mann-Whitney *U*-tests were conducted to determine whether the between-group differences are statistically significant (see Table 69). The results show that (1) the differences in the four measurements between the language learners and translation students are not significant; (2) the differences between the translation students and professional translators in the amount and proportion of attention allocated to consultation are statistically significant; and (3) the differences between these two groups in MFD and the number of transitions are not significant.

Table 69. Mann-Whitney *U*-tests (quantitative metrics of consultation when translating Text B by three groups of participants)

Metrics	Language learners vs. translation students		Translation students vs. professional translators	
	Statistic	**Sig.**	**Statistic**	**Sig.**
Amount of attention	120.000	> .05	114.000	< .05
Proportion of attention	108.000	> .05	122.000	< .05
MFD	145.000	> .05	143.000	> .05
Number of transitions	147.000	> .05	139.000	> .05

The amount of attention allocated to consultation and the proportion of consultation over the entire translation process and participants' translation experience forms an inverted U-shaped relationship: both the language learners and professional translators allocated a lower amount of attention to consultation than the translation students. This finding is consistent with Olalla-Soler (2018), who reported an increase in both the number of queries and time spent on queries with translation training years and a decrease from translation students to professional

translators. Moorthy et al. (1997) also observed this relationship between consumers' shopping experience and the amount of external search. They found that a consumer with little experience would have little incentive to search, a consumer with an intermediate level of experience is aware of more attributes and is able to make finer distinctions, and a consumer with an expert level would have relatively little uncertainty, hence little incentive to search. They argued that consumers' experience affected their search behaviours in two phases. Consumers' shopping expertise was initially dominant, which led to greater need for information, but the knowledge effect took over beyond a certain level of experience, leading to the declining part of the curve. Experience increases expertise and proficiency, with the former increases the need for more information, the latter reduces it.

The same effect of experience on consultation is likely to be true in translation. Language learners, who have the least experience in translation, may not realise the importance of consulting external resources. Translation students "are trained intensively and systematically in how to recognize what specific information needs they have with regard to a given translation assignment and how to fulfil that need" (Kastberg, 2002, p. 62), so they are aware that consulting external resources could help improve their translation quality. Compared to translation students, professional translators show a lower reliance on the consultation of external resources. This finding is partly supported by previous studies that suggest that as translation experience increases, translators' reliance on external resources decreases. For example, R. Kim (2006) reported that compared to translators with more experience, language learners showed a lack of self-confidence and had an excessive reliance on the external resources. Similarly, with a specific focus on translating cultural problems, Olalla-Soler (2019) found that translators with more experience showed a lower tendency to use external resources to solve cultural translation problems regardless of the level of internalised source-culture knowledge. Based on this finding, it is suggested that in translation training, students should be aware of the limitations of information resources and develop confidence in their internal knowledge. A similar suggestion was proposed by R. Kim (2006) that "teachers need to help students refrain from using dictionaries too much and move their focus toward developing strategies for extracting and assessing meaning and finding and selecting an appropriate target

rendering" (p. 297).

Another interesting result relates to the difference in the number of transitions across three groups of participants. The numbers of transitions conducted by the language learners and translation students were similar to each other, which indicates that translation training experience does not affect their cognitive efficiency. Compared to the translation students, the professional translators conducted more between-task transitions. Although the increase was not statistically significant, it indicates, to a degree, that the professional translators showed a lower level of cognitive efficiency.

7.1.2 Preference of Online Resources

Table 70 presents the number of participants in each group who consulted six types of online resources when translating Text B.

Table 70. Number of participants who consulted each type of online resource when translating Text B

Online resources	Language learners	Translation students	Professional translators
Search engines	13	14	12
Bilingual dictionaries	8	14	13
Monolingual dictionaries	0	3	0
Encyclopaedias	3	9	2
Online corpora	0	0	1
Online or field-specific portals	5	6	8

Table 70 reveals that: firstly, search engines and bilingual dictionaries were the two types of online resources preferred by all groups of participants. This result is consistent with Zheng (2014) and Sycz-Opoń (2019). Zheng (2014) found that dictionaries (including software dictionaries and hardcopy dictionaries) accounted for the majority of consultation methods in his study. Sycz-Opoń (2019) reported that in legal translation, dictionaries constituted up to three-quarters of all look-ups and bilingual dictionaries proved to be the most popular type of resources among the participants. In the present study, it was also observed that the use of

bilingual dictionaries was preferred by the majority of participants. Moreover, for the language learners, the use of search engines was even more popular than bilingual dictionaries. This was largely because many of the participants used search engines in the same way as they would use a bilingual dictionary. Figure 24 shows an example of this kind of consultation behaviour. This screenshot was retrieved from the translation of Text B performed by participant S03. In this web searching task, the participant was looking for the lexical meaning of the segment "coral reef". Instead of using a bilingual dictionary, this participant searched for this term using a popular Chinese search engine, Baidu, which provided the TL equivalent in the SERP. As this example shows, participants can use search engines in the same way as they used bilingual dictionaries: they can directly search for the problematic segment without clicking on more links.

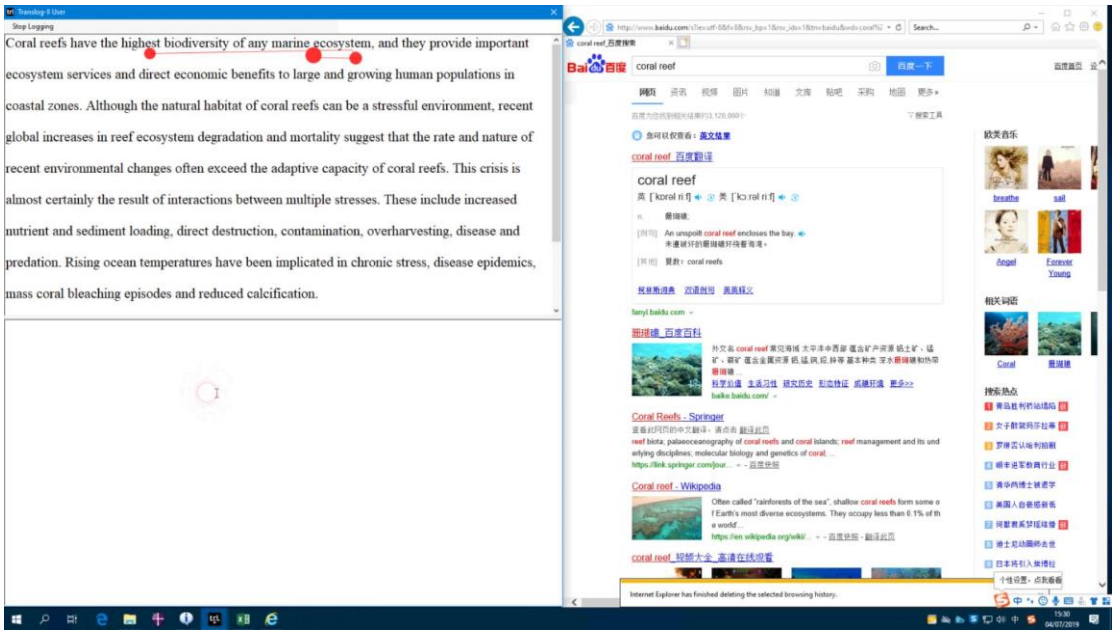

Figure 24. An example of using a search engine as a bilingual dictionary

Early studies on search engines have believed that clicking on search results should be a positive signal of the quality of the results. If users neither click a result of the SERP nor refine the query, they might have obtained the information they sought directly on the SERP or might be dissatisfied with the results and found no result worth clicking (Diriye et al., 2012; Joachims & Radlinski, 2007; Li et al., 2009). This behaviour is known as search abandonment, and is

usually an indicator of user dissatisfaction. However, over the past several years, search engines have added features that attempt to answer users' information needs directly on the SERPs without requiring users to click on any of the results. Leading search engines now provide a large array of these features for basic information needs such as weather reports, stock quotes, local business addresses and phone numbers, images, current news headlines, flight information, package delivery tracking, and many others. In addition, the result snippets returned by search engines have improved over time and may answer information needs directly (Turpin et al., 2007; Xue et al., 2006). In this case, the required information is directly presented on the SERP and information users do not need to click on any of the results. This kind of searching behaviour is known as "a good abandonment", which is defined as "an abandoned query for which the user's information need was successfully addressed by the search result page, with no need to click on a result or refine the query" (Li et al., 2009, p. 43). Based on randomly selected abandoned queries from Google PC and mobile search logs, Li et al. (2009) classified the potential good abandonment queries by the type of information need they expressed. They found that "the current search results page serves fairly well for relatively simple information needs" (Li et al., 2009, p.48). When participants searched for a segment in search engines, the SERP tended to provide its definition in a dictionary. In this case, the participants did not need to click on the result to obtain the lexical information for this segment. This feature of search engine is most likely the predominant reason that all three groups of translators frequently used search engines. This also explains why the three groups of participants show a preference for search engines and bilingual dictionaries. Among the three groups, the language learners are the only group of participants who show a higher preference towards search engines compared to bilingual dictionaries. Without translation training and work experience, they may not be familiar with online dictionaries, but be familiar with search engines. Therefore, when encountering the need to consult online resources, they choose the most familiar type of information resource. Translation students and professional translators would not conduct such behaviours, as they are familiar with online dictionaries and containing information.

In addition, professional translators do not show a higher preference towards monolingual dictionaries than the other participants. In fact, among the 21 professional translators with valid

eye-tracking data, none of them consulted monolingual dictionaries. Across the three groups of participants, only three translation students consulted monolingual dictionaries. However, these participants did not show a preference towards monolingual dictionaries. For instance, S18 only consulted the monolingual dictionary (Merriam-Webster) once after failing to obtain an acceptable TL equivalent by using a search engine. As mentioned in Chapter 3, previous studies have concluded inconsistent findings. Jääskeläinen (1989a, 1989b) reported that professional translators prefer to use monolingual dictionaries over bilingual dictionaries, while Zheng (2014) found that the percentage of monolingual dictionary consultations was very low for all participants and professional translators showed no specific preference for monolingual dictionaries compared to bilingual dictionaries.

The finding presented in the present study is consistent with Zheng (2014). Two reasons are proposed for this finding. Firstly, compared to monolingual dictionaries, bilingual dictionaries are more convenient to use when searching for equivalent expressions in the TL, especially when translating science-related texts. This possibility was also mentioned by Zheng (2014), who suggested that:

> Technical texts, however, are comparatively more straightforward to translate, since their contents are of universal application rather than culture-specific, and the lexis used includes exact equivalents. Although subject knowledge is of course more important in this area, what translators generally need when consulting dictionaries is to be able to find the equivalent expressions for specialist terms. In such cases, bilingual dictionaries in the required specialist field are more helpful to translators. (p.124)

Secondly, participants tend to complete the translation tasks as fast as possible under experimental conditions. In this case, monolingual dictionaries would be “simply not cost-effective for many learners in terms of rewards (correct choice of word) versus effort” (Thompson, 1987, p. 284). Yorio (1971) also observed that when students were given the choice of using bilingual or monolingual dictionaries, more than half of them showed a distinct preference to bilingual dictionaries. Based on this finding, Yorio (1971) suggested that:

> Although frequently inaccurate or misleading, the bilingual dictionary seems to give them security of a concrete answer, while the monolingual dictionary often forces them to guess the meaning, adding more doubts to the already existing ones. (p. 113)

It is assumed that the professional translators in the present study had the same perception of monolingual dictionaries. When translating Text B, which was a science-related text, all of them preferred to use bilingual dictionaries instead of monolingual dictionaries. There has been controversy regarding the use of monolingual or bilingual dictionaries. Some researchers advocate the use of monolingual dictionaries while others have doubts about the usefulness of monolingual dictionaries and propose the use of bilingual dictionaries instead. For instance, Yorio (1971) pointed out that bilingual dictionaries can give students a sense security that they will find concrete answers, while monolingual dictionaries may provide learners with a long, complicated, and confusing description that might not make the intended and desired meaning clear, and often leads students to guess or predict the meaning, which sometimes results in doubt and confusion. In contrast, Hayati (2006) suggested that many frequently used words are dealt with more appropriately in monolingual dictionaries than other dictionaries and showed that a monolingual dictionary demonstrates not only definitions but also other important aspects of vocabulary. He believed that monolingual dictionaries could improve language learners' fluency by offering definitions of new words and expressions in a specific context, while bilingual dictionaries provide word-for-word translations and equivalents that might not be as appropriate in some situations and could cause confusion and ambiguity. The present study shows that translators with different levels of experience all prefer bilingual dictionaries than monolingual dictionary. This finding partially indicates that translation students have a lack of training on how to use monolingual dictionaries effectively.

7.1.3 Background Search Style

As explained in section 4.3.2, Text C was specially selected to investigate the consultation of extralinguistic information. From the aspect of translating the entire text, the consultation of

extralinguistic information is considered to be the consultation of background information relating to the ST. The differences across three groups of participants were examined based on the starting point of searching for background information in the translation process. From the perspective of looking into the cognitive processes involved in translation, Jakobsen (2002) divided the translation process into three stages: the orientation stage, the drafting stage, and the end revision and monitoring stage. The orientation stage begins when the translator is presented with the ST and ends when the translator types the first keystroke when producing the TT. The drafting stage begins immediately after the orientation stage and ends when the translation of the last ST sentence is completed, which is indicated by typing the final full stop. The end revision and monitoring stage begins immediately after typing the final full stop and ends when the translator decides that the translation has been completed. Hvelplund (2011) suggested that different goals and objectives are pursued during each stage and indicated that the goal in the orientation stage is "to get familiar with the ST" and the goal in the drafting stage is "to create a translation of the SL message in the TL" (p. 49).

Based on this division of the translation process, the starting point of the search for background information reveals different goals as well. On the one hand, when the participants start the background search during the orientation phase, they may be satisfying an information need in order to comprehend the ST. On the other hand, when participants start searching for background information during the drafting phase, they may not perceive the need for background knowledge to comprehend the ST, but they feel the need to retrieve this information to produce the TT. Therefore, three types of background information search styles are defined in the present study: search before drafting, search during drafting, and no background search. Before drafting refers to the situation in which the search for background information starts during the orientation phase, which is before the drafting phase. It does not mean that participants with this kind of background search style do not search for any background information after the orientation phase. During drafting refers to the situation in which participants start searching for background information after the orientation phase or they do not have an orientation phase. No consultation refers to when the participants do not search for any background information at all. The number of participants in each group with three types

of background information search styles are presented in Table 71.

Table 71. Number of participants in each group with three types of background information search styles

Participant	Background information search style		
	Before drafting	**During drafting**	**No background search**
Language learners	2	13	2
Translation students	7	9	2
Professional translators	6	7	8

Most language learners (15/17, 88.24%) consulted extralinguistic information in translation, but fewer language learners (2/17, 11.76%) conducted the search before drafting. Due to lack of training and work experience, language learners may not know about the necessity of extralinguistic information in translation. Hence, most of them started translating without perceiving the need to consult extralinguistic information. As the translating process continued, they gradually encountered the need for extralinguistic information and sought help from extralinguistic consultation. Compared to the language learners, more translation students (7/18, 38.89%) consulted extralinguistic information before drafting. They followed almost the same consultation procedures: read through the ST first and then worked on extralinguistic consultation. Translation students are taught that translation requires information that tends to be "multilingual and specific, belonging to a range of disciplines" (Sales et al., 2018, p. 188), so they would know to search for the background information before drafting. Compared to the language learners, they have a higher level of incentive to consult extralinguistic information. However, not all translation students in the present study followed this procedure. Among the translation students who did not consult extralinguistic information before drafting, the majority of students (9/11, 81.82%) performed similar procedures to the language learners, who did not perceive the need for background information when comprehending the ST, but realised the need for background information during drafting. In contrast, among the professional translators who did not search for background information before drafting, less than half (7/15, 46.67%) changed their opinion and considered searching for background information a necessity in order to produce the TT. Their attitude towards background information was

determined at the very beginning of the translation process and was not affected by the problems encountered thereafter: they were confident in their internal knowledge and clear about the consequences of not consulting more background information throughout the translation process.

These results show that language learners, translation students, and professional translators have different attitudes towards the consultation of background information in translation. Both language learners and student translators show a greater reliance on background information than professional translators, but these two groups of participants perform differently. Language learners tend to neglect the need for background information when they read the ST and come back to consulting when producing the TT. In contrast, translation students are able to realise the necessity of preparing for the drafting stage by consulting background information. Compared to translation students, professional translators show a lower reliance on background information and a higher confidence in their internal knowledge. If they do not find background searching necessary during the orientation phase, more than half of professionals would not change their mind after further consultation. Sirén and Hakkarainen (2002) pointed out that "before solving a problem, experts may spend time analysing it, while novices often attempt to solve a problem immediately" (p. 73). Even when novices have started drafting without any extralinguistic consultation, it does not necessarily mean that they have sufficient knowledge to translate the text, which was reflected in their postponed consultations.

7.1.4 Conclusion

The investigation of the effect of translation experience on consultation when translating the entire text reveals the following findings. First, the amount of attention allocated to consultation and the proportion of consultation over the entire translation process and participants' translation experience formed an inverted U-curve relationship: both the language learners and professional translators allocated a lower amount of attention to consultation than the translation students. Second, neither training experience nor professional work experience is a significantly influential factor on cognitive load indicated by fixation duration or cognitive

efficiency. Third, despite their translation experience, all translators show a preference towards search engines and bilingual dictionaries. Fourth, professional translators do not show a specific preference towards monolingual dictionaries. Fifth, three groups of participants performed differently when consulting for background information: (1) language learners tend to neglect the need for background information when they read the ST and come back to consulting when producing the TT; (2) student translators are able to realise the necessity of preparation with background information before drafting; and (3) professional translators show a lower reliance on background information and a higher level of confidence in their internal knowledge.

7.2 Translation Experience and Individual Web Search Tasks

This section presents the results on the effect of translation experience on consultation when translating individual segments. The investigation was conducted based on five selected Rich Points from the STs: (1) “steadfastly” from Text A, (2) “alas” from Text A, (3) “a stressful environment” from Text B, (4) “latke” from Text C, and (5) “the ‘attendant’ candle” from Text C. The first three Rich Points were selected as typical examples of three types of translation problems. It is possible that different participants, even with the same level of translation experience, consider the same Rich Point to be different types of translation problems. As mentioned in section 5.2.1, the categorisation of translation problem type was subjective, so only the web search tasks for translating each Rich Point that are triggered by the same type of translation problem were used for data analysis in this sub-section. For example, the majority of participants considered “steadfastly” as a Type 1 translation problem, but Participant S02 categorised it as a Type 2 translation problem. His/her data were thus eliminated from the analysis. Table 72 shows the number of participants with valid web search tasks for each Rich Point.

Table 72. Number of participants with valid web search tasks for each Rich Point

Rich Point	Translation problem type	Number of participants		
		Language learners	Translation students	Professional translators
Steadfastly	Type 1	13	13	7
Alas	Type 2	10	11	12
A stressful environment	Type 3	6	9	7

The data analysis for these three Rich Points is conducted using both quantitative and qualitative methods. For the quantitative analysis, the amount of attention, which is indicated by gaze time allocated to consultation, was used as a dependent variable while training experience and work experience are considered to be two independent variables. For the qualitative analysis, participants' search style is investigated based on the screen-recording data.

The fourth and fifth Rich Points were selected to examine the differences in the consultation of extralinguistic information across three groups of participants. The effect of translation problem type is not a considered to be an issue in the analysis with these two Rich Points. "Latke" refers a type of Jewish food and its TL equivalents can easily be located through linguistic consultation, such as 土豆烙饼 or 马铃薯饼 (Gloss: potato pan-fried pancake) provided by Youdao (a bilingual online dictionary). Therefore, translating this Rich Point is considered to have a relatively higher need for linguistic information rather than extralinguistic information. The other Rich Point, "the 'attendant' candle", refers to the tallest candle on a Jewish menorah, which is used to light the other candles. One of the possible TL equivalents is 头灯 (Gloss: headlamp). Its TL equivalents are difficult to locate in linguistic resources. Therefore, it is assumed that translating this Rich Point and understanding the function of the candle would require a relatively higher need for extralinguistic information. In this sub-section, the descriptive data of web search tasks for each Rich Point are presented separately with a summary at the end. The data analysis for the two Rich Points is conducted mainly using qualitative methods. Based on the transcription data of screen-recording videos, participants' search style, especially how and when they search for extralinguistic information, are summarised and compared.

7.2.1 Translation Problem Type

Steadfastly

This Rich Point was considered to be a Type 1 translation problem, which meant that the participants found it difficult to comprehend its lexical meaning. In the present study, 13 language learners, 13 translation students, and seven professional translators consulted online resources and their data were used for further investigation. The amount of gaze time was used to indicate the amount of attention allocated to consultation when translating this Rich Point and the mean values of this indicator are presented in Table 73. The results show that the mean values for the three groups of participants are similar to each other.

Table 73. Amount of gaze time (seconds) allocated to consultation when translating "steadfastly" by three groups of participants

Group	Amount of gaze time		
	N	Mean	SD
Language learners	13	7.39	3.83
Translation students	13	8.06	1.32
Professional translators	7	9.37	8.10

Since the data sets were normally distributed but the group variance was not homogeneous (see Table 74), Welch's *t*-tests were conducted and determined that the between-group differences were not statistically significant (see Table 75).

Table 74. Test of normality and homogeneity of variances (amount of gaze time allocated to consultation when translating "steadfastly" by three groups of participants)

Group	Shapiro-Wilk			Leneve			
	Statistic	*df*	Sig.	Statistic	*df1*	*df2*	Sig.
Language learners	.906	13	> .05				
Translation students	.889	13	> .05	10.318	2	30	< .05
Professional translators	.844	7	> .05				

Table 75. Welch's *t*-tests (amount of gaze time allocated to consultation when translating "steadfastly" by three groups of participants)

Comparison pair	Statistic	Sig
Language learners vs. translation students	.872	> .05
Professional translators vs. translation students	.224	> .05

The transcription data based on screen-recording videos showed that despite the difference in participants' translation experience, they all followed a similar consultation style when translating this Rich Point. They tended to conduct a relatively simple and straightforward enquiry with bilingual dictionaries. Table 76 shows the transcription of the web search task conducted by Participant S13. He/she looked up this Rich Point in a bilingual dictionary, read the TL equivalent, and used it directly in the TT.

Table 76. Web search task for "steadfastly" by Participant S13

Time frame	Action	Sequence	URL	Resource type	Query	TT
07:07	11		youdao.com	Bilingual dictionary		
07:10	20	1			steadfastly	
07:11	30					
07:22	60					不变地

This was the consultation style for all groups of participants when translating this Rich Point. Among the 37 participants, none of them consulted extralinguistic information. They all showed a high reliance on bilingual dictionaries and a high level of confidence in the TL equivalent provided by the dictionaries.

Alas

This Rich Point was considered to be a Type 2 translation problem, which meant that the participants had difficulty in producing its TL equivalent. In the present study, 10 language learners, 11 translation students, and 12 professional translators consulted online resources when translating this Rich Point. The mean values of the amount of gaze time allocated to

consultation when translating this Rich Point across the three groups of participants are similar to each other as well (see Table 77).

Table 77. Amount of gaze time (seconds) allocated to consultation when translating "alas" by three groups of participants

Group	Amount of gaze time		
	N	Mean	SD
Language learners	10	7.18	4.49
Translation students	11	5.65	4.54
Professional translators	12	6.59	4.11

Tables 78 shows that the group variances were homogeneous, and all the groups of data were normally distributed. Independent *t*-tests were conducted and determined that the between-group differences were not statistically significant (see Table 79).

Table 78. Test of normality and homogeneity of variances (amount of gaze time allocated to consultation when translating "alas" by three groups of participants)

Group	Shapiro-Wilk			Leneve			
	Statistic	*df*	Sig.	Statistic	*df1*	*df2*	Sig.
Language learners	.896	10	> .05				
Translation students	.876	11	> .05	.038	2	30	> .05
Professional translators	.903	12	> .05				

Table 79. Independent *t*-tests (amount of gaze time allocated to consultation when translating "alas")

Comparison pair	Statistic	Sig
Language learners vs. translation students	.779	> .05
Professional translators vs. translation students	.524	> .05

The transcription data showed no obvious differences in the consultation styles across the three groups of participants when translating this Rich Point, but there were some exceptions. Most of the participants, despite their translation experience, followed the same consultation style: they relied heavily on the lexical information provided by bilingual dictionaries. Nevertheless, several exceptions were observed with their web search tasks being carried out as follows. Participant S11 consulted Google, a search engine, which directly provided the TL

equivalent of “alas” from Google Translate. He/she showed dissatisfaction towards the search result, scrolled down the SERP, and checked the other links on this page. Although this participant abandoned the search results by making no further attempts, he/she showed dissatisfaction with the lexical information and tried to seek more information. Another exception was Participant S14, whose searching actions are presented in Table 80. He/she initiated the consultation by using a bilingual dictionary. When the provided TL equivalent was satisfactory, this participant devoted a significant amount of time (about 31 seconds) to reading the example sentences and clicked on one of the in-site links to read more bilingual idioms and sentences that contained “alas”. The following enquiry indicated that this participant showed little confidence in the result from the bilingual dictionary and was determined to carry out additional searching actions.

Table 80. Web search task for “alas” by Participant S14

Time frame	Action	Sequence	URL	Resource type	Query	TT
15:42	112		dictionary.cambridge.com	Bilingual dictionary		
15:44	20	1			alas	
15:45	30					
16:16	41	2	dictionary.cambridge.com	Bilingual dictionary		
16:20	30					
18:40	60					呜呼

These two exceptions are both taken from the group of translation students. Considering there were only two exceptions, it is not reliable enough to conclude this kind of exceptional behaviour is a between-group difference. However, it still shows that translation students are more likely to be suspicious of the TL equivalent provided in bilingual dictionaries compared to language learners and professional translators.

A stressful environment

This Rich Point was considered to be a Type 3 translation problem by all participants, which

indicated that the difficulty when translating this Rich Point was not in comprehending the lexical meaning, but in producing a TL equivalent that fit the text. In the present study, six language learners, nine translation students, and seven professional translators consulted online resources when translating this Rich Point. Table 81 presents the mean values of the amount of gaze time allocated to consultation when translating this Rich Point by three groups of participants. The results show that the group of translation students allocated a larger proportion of attention to consultation than the other two groups.

Table 81. Amount of gaze time (seconds) allocated to consultation when translating "a stressful environment" by three groups of participants

Group	Amount of gaze time		
	N	Mean	SD
Language learners	6	17.20	17.12
Translation students	9	31.43	24.24
Professional translators	7	20.61	34.86

As the group variances were homogeneous but not all the groups of data were normally distributed (see Table 82), Mann-Whitney *U*-tests were conducted and determined that the between-group differences were not statistically significant (see Table 83).

Table 82. Test of normality and homogeneity of variances (amount of gaze time allocated to consultation when translating "a stressful environment" by three groups of participants)

Group	Shapiro-Wilk			Leneve			
	Statistic	*df*	Sig.	Statistic	*df1*	*df2*	Sig.
Language learners	.836	6	> .05				
Translation students	.873	9	> .05	.769	2	19	> .05
Professional translators	.552	7	< .05				

Table 83. Mann-Whitney *U*-tests (amount of gaze time allocated to consultation when translating "a stressful environment")

Comparison pair	Statistic	Sig
Language learners vs. translation students	1.179	> .05
Professional translators vs. translation students	1.747	> .05

The transcription data from screen-recording videos were analysed to explore the

differences in the searching styles across three groups of participants. Most language learners started the web search tasks by consulting linguistic resources, such as bilingual dictionaries or the lexical information provided directly in a SERP. Participant L10 provided a typical example of this consultation behaviour (see Table 84). When encountered this problem, he/she conducted two queries, both with the same bilingual dictionary. Participant L10 was likely unsatisfied with the retrieved TL equivalents from the dictionary, since he/she did not use the equivalents in the TT. Nevertheless, Participant L10 did not consult any other types of online resources.

Table 84. Web search task for "a stressful environment" by Participant L10

Time frame	Action	Sequence	URL	Resource type	Query	TT
09:38	10		iciba.com	Bilingual dictionary		
09:40	20	1			stressful	
09:47	30					
09:55	111		iciba.com	Bilingual dictionary		
10:01	20	2			stressful environment	
10:17	60					环境面临着诸多生存压力

Similar to the language learners, the translation students tended to start their web search tasks for this Rich Point with bilingual dictionaries. However, when they found no satisfactory results from the lexical information, the translation students showed a higher tendency to use more diverse types of online resources. A typical example of the translation students' web search tasks when translating this Rich Point is presented in Table 85. Similar to Participant L10, Participant S04 started his/her search with a bilingual dictionary. When he/she found that the dictionary could not provide an appropriate TL equivalent, this participant expanded the web search episode by consulting a search engine and an encyclopaedia. However, this participant did not find an appropriate TL equivalent from these two types of online resources as well, so he/she re-checked the lexical meaning from a bilingual dictionary and the

explanation from the search engine. Based on the consultation of various types of information resources, this participant eventually produced a TL equivalent, which was not retrieved from any of the resources, but was a solution provided by his/her own understanding.

Table 85. Web search task for "a stressful environment" by Participant S04

Time frame	Action	Sequence	URL	Resource type	Query	TT
21:23	10		youdao.com	Bilingual dictionary		
21:24	20	1			stressful environment	
21:25	30					
21:35	112		baidu.com	Search engine		
21:35	20	2			珊瑚礁 生存环境 (LT: coral reef living environment)	
21:37	30					
21:44	40	3	baike.baidu.com	Encyclopaedia		
21:50	30					
22:24	112		youdao.com	Bilingual dictionary		
22:27	20	4			stressful	
22:48	10		google.co.uk	Search engine		
22:50	20	5			stressful	
22:51	30					
23:11	61					对生存环境要求较为苛刻

Compared to the translation students, the professional translators allocated significantly less attention to consultation when translating this Rich Point. They tended to follow the same style as the language learners. Among the seven professional translators who consulted online resources for this Rich Point, six of them only consulted bilingual dictionaries. Table 86 presents a typical web search task performed by Participant P12. Similar to the language learners and translation students, this professional translator also initiated the consultation with

the use of a bilingual dictionary. It seemed that this participant did not find the TL equivalent from the dictionary completely acceptable, since he/she produced the translation solution with some modifications. It is worth mentioning that Participant P12 used other types of online resources like search engines when translating this Rich Point, which meant that he/she was aware of and willing to use other types of online resources.

Table 86. Web search task for "a stressful environment" by Participant P12

Time frame	Action	Sequence	URL	Resource type	Query	TT
07:49	112		youdao.com	Bilingual dictionary		
07:50	20	1			stressful	
07:51	30					
08:20	60					环境压力重重

In summary, in the consultation when translating Type 1 and Type 2 problems, the effect of translation experience on individual web search tasks is not significant. However, in the consultation when translating the Type 3 problem, three groups of participants showed different consultation styles: the language learners and professional translators allocated significantly less attention to consultation than the translation students and mainly used linguistic resources, such as bilingual dictionaries, even when they found the provided TL equivalents unacceptable. In contrast, the translation students tended to conduct more detailed consultation using various types of online resources.

7.2.2 Extralinguistic Consultation

Two Rich Points, "latke" and "the 'attendant' candle" were selected to examine the differences in consultation when the participants faced a need for extralinguistic information. Therefore, in this subsection, instead of the amount of attention allocated to consultation, the proportions of attention allocated to linguistic information (including lexical and extra-lexical information sections) and extralinguistic information sections are used and compared.

Latke

Since "latke" is not a frequently used term, it was assumed that translating this Rich Point would require more linguistic information and less extralinguistic information than translating "the 'attendant' candle". In the present study, 13 language learners, 18 translation students, and 18 professional translators consulted online resources when translating this Rich Point. Table 87 shows the proportions of attention allocated to linguistic and extralinguistic information section. The results indicate that compared to both the language learners and professional translators, the translation students allocated a larger proportion of attention to extralinguistic information.

Table 87. Proportions of attention (in percentage) allocated to linguistic and extralinguistic information sections when translating "latke"

Group	N	Linguistic information		Extralinguistic information	
		Mean	SD	Mean	SD
Language learners	13	80.97	31.79	19.03	31.79
Translation students	18	51.13	48.39	48.87	48.39
Professional translators	18	80.34	37.00	19.66	37.00

Statistical analysis was conducted to determine whether the between-group differences in the proportion of attention allocated to extralinguistic information were significant. Since the group variances were not homogeneous and the data sets were not normally distributed (see Table 88), the Welch's *t*-tests on the rank transformation of the raw data were conducted. The results show that the between-group differences were both statistically significant (see Table 89).

Table 88. Test of normality and homogeneity of variances (proportions of attention allocated to extralinguistic information sections when translating "latke")

Group	Shapiro-Wilk			Leneve			
	Statistic	*df*	Sig.	Statistic	*df1*	*df2*	Sig.
Language learners	.633	13	< .05				
Translation students	.711	18	< .05	7.118	2	46	< .05
Professional translators	.580	18	< .05				

Table 89. Welch's *t*-tests on the rank transformation of the raw data (proportions of attention allocated to extralinguistic information sections when translating "latke")

Comparison pair	Statistic	*df*	Sig
Language learners vs. translation students	2.070	29	< .05
Professional translators vs. translation students	2.034	34	< .05

All participants started their consultation with linguistic information, but their subsequent search actions were influenced by their levels of translation experience. The translation students tended to double check the initial search result with further extralinguistic consultation even after they had correctly identified the meaning, so they allocated a larger proportion of attention to extralinguistic consultation. For a typical example, participant S08 first looked up "latke" in Youdao Bilingual Dictionary and located an acceptable TL expression during the first query. He/she then consulted extralinguistic information by searching "how to celebrate Hannukah" in WikiHow. The language learners and professional translators seldom performed such confirmation behaviours. Most of the language learners (11/13, 84.62%) did not consult any extralinguistic information when they found its meaning in a bilingual dictionary. The professional translators performed similarly to the language learners: when they found the meaning in a bilingual dictionary, they immediately turned back to translating the text without further consultation.

The "attendant" candle

When translating "the 'attendant' candle", 13 language learners, 17 translation students, and 17 professional translators consulted online resources. Similar to the consultation performed when translating the previous Rich Point, the participants also started their consultation with linguistic information, such as looking up this segment in a bilingual dictionary. However, in this case, they failed to locate an acceptable TL equivalent. The three groups of participants reacted differently when the search failed. Table 90 presents the mean values of the proportions of attention allocated to linguistic and extralinguistic consultation when translating this Rich Point. The translation students allocated the largest proportion of attention to extralinguistic consultation among all three groups of participants.

Table 90. Proportions of attention (in percentage) allocated to linguistic and extralinguistic information sections when translating "the 'attendant' candle"

Group	N	Linguistic information		Extralinguistic information	
		Mean	SD	Mean	SD
Language learners	13	51.61	43.86	48.39	43.86
Translation students	17	26.34	31.36	73.66	31.36
Professional translators	17	63.43	38.57	36.57	38.57

Table 91 shows that the group variances were homogeneous, but the data sets were not normally distributed. Mann-Whitney *U*-tests were conducted and determined that the between-group differences were both statistically significant (see Table 92).

Table 91. Test of normality and homogeneity of variances (proportions of attention allocated to extralinguistic information sections when translating "the 'attendant' candle")

Group	Shapiro-Wilk			Leneve			
	Statistic	*df*	Sig.	Statistic	*df1*	*df2*	Sig.
Language learners	.812	13	< .05				
Translation students	.786	17	< .05	3.057	2	44	> .05
Professional translators	.813	17	< .05				

Table 92. Mann-Whitney *U*-tests (proportions of attention allocated to extralinguistic information sections when translating "the 'attendant' candle")

Comparison pair	Statistic	Sig
Language learners vs. translation students	1.392	< .05
Professional translators vs. translation students	2.698	< .05

As mentioned at the beginning of this subsection, translating "the 'attendant' candle" required a larger amount of extralinguistic knowledge than translating "latke". The differences in the participants' consultation style when translating the two Rich Points were also investigated by examining the transcription of screen-recording videos. The language learners allocated a larger proportion of attention to extralinguistic consultation when translating this Rich Point than when translating "latke", but the professional translators did not show an obvious increase in the amount of attention allocated to extralinguistic consultation. As described previously, when translating "latke", the language learners tended to use the definitions from bilingual dictionaries without further consideration or confirmation. When

translating this Rich Point, when they could not locate suitable TL equivalents, they continued to consult extralinguistic information, which resulted in an increase in the proportion of attention allocated to extralinguistic consultation between the translation of the two Rich Points (19.02% and 48.39%). A typical example of this searching style, from Participant L13, is presented in Table 93. This participant started the consultation with a bilingual dictionary and did not find a satisfactory result. He/she then consulted several different types of online resources, including an encyclopaedia, a search engine, and an online portal, for extralinguistic information.

Table 93. Web search task for "the 'attendant' candle" by Participant L13

Time frame	Action	Sequence	URL	Resource type	Query	TT
09:22	112		fanyi.baidu.com	Bilingual dictionary		
09:23	20	1			attendant	
09:26	30					
10:19	112		baike.baidu.com	Encyclopaedia		
10:20	21	2			光明节 (Gloss: Hanukkah)	
10:22	30					
11:33	112		baidu.com	Search engine		
11:35	21	3			光明节 (LT: Hanukkah)	
11:45	40	4	d1xz.com	Online portal		
11:47	30					
12:03	112		baidu.com	Search engine		
12:04	21	5			光明节点灯 (LT: Hanukkah lighting)	
12:04	30					
12:50	60					"随从"蜡烛 (LT: "attendant" candle)

The translation students and professional translators, on the other hand, did not change their consultation style much when translating this Rich Point. The translation students always sought help from extralinguistic consultation regardless of whether the linguistic consultation was successful or not, and the professional translators tended to rely on their internal knowledge to translate this segment after failing to obtain the desired outcome through linguistic consultation.

7.2.3 Conclusion

Section 7.2 aims to investigate the effect of translation experience on individual web search tasks by comparing the differences across three groups of translators: language learners, translation students, and professional translators. Two major findings are presented. Firstly, when translating Type 1 and Type 2 translation problems, the differences in consultation styles across the three groups of participants were not significant. When translating Type 3 translation problems, the language learners and professional translators allocated significantly less attention to consultation and mainly used bilingual dictionaries even when they found the TL equivalents unacceptable, while the translation students tended to conduct more detailed consultation, with various types of online resources. Secondly, translators reacted differently when they encountered an increase in the need for more extralinguistic information. The translation students and professional translators maintained the same type of consultation styles while the language learners tended to allocate more attention to extralinguistic information.

A similarity was evident when the participants were translating the Type 3 problem and translating a segment that requires extralinguistic information: they both required a higher level of extralinguistic information. Lexical information is usually placed in systematic linguistic resources, such as bilingual and monolingual dictionaries. The consultation of this type of information is more likely to retrieve a certain result, which makes it easier to determine how acceptable and accurate the result is. However, extralinguistic information is usually provided in general resources, such as search engines and online portals. It would take more time and be more difficult to locate the relevant information. Therefore, when participants decide to search for extralinguistic information, they face a higher possibility of uncertainty. Pym (2015) defined this kind of uncertainty as the risk in translation process and developed a model of risks and efforts (see Table 94).

Table 94. Pym's model of risks and efforts (Pym, 2015, p. 73)

	Low chance of non-cooperation	**High chance of non-cooperation**
Low effort	Low-risk (risk aversion, risk transfer)	Mid-risk ("under-work", guesswork)
High effort	Mid-risk (overwork, inefficient [labour])	High-risk (risk transfer, risk taking)

Based on this model, translating a segment without consulting extralinguistic information could be considered as two different tasks: one with a low chance of non-cooperation and one with a high chance of non-cooperation. When facing the difference in the uncertainties between the two tasks, both translation students and professional translators maintained the same level of effort. The translation students always allocated a high level of effort when faced with a translation problem even though this might be considered an inefficient use of effort as the professional translators allocated a low level of effort. This finding shows that the professional translators had a high level of confidence in their internal knowledge. This finding is in line with the conclusion made by Künzli (2004), who reported that experienced translators are more likely to use risk-transfer strategies. Fraser (2000) and House (2000) also pointed out that compared to non-professionals, professional translators are high risk-takers, which means that professionals have a lower reliance on external resources. Unlike the other two groups of participants, the language learners increased the level of effort allocated to the translation problem when faced with a task with a high chance of non-cooperation, which seemed to be a more rational risk management strategy. Massey and Ehrensberger-Dow (2011) reported that "students show a greater inclination than instructors to use multilingual resources for both linguistic and extralinguistic research, but use monolingual dictionaries and special search facilities rather less" (p. 198). Enríquez Raído (2014) found a similar result as the student participants typically used dictionaries as their first port of call in searching for both linguistic and extralinguistic information. However, this behaviour in fact revealed their lack of information evaluation ability, which can be defined as information literacy (Massey & Ehrensberger-Dow, 2011). The language learners tended to trust the information from online dictionaries and their subsequent extralinguistic consultation was conducted purely based on the dictionary search result without evaluation.

The investigation presents a similar finding as the investigation of holistic consultation tasks: compared to both the language learners and professional translators, the translation students were more reliant on online resources. In addition, the investigation presented in this sub-section shows that translation experience affects participants' risk management strategies. Translation training experience makes participants more conscious of external information in a high-risk situation and professional work experience makes participants more confident in their internal knowledge and more assertive in their translation strategies. Both types of risk-management strategies have their own advantages and disadvantages. Although translation students allocate more attention to translation, which might lead to a decrease in consultation efficiency, they are more likely to produce a better translation solution. The strategy used by professional translators seems to be the most optimal, but this is because they are more competent in translation. Therefore, although the effect of translation experience is observed and summarised in the present study, it is not considered to be a suggestion for translation training. It is assumed that the exhaustive consultation for external resources is part of the learning process for translation students. A longitudinal study might be helpful to further investigate of this process.

Chapter 8: Consultation and Translation Quality

This Chapter aims to answer the third research question: what is the effect of consultation on translation quality? The answer to this question is based on the correlations between difference aspects of consultation and translation quality. Both the holistic consultation and the embedded web search tasks are considered in this Chapter. For the holistic consultation, three aspects are included: (1) the amount and proportion of attention allocated to consultation, (2) the online resource variety, and (3) the consultation style, which is specifically used for the investigation of consultation when translating Text C. The holistic translation quality scores for three STs obtained by 56 participants are used in this analysis. For the embedded web search tasks, three aspects are included: (1) the amount of attention allocated to each task, (2) the consultation complexity, which is indicated by the online resource variety and number of queries, and (3) the consultation style. The first two measurements are used in the examination of all 978 individual translation segments and the third measurement is used for five selected Rich Points.

8.1 Consultation and Holistic Translation Quality

This section presents the correlations between consultation and holistic translation quality scores. The assessment method for translation quality is presented in section 5.2.4. There are two controlled variables involved: participants and texts. The correlation between participants and translation quality scores is first analysed to see if translation experience correlates with translation quality. Based on the descriptive results presented in Table 95, it is found that when translating all three STs, the participants with more translation experience obtained higher translation quality scores.

Table 95. Holistic translation quality scores for three STs obtained by all participants

Group	N	Text A		Text B		Text C	
		Mean	SD	Mean	SD	Mean	SD
Language learners	17	85.27	14.91	76.31	3.32	68.33	14.64
Translation students	18	88.63	13.48	77.68	3.88	71.74	13.27
Professional translators	21	94.21	7.18	82.44	2.59	80.72	12.71

Additional statistical analyses were performed to determine whether the correlation

between translation experience and the holistic translation quality scores was significant. Tables 96 and 97 show that the group variances were homogeneous but not all the groups of data were normally distributed.

Table 96. Test of homogeneity of variances (holistic translation quality scores for three STs obtained by all participants)

Text	Statistic	*df1*	*df2*	Sig.
A	2.811	2	53	> .05
B	1.204	2	53	> .05
C	.003	2	53	> .05

Table 97. Shapiro-Wilk normal distribution test (holistic translation quality scores for three STs obtained by all participants)

Text	Group	Shapiro-Wilk		
		Statistic	*df*	Sig.
A	Language learners	.861	17	< .05
	Translation students	.806	18	< .05
	Professional translators	.789	21	< .05
B	Language learners	.855	17	< .05
	Translation students	.913	18	< .05
	Professional translators	.783	21	< .05
C	Language learners	.981	17	> .05
	Translation students	.947	18	> .05
	Professional translators	.924	21	> .05

Therefore, Spearman correlation coefficients were performed to determine the correlations between translation experience and holistic translation quality scores (see Table 98). The results show that in the translations of three STs, the correlations between translation experience and holistic translation scores are statistically significant. The results further confirm that in the present study, the differences in translation experience leads to differences in translation competence. The participants with more translation experience were also more competent in translation.

Table 98. Spearman correlation coefficients between attention distribution on consultation and holistic translation quality for three groups of participants

Text	Holistic translation quality scores	
	Rho	**Sig.**
A	.260	< .05
B	.199	< .05
C	.364	< .05

The effect of consultation on translation quality will be presented using three measurements: (1) the amount and proportion of attention, (2) the number of online resource types, and (3) the background information search style. Since the homogeneity of variances and normal distribution of the datasets used in this Chapter have been presented in section 6.1 and show that these datasets do not meet the assumptions for parametric tests, a non-parametric test, Spearman correlation coefficient, is used to calculate the correlations.

8.1.1 Amount and Proportion of Attention, and Online Resource Variety

Table 99 presents the correlations between three measurements of consultation, including the amount of attention, the proportion of attention, and the number of online resource types, and holistic translation scores of three STs by 56 participants. The results show the effect of consultation on translation quality was different for three STs. When translating Text A and B, no significant correlation is found between the three measurements of consultation and translation quality scores for all three groups of participants. However, in the translation of Text C, the correlations between two measurements, the amount and proportion of attention on consultation, and translation scores for all three groups of participants are statistically significant, while the correlations between the number of online resource types and translation quality scores remain unsignificant.

Table 99. Spearman correlation coefficients between consultation and holistic translation quality scores

Group	Text	Amount of attention		Proportion of attention		Resource type number	
		Rho	**Sig.**	**Rho**	**Sig.**	**Rho**	**Sig.**
Language learners	A	.245	> .05	.023	> .05	.354	> .05
	B	.164	> .05	.164	> .05	.284	> .05
	C	.422	< .05	.365	< .05	.389	> .05
Translation students	A	.019	> .05	.209	> .05	.323	> .05
	B	.107	> .05	.032	> .05	.114	> 05
	C	.529	< .05	.346	< .05	.269	> .05
Professional translators	A	.221	> .05	.101	> .05	.036	> .05
	B	.098	> .05	.144	> .05	.159	> .05
	C	.537	< .05	.566	< .05	.133	> .05

The results reveal two main findings. Firstly, when translating texts that do not have a special requirement for background information, neither the length nor the complexity of consultation has a significant effect on the holistic translation quality scores. Since a large proportion of attention is allocated to consultation during translation, this finding is unexpected. However, previous studies have also supported this finding by indicating that neither the length nor the complexity of consultation is correlated with the holistic translation quality. Dancette (1997) found that "the number of consultations does not correlate with the quality of the translation" (p. 101). Livbjerg and Mees (1999) reported a similar finding: in translating a non-domain specific text, the consultation of external resources did not result in any improvements. These findings suggest that the holistic translation quality is mainly determined by participants' internal support, such as the translation strategies they choose, rather than by the external support. The assessment reports provided by the assessors in the present study also support this argument. They show that the production of many incorrect translation solutions did not involve any consultation of external resources. For instance, in the translation of Text A, participant P03 translated "revolutionary" into "从进化论的角度 (LT: from the evolutionary aspect)", which was annotated as a critical mistake by both assessors. Clearly, this participant confused the two words, revolutionary and evolutionary, but he/she did not realise and produced the incorrect translation solution. In this case, participant P03 believed that he/she understood the lexical meaning of this word and was able to produce a satisfactory solution, so this participant did not

feel the need for external consultation. This was the only mistake made by this participant in the translation of Text A, but it affected the final score of the holistic translation quality. Thus, it can be concluded that the holistic translation quality score may be affected by various elements other than the three features of consultation investigated in this section. In order to minimise interferences, the effect of consultation on translation quality is further analysed by focusing on the individual translation tasks in section 8.2.

Secondly, when translating Text C, the amount of attention allocated to consultation has a significantly positive effect on the holistic translation quality score. In other words, when translating a text with a greater need for background information, longer and more diverse consultation leads to a better-quality translation. Compared to translating Text A and B, external information plays a more important role when translating Text C. For instance, some terms in Text C, like "latke", are highly challenging to understand without external information, but are easily comprehended with online consultation. Therefore, when translating Text C, the lexical information from online resources would be a greater help for participants than when translating Text A and B. This finding suggests that consultation on specific-domain texts is more vital than general texts and should receive more attention in translation training. There are other researchers who have proposed this suggestion in medical and legal translation, two types of domain-specific translation. For medical translation, based on the guidelines provided by the International Medical Interpreters Association (IMIA, 2009), Karwacka (2014) suggested that medical translators and interpreters should not only have translation skills (such as a formal education in the source and target languages, and in translation theory and practice), but should also have "expert knowledge of the subject matter terminology, understand the source text, have proficient writing skills and adequate skills in using specialised, professional dictionaries and glossaries" (p. 23). With evidence from an empirical study, Shih (2019) found that in the translation of medical texts, many unsuccessful web search episodes were the result of one-step research episodes, or the result of quick and superficial searches. She suggested that in order to obtain optimal results through the consultation of online resources when translating a medical text, translators should have more engagement with SERPs, such as "clicking beyond the top three search results or taking the time to process potentially relevant contents in selected search

results" (Shih, 2019, p. 922). In other words, translators should be more patient and devote more time to the consultation of external resources. Besides, Sycz-Opoń (2019) specifically pointed out the importance of information-seeking behaviour in legal translation since "the information needs of legal translators do not equal the needs experienced by the translators dealing with other types of texts" (p. 153). She summarised three factors that contribute to the complexity of legal translation: (1) the specialist subject matter, (2) the incongruity of legal concepts and the terminology that reflects them, and (3) the terminological multivalence. Because of these three factors, legal translators are more likely to have a greater reliance on external consultation and their translation quality might be affected by consultation more significantly. Overall, when translating domain-specific texts, such as legal, medical, and cultural texts, an increase in the amount of attention allocated to consultation leads to an increase in the holistic translation quality.

8.1.2 Background Search Style

As reported in section 8.1.1, when translating a text that requires more background information, the amount and proportion of attention allocated to consultation has a significant and positive effect on the holistic translation quality score. Further investigation is thus conducted to find out whether the style used when searching for background information has a significant correlation with translation quality. The style used when searching for background information is the measurement employed in section 7.1.3. It is categorised into three types based on the starting point of the background search: before drafting, during drafting, and no consultation. Background search before drafting means that the translator starts consulting for background information while reading the ST, which refers to the phase before producing any translation solutions. Background search during drafting means that the translator firstly starts producing the TT and then consult background information. No background consultation means that the translator does not consult any background information during the entire translation process. Overall, 15 participants (including two language learners, seven translation students, and six professional translators), 29 participants (including 13 language learners, nine translation

students, and seven professional translators), and 12 participants (including two language learners, two translation students, and eight professional translators) were observed to have these three types of background information searching styles, respectively.

The mean values of the holistic translation scores for Text C obtained by three groups of participants with each type of background searching style are presented in Table 100. The results present a similar trend for all three groups of participants: the later the starting point of the background information search in the translation task, the lower the translation quality score is.

Table 100. Holistic translation scores for Text C by participants with three background searching styles

Group	Before drafting			During drafting			No consultation		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Language learners	2	84.62	5.44	13	69.45	11.99	2	44.72	3.40
Translation students	7	78.30	8.98	9	69.65	14.67	2	58.17	8.84
Professional translators	6	91.62	9.05	7	81.89	9.17	8	70.31	9.37

Spearman correlation coefficients were conducted to examine the correlations between background information search styles and translation quality scores by three groups of participants (see Table 101). The results show that the correlations for all three groups of participants are statistically significant.

Table 101. Spearman correlation coefficients between background searching styles and holistic translation quality scores by three groups of participants

Group	Spearman correlation coefficients	
	Rho	Sig.
Language learners	-.695	< .05
Translation students	- .500	< .05
Professional translators	-.664	< .05

The correlations show two findings. Firstly, participants who search for background information before drafting and during drafting produce a significantly better translation than participants who do not search for background information throughout the translation task. In other words, participants who have background knowledge of the ST perform better than

participants who do not. This finding is consistent with the other findings reported in previous translation studies (H. Kim, 2006; Liu, 2007; Zheng & Xiang, 2014). H. Kim (2006) divided translation students into two groups, in which one group was asked to collect background information before translating while the other group was not. She reported that the students from the first group produced significantly better target texts than the students from the other group. Liu (2007) investigated the effect of short-term preparation on the quality of both written translation and interpreting, and reported that preparation was positively correlated with students' performances in both tasks. The positive effect of background information search on translation quality was also observed in sight translation. Zheng and Xiang (2014) assigned 68 interpreting students to a control group and an experimental group. Only the students in the experimental group were given relevant background information before the sight translation task. They also found that the students with background information produced better-quality translations. In both scenarios, the background information search before the translation task improves translators' content schema, which refers to a representation of one's world knowledge or possessing background knowledge about a text's domain (Carrell & Eisterhold, 1983). Schema, which can refer to either content or formal schema (Kafipour & Jahansooz, 2017), is a reference "to an active organization of past reactions, or of past experiences, which must always be supposed to be operating in any well-adapted organic response" (Bartlett, 1932, p. 201). Based on schema theory, several existing studies on second-language learning and reading comprehension indicate that prior knowledge is extremely important in text comprehension (Al-Jarrah & binti Ismail, 2018; Kafipour & Jahansooz, 2017; Shakir, 2002). In the present study, all participants did not have much background knowledge about the topic of Text C, so they had to increase their background knowledge through consultation online resources. In other words, participants who search for background information during the translation process develop better schemata about the ST, and therefore develop a better understanding of the ST, which ultimately benefits the production of the TT.

Secondly, participants who search for background information before drafting produce better-quality translations than participants who do not. The behaviour of searching for background information before drafting can be considered as a type of pre-task planning. By

conducting this type of behaviour, participants postpone the drafting stage and prepare themselves for potential problems. Various studies have reported that planning can benefit task performance. For example, Unterrainer and Owen (2006) reported that when instructed to plan ahead the entire task before starting to interact with it, participants' performance improved. Furthermore, Albert and Steinberg (2011) used first move latency to indicate the length of initial planning phase in a problem solving task and found that first move latency is positively related to task performance. In a translation process, which is also considered as a problem solving task, background information search before drafting enables translators to have a planning stage of the task including both the drafting and forthcoming consultation, and benefit the translation quality.

Compared to written translation, the importance of pre-task preparation in interpreting has received more recognition and has been researched more widely. Since interpreters cannot search for external information during interpreting, complete and accurate interpreting depends largely on their grasp of the subject knowledge and context (Seleskovitch, 1978). Similar to written translation, "in many interpreting cases, the subject knowledge of interpreting is new to the interpreter, which establishes the necessity of pre-interpreting preparation" (Song & Tang, 2020, p.1641), so the preparation before interpreting is of great importance. In an empirical study that investigates the effect of preparation on the quality of both written translation and interpreting, Liu (2007) divided the students into three groups: students who have prepared both the text subject and the key terms, students who have prepared only the subject, and students who have not carried out any preparation. She reported that in both written translation and interpreting tasks, preparation is positively correlated with students' performance. Moreover, she also found that in interpreting, the correlation is more significant than in written translation, and preparation on the text subject is more important than preparation of the key terms. Zhong (2016) also reported that subject familiarity significantly improves the accuracy of terms and core concepts in the interpreting process. With a focus on business interpreting, Song and Tang (2020) analysed the effect of pre-interpreting preparation. They also found that pre-task preparation has a positive effect on the overall quality of interpreting output, especially in relation to the accuracy of terminology and the logical coherence of the target-language speech.

However, the investigation of pre-task preparation in written translation does not attract as much attention as interpreting. The preparation can be divided into two types: long-term preparation and short-term preparation. In written translation, long-term preparation refers to the training of translation strategies, obtaining domain-specific knowledge in various field, and translation practices, etc. While short-term preparation mainly includes preparation on the subject knowledge and terminology. The existing studies on the pre-task preparation in written translation mainly focus on long-term preparation. For instance, PACTE (2003) developed a translation competence model, which suggests that translators should have "the knowledge and abilities associated with the practise of professional translation: knowledge and use of all kinds of documentation sources; knowledge and use of new technologies; knowledge of the work market and the profession (prices, types of briefs, etc.)" (p. 51). These types of knowledge are gained from long-term rather than short-term preparation. Compared to Interpreting Studies, fewer researchers have conducted research on pre-task preparation in written translation. H. Kim (2006) found a significantly positive effect of pre-task preparation on translation quality. It is possible that, compared to interpreters, translators have the time and opportunity to search for more information during translation, which reduces the need to carry out short-term preparation. Based on the empirical evidence provided by the present study, it proves that the pre-task preparation can significantly improve the holistic translation quality.

8.1.3 Conclusion

Section 8.1 aims to answer the research question: what is the effect of consultation on translation quality when translating the holistic task? Three aspects of consultation were investigated: (1) the amount and proportion of attention allocated to consultation, (2) the number of online resource types, and (3) the background information search style.

In summary, the findings provided in section 8.1 are presented as follows. Firstly, when translating general-purpose texts, neither the length nor the complexity of consultation has a significant effect on the holistic translation quality. Secondly, when translating domain-specific texts, the amount of attention allocated to consultation has a significantly positive correlation

with the holistic translation quality, but the online resource variety does not have such correlation. Thirdly, participants who search for background information produce significantly better-quality translations than participants who do not. Fourthly, participants who perform pre-task preparation produce better-quality translations than participants who do not.

Based on these findings, two suggestions for translation training and further research are proposed. Firstly, translators should be specially trained in the use of external resources when translating domain-specific texts, such as in legal and medical translations. Secondly, short-term preparation in written translation requires more research. For instance, in Interpreting Studies, the investigation of pre-task preparation has been conducted from several aspects, including its effect on interpreting performance and output, and the preparation features that contribute the most to the improvement of interpreting. These research methods can be borrowed and applied to further studies on preparation in written translation.

8.2 Consultation and Acceptability of Translation Segments

8.2.1 Amount of Attention and Consultation Complexity

As mentioned in section 8.1, the holistic translation quality may be interfered with by other factors apart from consultation. In order to avoid these interferences, this section explores the correlations between individual web search tasks and the translation acceptability of specific segments. In total, 978 solutions of individual translation problems were assessed. The assessment method for determining translation acceptability for each translation problem is presented in section 5.2.4. Based on this method, each translation solution was assessed to be acceptable (A), semi-acceptable (SA), and non-acceptable (NA). Table 102 presents the assessment results of translation solutions that are categorised using two variables: the group of participants and translation problem type. In general, two trends are observed based on the results. Firstly, the percentages of solutions that are assessed as acceptable show a decreasing trend from Type 1 to Type 3 translation problems for all three groups of participants. Secondly, for all three types of translation problems, the increase in translation experience leads to an

increase in the proportions of acceptable solutions.

Table 102. Percentage of assessments of individual translation segments

Group	Translation problem type	A		SA		NA	
		N	Percentage	N	Percentage	N	Percentage
Language learners	Type 1	137	77.40%	19	10.73%	21	11.87%
	Type 2	29	70.73%	7	17.07%	5	12.20%
	Type 3	43	56.58%	15	19.74%	18	23.68%
Translation students	Type 1	141	79.66%	18	10.17%	18	10.17%
	Type 2	54	72.97%	16	21.62%	4	5.41%
	Type 3	75	66.96%	21	18.75%	16	14.29%
Professional translators	Type 1	142	80.21%	13	7.34%	22	12.45%
	Type 2	31	79.49%	3	7.69%	5	12.82%
	Type 3	75	71.43%	21	20.00%	9	8.66%

The effect of consultation on the acceptability of individual translation solutions is firstly analysed using two quantitative measurements: (1) the amount of attention, which is indicated by the total amount of gaze time allocated to the consultation when translating individual ST segments; and (2) the consultation complexity, which is reflected in the number of online resource types and the number of queries within one web search task. In addition, the characteristics of web search tasks when producing the acceptable and unacceptable solutions of several selected translation segments are summarised and investigated in this section.

The correlations between the two quantitative measurements of consultation and the individual translation acceptability for three groups of participants were explored with Spearman correlation coefficients (see Table 103). The results show that for the translation students and professional translators, both the amount of attention allocated to consultation and the consultation complexity are significantly correlated with the acceptability of individual translation solutions. However, for the language learners, the consultation complexity does not correlate with the acceptability of individual translation solutions.

Table 103. Spearman correlation coefficients between consultation and translation acceptability

Group	Amount of attention		Resource type number		Query number	
	Rho	**Sig.**	**Rho**	**Sig.**	**Rho**	**Sig.**
Language learners	.197	< .05	.220	> .05	.203	> .05
Translation students	.256	< .05	.208	< .05	.181	< .05
Professional translators	.104	< .05	.593	< .05	.659	< .05

A significant correlation is found between the amount of attention allocated to consultation and the acceptability of individual translation solutions. A longer consultation led to a higher level of translation acceptability. In the web search tasks for most unacceptable translation solutions, participants tended to conduct only one query either in a bilingual dictionary or a search engine and give up searching fairly quickly. A typical example of this kind of query is presented in Table 104. The ST segment here is “a stressful environment”, which refers to how the living environment of coral reefs is affected by various external influences. This segment can also be used to indicate a difficult living situation for people. The context of the translation problem can result in the TL equivalents being different. In Participant P17’s case, he/she only looked up the ST segment in a bilingual dictionary, found the TL equivalent 逆境 (Gloss: adversity), and allocated 4.03 seconds of gaze time on this web search task. Obviously, this TL equivalent is not suitable for describing the living conditions of coral reefs. However, Participant P17 did not question this TL equivalent or conduct subsequent queries.

Table 104. Web search task for “a stressful environment” by Participant P17

Time frame	Action	Sequence	URL	Resource type	Query	TT
07:55	112		youdao.com	Bilingual dictionary		
07:55	20	1			a stressful environment	
07:56	30					
08:27	60					遇到困境

On the other hand, in the web search tasks for the acceptable translation solutions,

participants tended to allocate a larger amount of attention to consultation, by spending more time reading search results. An example demonstrating a web search task in producing an acceptable translation solution for the ST segment “a stressful environment” by Participant S07 is presented in Table 105. Like Participant P17, Participant S07 only used a bilingual dictionary, but he/she allocated a larger amount of attention to read the search results (4.03 seconds vs. 17.07 seconds). Moreover, this participant was more conscious about the TL equivalent directly provided in the dictionary and spent more time reading the example sentences.

Table 105. Web search task for “a stressful environment” by Participant S07

Time frame	Action	Sequence	URL	Resource type	Query	TT
06:20	112		youdao.com	Bilingual dictionary		
06:20	20	1			stressful	
06:24	30					
07:16	50					
09:38	60					艰苦的自然环境中

To summarise, the amount of attention allocated to consultation is one of the significant variables that affect the acceptability of translation solutions. Compared to the production of unacceptable solutions, the participants tended to allocate more attention to the production of acceptable solutions. The increase in the amount of attention is usually triggered by spending more time reading the search results and more effort in evaluating and understanding the online information.

This finding is supported by previous studies. Olalla-Soler (2018) explored the relationship between the time spent on queries and the quality of the proposed solutions produced by undergraduate translation students at different levels. Although no significant correlations were found, he reported the differences in the levels of acceptability across translators who spent a longer or shorter amount of time on queries, which are presented as follows:

> Amongst the first-year students, there is hardly any difference between the

> acceptability obtained by the subjects who spent a low amount of time on queries and those who spent an average time. In the case of the second year, the more time spent on queries, the higher the degree of acceptability. The tendency observed in the second year was maintained in the third one. In the fourth year, the subjects who spent an average amount of time on queries obtained a higher level of acceptability than those who spent a lower amount of time. (p. 1309)

A similar result was presented by Shih (2019). With a focus on the characteristics of successful and unsuccessful web search episodes when translating selected segments, Shih (2019) indicated that shorter consultation usually led to unsuccessful results, by reporting that "in most unsuccessful web search episodes, trainees tended to give up searching fairly quickly, posing one single ST term as a query either in an online dictionary or a search engine" (p. 917). She concluded that the most significant difference between the unsuccessful and successful web search episodes was that participants spent a longer amount of time reading and assessing SERPs.

Another finding is that there are significant correlations between the complexity of consultation and translation acceptability for translation students and professional translators, but no correlations for language learners. Based on the characteristics of web search tasks in producing successful and unsuccessful solutions by three groups of participants, this finding is further examined from two perspectives. The differences between web search tasks with a high complexity and with a low complexity are firstly investigated. Table 106 presents a web search task involving two queries for translating "a stressful environment" by Participant L04. He/she started this consultation with a bilingual dictionary and found the result insufficient to produce an appropriate TL solution. Instead of accepting the TL equivalent like Participant P17 did (see Table 103), Participant L04 consulted a new term using the bilingual dictionary, read more example collocations and sentences, and produced an acceptable TL solution.

Table 106. Web search task for “a stressful environment” by Participant L04

Time frame	Action	Sequence	URL	Resource type	Query	TT
06:15	112		youdao.com	Bilingual dictionary		
06:16	20	1			stressful	
06:17	30					
06:39	112		youdao.com	Bilingual dictionary		
06:39	20	2			a stressful environment	
06:39	30					
07:08	50					
21:36	60					自然条件不佳的环境

Secondly, the differences between the language learners and other two groups of participants are examined. For some language learners, although they may be conscious of the search results and consult multiple webpages from different resources, they could still potentially misunderstand the ST and fail to retrieve the correct information. Table 107 presents a typical example, which is the web search task when translating the ST segment “a stressful environment” by Participant L22. In this case, he/she firstly looked up “stressful” in a bilingual dictionary. After failing to obtain a satisfactory result, Participant L22 produced two TL equivalents, but he/she was not confident about the solutions and double checked these results by searching for them using a search engine. As previously mentioned, the TL equivalents for this segment “a stressful environment” are different depending on the context. Since Participant L22 made straightforward queries and only examined several results at the top of the SERPs, he/she did not find any evidence to support the solutions.

Table 107. Web search task for “a stressful environment” by Participant L22

Time frame	Action	Sequence	URL	Resource type	Query	TT
11:52	11		youdao.com	Bilingual dictionary		
11:53	20	1			stressful	
11:55	30					
12:46	112		baidu.com	Search engine		
12:47	21	2			有压环境 (LT: with stress environment)	
12:49	30					
13:13	112		baidu.com	Search engine		
13:13	21	3			负压环境 (LT: negative pressure environment)	
13:16	30					
13:35	60					负压环境 (LT: negative pressure environment)

It can be observed that the language learners tended to make simple and straightforward queries, which are not effective in translation. On the other hand, the participants with more experience who conducted more complex consultations tended to optimise their subsequent queries. Table 108 presents the web search task when translating “a stressful environment” by Participant P01. This participant realised that the literal translation of “stressful” would be problematic in this context, so he/she started the web search task by searching for the information about the growing environment of coral reefs using a search engine. Compared to Participant L22, Participant P01 read more than one SERP, which indicated a more thorough evaluation of the online information. In this web search task, he/she did not solely look for the TL equivalent, but tried to obtain extralinguistic knowledge to enhance the comprehension of the ST. Similar to Participant L22, Participant P01 did not locate an acceptable TL equivalent

in the search results, but he/she managed to produce an acceptable translation solution based on the extralinguistic information consulted during this web search task.

Table 108. Web search task for “a stressful environment” by Participant P01

Time frame	Action	Sequence	URL	Resource type	Query	TT
06:10	112		baidu.com	Search engine		
06:11	21	1			珊瑚礁的生长环境 (LT: coral reefs' growing environment)	
06:18	30					
07:04	112		baidu.com	Search engine		
07:05	21	2			海底 有压力的环境 (LT: seafloor stressful environment)	
07:12	30					
07:34	40	3	zhidao.baidu.com	Online portal		
07:35	30					
08:12	112		google.co.uk	Search engine		
08:17	201	4			“stressful environment ” undersea	
08:20	30					
08:48	112		baidu.com	Search engine		
08:48	21	5			海底 有压力的环境 (LT: seafloor stressful environment)	
08:55	30					
09:40	60					生态压力大的环境 (LT: ecologically stressful environment)

In both web search tasks, the participants conducted a relatively more complex consultation behaviour. The major difference between these two tasks was how the participants made the subsequent queries after failing to obtain a satisfactory search result from the first query. The increase in the consultation complexity can trigger more diverse types of information, which eventually benefit the production of translation solutions. All the queries made by the language learners within one web search task, even with different types of online resources, tended to have the same purpose: looking for an acceptable TL equivalent. However, the subsequent queries were not based on the search result from the previous query. In other words, in a complex web search task, language learners cannot combine the search results from different queries. In contrast, participants with more experience show the capability of tailoring subsequent queries based on the search results from previous queries.

Similar results are reported in previous studies. Olalla-Soler (2018) found that the acceptability of cultural segments is not significantly affected by either the variety of resources or the number of queries. He suggested that participants may "engage in a repetitive, poorly organised and ineffective information-seeking process" (p. 1311) and tend to conduct ineffective information-seeking behaviours, so the quality of their translations do not benefit from an increase in the complexity of consultation. Shih (2019) found that in some cases, although the participants spent a long period of time and consulted multiple webpages in one web search task, they tended to use "a few habitual web resources throughout all her/his translation process" (p. 916) and could not effectively retrieve the correct information.

The findings show that the positive effect of consultation complexity on the acceptability of individual translation solutions is only positive when the information being consulted is relevant to the translation. This finding suggests that online consultation skills for translators should receive more attention when designing translation curricula, for example "asking students to translate a text with limited queries for each translation problem, or to translate a text while being screen-recorded and then view their translation process recordings and write a report on their information-seeking processes" (Olalla-Soler, 2018, p. 1313). Besides, the results also show that inexperienced translators are not proficient in using general types of resources, such as search engine. Based on the survey of information literacy instruction in

Spain, Pinto and Sales (2008) reported that "well ahead of the rest of the items, the translation and interpreter trainers see the first need of a specialized translator as being the skill of information search (68%)" (p. 61). Enríquez Raído (2014) suggested that translation training should particularly focus on "(a) knowledge about search engine performance for data retrieval as opposed to information retrieval, and (b) the use of search engine features to efficiently construct (advanced) queries for finding relevant information on the web" (p. 182). the present study also suggests that translation students should be specially trained about the use of search engine.

8.2.2 Conclusion

Section 8.2 aims to answer the following research question: what is the effect of consultation on translation quality from the perspective of individual translation segments? The investigation is conducted from two aspects: (1) the amount of attention allocated to individual web search tasks; and (2) the consultation complexity, which is reflected in the number of online resource types and queries.

The following findings are summarised. Firstly, a significant correlation is found between the amount of attention allocated to consultation and the acceptability of individual translation solutions, with a larger amount of attention leading to a higher level of translation acceptability. Secondly, significant correlations between the complexity of consultation and translation acceptability are found for translation students and professional translators, but not for language learners. The biggest difference between inexperienced and experienced translators is their subsequent queries after failing to obtain a satisfactory search result from the first query. Experienced translators, including translation students and professional translators, are able to tailor subsequent queries based on the previous search results and consult more diverse types of information, while language learners do not have this ability.

These two findings show that in order to produce translation solutions with higher degrees of acceptability, participants have to allocate a sufficient amount of attention to consultation and consult relevant information resources. These findings further support the notion that

translators' competence models should include instrumental competence as a key component.

Chapter 9: Conclusion

The fundamental goal of the present study is to investigate the consultation of online resources in English to Chinese translation by translators with different levels of experience and the effect of consultation on translation quality. The present study is based on two assumptions: (1) information needs and translators' experience are two influential factors on consultation behaviours, and (2) consultation affects the quality of translation products. These two assumptions are examined with the following research questions:

Research Question 1:

What is the effect of information needs on consultation behaviour?

1a) What is the effect of the level of perceived translation difficulty on consultation behaviour?

1b) What is the effect of translation problem type on consultation behaviour?

Research Question 2:

What is the effect of translation experience on consultation behaviour?

2a) What is the effect of translation experience on holistic consultation behaviour?

2b) What is the effect of translation experience on consultation for translating individual segments?

Research Question 3:

What is the effect of consultation behaviour on translation quality?

3a) What is the effect of consultation behaviour on the holistic translation quality?

3b) What is the effect of consultation behaviour on the acceptability of individual translation segments?

In the present study, 68 participants (including 22 language learners, 23 translation students, and 23 professional translators) were recruited to translate three STs from their L2 (English) to their L1 (Chinese), with their translation and consultation processes being recorded with eye-tracking and screen-recording, and question-based retrospective interviews. Based on

a combination of several models of information-seeking behaviour (Choo et al., 1999; Ellis, 1989; Foster, 2004; Kuhlthau, 1991; Wilson, 1981), a new model of consultation in translation is proposed to illustrate the linear process and the interactive features of consultation (see section 2.3).

Quantitative and qualitative data were collected and analysed in the present study. The quantitative data were retrieved from eye-tracking and used to indicate the amount of attention allocated to consultation, the proportion of attention allocated to consultation over the entire translation process, cognitive load, cognitive efficiency, and the proportion of attention allocated to different information sections in individual web search tasks. Three eye-tracking measurements were used: the amount of gaze time, MFD, and the number of between-task transitions. The qualitative data were retrieved from the transcription of screen-recording videos and were used to calculate the numbers of online resource types and queries, and to summarise the characteristics of information search styles. In addition, the product data were also used in the present study and were represented with the translation quality of holistic texts and the acceptability of individual translation segments.

This concluding Chapter provides a summary of the findings presented in Chapters 6, 7, and 8, highlights the limitations of the present study, and suggests several possible avenues for future research.

9.1 Answers to Research Questions

This section presents the main findings reported in this thesis. It is divided into three sub-sections: (1) the effect of information needs on consultation, (2) the effect of translation training experience and professional work experience on consultation, and (3) the effect of consultation on holistic translation quality and the acceptability of translation segments.

9.1.1 Information Need and Consultation

The first research question concerns the relationships between information needs and

consultation behaviours. The investigation of this question is conducted from two perspectives: (1) the perceived translation difficulty in the holistic translation tasks as the information need, and (2) the types of translation problems when translating individual segments as the information need. Details of the findings are summarised as follows.

Holistic translation tasks

Four findings regarding the relationships between the perceived translation difficulty and the holistic consultation process are summarised.

Firstly, an increase in perceived translation difficulty leads to a greater amount of attention allocated to consultation that also accounts for a larger proportion of the entire task for all participants. This finding suggests that in translating more difficult texts, consultation of online resources accounts for a larger proportion of the translation process. Therefore, the effectiveness and efficiency of consultation has a more important role when translating more difficult texts for all translators.

Secondly, an increase in perceived translation difficulty triggers more complex consultation behaviours that involving more types of online resources and show a greater reliance on general-purpose resources like encyclopaedias and online portals. This finding indicates that the increase in the perceived translation difficulty is triggered by the increase in not only the number of lexical problems but also the need for domain information and problem-solving information.

Thirdly, the increase in perceived translation difficulty does not affect participants' cognitive load. This finding supports one of the features of the consultation model proposed in the present study: consultation and translating are two concurrent but separate sub-tasks of translation. Therefore, although the perceived translation difficulty affects translating, it does not influence cognitive load allocated to consultation.

Fourthly, the increase in perceived translation difficulty leads to an increase in switch cost, which indicates a decrease in cognitive efficiency. This finding suggests that the increase in perceived translation difficulty requires a higher demand on translators' working memory

capacity.

Individual translation tasks

The effect of information needs on consultation when translating individual segments was investigated with the type of translation problems as the measurement indicating information needs. The individual translation segments were categorised into three types: comprehension problems, transfer problems, and production problems (referred to as Type 1, Type 2, and Type 3, respectively). The analysis was conducted from the following four aspects: (1) the amount of attention allocated to each web searching task, which was indicated by TFD; (2) consultation complexity, which was reflected in the number of consulted online resource types and webpages; (3) cognitive load, which was indicated by fixation duration; and (4) the information evaluation behaviours, which was indicated by the proportion of attention allocated to three information sections. The findings can be summarised as follows.

Firstly, translation problem type significantly influences the amount of attention distributed to online resources and the complexity of consultation. From Type 1 to Type 3 translation problems, as the information needs become more general and less linguistic-related, both aspects of web search tasks present an upward trend, showing that translators allocate a larger amount of attention to the translation problem and use more types of online resources and webpages in consultation. Compared to the other two types of translation problems, translating Type 1 problems triggers the web search tasks focusing on answering a specific question, which results in the lowest number of online resource types and queries among the three translation problem types.

Secondly, the effect of translation problem type on cognitive load allocated to web search tasks was significant for the language learners and professional translators but not significant for the translation students. The finding suggests that cognitive load might be affected by various elements in a complex task like consultation in translation.

Thirdly, when translating all three types of problems, the lexical information section always attracted the largest proportion of attention. In addition, from Type 1 to Type 3

translation problems, the proportion of attention allocated to lexical information presents a downward trend while the proportion of attention allocated to extralinguistic information presents an upward trend. This finding suggests that translators look for different types of information and use different searching strategies when they consult online resources when translating different types of translation problems.

Fourthly, the consultation of linguistic information leads to higher cognitive load, more deep processing, and less scanning than the consultation of extralinguistic information. As extralinguistic information is not specially designed for translators, it would take more effort to locate and comprehend the relevant information. Therefore, this finding indicates that the use of general resources, like encyclopaedias and search engines, should receive more attention in translation training.

9.1.2 Translators' Experience and Consultation

The second research question investigates the effect of translators' experience on consultation. Translators' experience consists of two aspects: translation training experience and professional work experience. The data collected from three groups of participants: language learners, translation students, and professional translators, were used in the analysis from two levels of consultation: the holistic consultation behaviours and the individual web search tasks. Details of the findings are presented as follows.

Holistic consultation behaviour

The investigation of the effect of translation experience on consultation when translating the entire text is presented from five perspectives: (1) the amount of attention allocated to consultation and the proportion of attention over the entire translation process, (2) cognitive load, (3) cognitive efficiency, (4) the preference for online resource types, and (5) the style of background information search. The findings can be summarised as follows.

Firstly, language learners and professional translators allocate a lower amount of attention

to consultation that accounts for a lower proportion over the translation process than translation students. The results show that the amount of attention allocated to consultation and the proportion of consultation over the entire translation process and the participants' translation experience form an inverted U-curve relationship. Language learners, who have the least experience in translation, do not seem to realise the importance of consulting external resources. Translation students have training experience so they are aware that consulting online resources can help improve their translation performance. Compared to translation students, professional translators show a lower reliance on the consultation of external resources since they are more confident in their internal knowledge and the use of translation strategies.

Secondly, translators with different levels of experience do not show differences in cognitive load allocated to consultation or cognitive efficiency in performing the translation task. This finding suggests that in a complex task like consultation in translation, the redundant amount of cognitive resources, such as unnecessary amount of between-task switches, is barely considered by translators as a possible measurement to improve their translation efficiency.

Thirdly, all translators prefer to use search engines and bilingual dictionaries. In some cases, translators use search engines in the same way as they use bilingual dictionaries as leading search engines can provide basic information, such as a definition from a dictionary, directly in the SERP. In addition, translators with different levels of experience do not show a significant difference in their preference for different types of online resources. Compared to language learners and translation students, professional translators do not have a specific preference for monolingual dictionaries.

Fourthly, three groups of translators perform differently when consulting for background information. Language learners tend to neglect the need for background information when they read the ST and come back to consulting when producing the TT. Translation students realise the necessity of preparation with background information before drafting. Professional translators show a lower reliance on background information and a higher level of confidence in their internal knowledge.

Individual web search task

The effect of translation experience on individual web search tasks was investigated using the transcription data of web search tasks when translating the selected Rich Points. Overall, five Rich Points were selected, among which three Rich Points were used to present the characteristics of web search tasks when translating all three types of translation problems and two Rich Points were used to explore the consultation of extralinguistic information. The analysis was conducted using two measurements: (1) the amount of attention allocated to web search tasks, and (2) the search characteristics. The summarised findings are presented as follows.

Firstly, when translating Type 1 and Type 2 translation problems (source language comprehension problems and source language-target language transfer-of-meaning problems, respectively), all translators perform similarly in the amount of attention allocated to consultation and the characteristics of search styles. When translating Type 1 problems, they tend to conduct a relatively simple and straightforward query with bilingual dictionaries. When translating Type 2 problems, the majority of the translators follow the same search style than when translating Type 1 problems: they rely heavily on the lexical information provided in bilingual dictionaries. Nevertheless, translation students are more conscious when translating Type 2 problems than language learners and professional translators. When translating Type 3 translation problems (target language text production problems), language learners and professional translators allocate a significantly lower amount of attention to consultation and mainly use bilingual dictionaries even when they find the TL equivalents unacceptable, while translation students tend to conduct more detailed consultation, with various types of online resources.

Secondly, when translating a ST segment that does not require much extralinguistic information, translation students allocate a larger proportion of attention to extralinguistic consultation compared to language learners and professional translators. When translating a segment that requires more extralinguistic information, translation students and professional translators maintain similar search styles, but language learners increase the proportion of

attention allocated to extralinguistic consultation.

These two findings suggest that in consultation for translating individual ST segments, translation students always allocate a high level of effort even though this may be considered an inefficient use of effort, while language learners and professional translators show a lower reliance on external resources.

9.1.3 Consultation and Translation Quality

The third research question focused on the effect of consultation on the quality of target texts and the acceptability of translation segments. Details of the findings are presents as follows.

Holistic translation quality

The effect of consultation on the holistic translation quality was investigated from three aspects of consultation: (1) the amount and proportion of attention allocated to consultation, (2) the number of online resource types, and (3) the background information searching style. The summarised findings are presented as follows.

Firstly, when translating general-purpose texts, neither the amount of attention nor the number of online resource types has a significant effect on the holistic translation quality. This finding seems to be unexpected since the consultation of external resources is always believed to be helpful in the translation process. It suggests that the holistic translation quality is mainly determined by participants' internal support, such as the translation strategies they choose, rather than by external support.

Secondly, when translating a domain-specific texts (a culture-related text in the present study), the amount of attention allocated to consultation has a significantly positive correlation with the holistic translation quality, but the online resource variety does not have such correlation. In other words, when translating a text with a higher need for background information, longer consultation leads to a better-quality translation, but more complex consultation does not.

Thirdly, when translating a domain-specific text, the background information search style significantly affects the holistic translation quality. On the one hand, translators who consult background information for the ST produce a better-quality translation than translators who do not. On the other hand, translators who make pre-task preparation by searching for background information before drafting produce better-quality translations than translators who do not.

Acceptability of translation segments

The effect of consultation on the acceptability of individual translation segments was investigated from three aspects: (1) the amount of attention allocated to individual web search tasks; (2) consultation complexity, which is reflected in the number of online resource types and the number of queries within one web search task; and (3) the characteristics of web search tasks when producing acceptable or unacceptable solutions for the selected translation segments. The following two findings are summarised.

Firstly, a significant correlation is found between the amount of attention allocated to the web search tasks and the acceptability of individual translation solutions, with a larger amount of attention leading to a higher level of translation acceptability. In the web search tasks for the unacceptable translation solutions, translators tend to give up searching fairly quickly, conducting only one query either in a bilingual dictionary or a search engine. On the other hand, in the web search tasks for the acceptable translation solutions, translators tend to spend more time reading search results.

Secondly, significant correlations between the complexity of consultation and translation acceptability are found for translation students and professional translators, but not for language learners. In some web search tasks for unacceptable translation solutions, although language learners are conscious of the search results and consult multiple webpages from different resources, they tend to make simple and straightforward queries, which are not effective in producing the solutions, and thus fail to retrieve the correct information. On the other hand, translation students and professional translators are able to tailor the subsequent queries based on the previous search results and consult more diverse types of information.

9.2 Significance of the Study

The significance of the present study is presented in three aspects. Firstly, previous researches on the use of external resources considered five features of consultation: (1) the types of consultation needs encountered by translators (e.g., Enríquez Raído, 2014; Zheng, 2014), (2) the types of information resources used and preferred by translators (e.g., Atkins & Varantola, 1997; Enríquez Raído, 2014; Mackintosh, 1998; Shih, 2017; Sycz-Opoń, 2019; Zheng, 2014), (3) the formulation of individual web search tasks (e.g., Atkins & Varantola, 1997; Enríquez Raído, 2014; Shih, 2019), and (4) the allocation of cognitive resources (e.g., Hvelplund, 2017, 2019). They have revealed that translators mainly consult external resources to translate comprehension problems with bilingual dictionaries, the characteristics of individual consultations are influenced by translation experience and the purpose of the consultation, and consultation accounts for a large proportion of attention in the translation process. Based on previous research, the present study investigates the use of online resources in translation by presenting the characteristics of consultation and explores the relationships between task and user attributes and these characteristics. In addition, the present study expands the scope of current research as it performs cognitive analysis through the investigation of the allocation of attention, cognitive load, and cognitive efficiency.

Secondly, previous studies reported that the consultation of external resources does not correlate with the improvement of translation quality or translation performance (e.g., H. Kim, 2006; Laukkanen, 1996; Livbjerg & Mees, 1999). The present study proposes a consistent finding that the holistic translation quality may be affected by various factors other than the use of external resources. However, it moves a step further by indicating a significantly positive effect of the short-term preparation on consultation in written translation, which is a research topic being neglected. In addition, the present study examines the relationship between individual web search tasks and the acceptability of translation segments, and suggests that translation training should focus more on the consultation of general resources.

Thirdly, the triangulation of eye-tracking, screen-recording, and question-based retrospective interviews provides a combination of both quantitative and qualitative data for the

present study. This combination of data collection not only paints an elaborate picture of the participants' allocation of cognitive resources, but also presents detailed characteristics that can be used to explain the statistical results. In addition, the present study proposes a transcription method of screen-recording data for the use of online resources in consultation. This method unites the qualitative features that can be investigated, presents a new data analysis method for consultation in translation, and improves the reproducibility of the present study for future research.

9.3 Future Avenues of the Research

In terms of the methodology of the present study, some avenues could be considered to conduct the analysis of consultation in translation in the future.

The first avenue relates to the limitation of not investigating the effect of text type on consultation in the present study. The consultation for translating specialised text has been taken into consideration by using Text C as one of the STs. The fact that it contains a relatively high requirement for extralinguistic information makes it incomparable with Text A and B. Therefore, it is difficult to compare the consultation between translating a general text and a specialised text without it being interfered with by the difference in their translation difficulty. As the comparability of perceived translation difficulty between texts from different domains become more feasible, future studies can be conducted on the effect of text type on consultation.

Secondly, in order to reduce the effect of fatigue on translation, the three STs used in the present study are designed to be relatively short (approximately 100 words), which is an uncommon length for real-world translation tasks. If the development of eye-trackers allows participants to conduct experiments outside the lab, it will be possible to collect data under an environment with a higher ecological validity.

Thirdly, in addition to eye-tracking, screen-recording, and retrospective interviews, there are other approaches that could be used to examine translation process. For instance, as mentioned in section 6.2.3, the investigation of cognitive load in consultation suggests that emotion might influence translators' cognitive status during consultation. Future studies can be

conducted by using self-report questionnaires to indicate translators' emotional status during translation and its effect on consultation.

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Appendices

Appendix I: Experimental texts

Warm-up text

Source: *Sciencedaily*

Plant pollens vary in quality as food sources for bees, and pollen from the sunflower family is known to have some unpleasant qualities. Bees fed exclusively sunflower pollen often develop poorly, slowly, or not at all. Yet many bee species collect pollen exclusively from this family; in fact, specialization on sunflower pollen has evolved multiple times in bees.

(Number of words: 58)

Text A

Source: *New Scientist*

There was a time when we thought humans were special in so many ways. Now we know better. We are not the only species that feels emotions, empathises with others or abides by a moral code. Neither are we the only ones with personalities, cultures and the ability to design and use tools. Yet we have steadfastly clung to the notion that one attribute, at least, makes us unique: we alone have the capacity for language. Alas, it turns out we are not so special in this respect either. Key to the revolutionary reassessment of our talent for communication is the way we think about language itself.

(Number of words: 107)

Text B

Source: *Coral Reef and Global Climate Change*

Coral reefs have the highest biodiversity of any marine ecosystem, and they provide important ecosystem services and direct economic benefits to large and growing human populations in coastal zones. Although the natural habitat of coral reefs can be a stressful environment, recent global increases in reef ecosystem degradation and mortality suggest that the rate and nature of

recent environmental changes often exceed the adaptive capacity of coral reefs. This crisis is almost certainly the result of interactions between multiple stresses. These include increased nutrient and sediment loading, direct destruction, contamination, overharvesting, disease and predation. Rising ocean temperatures have been implicated in chronic stress, disease epidemics, mass coral bleaching episodes and reduced calcification.

(Number of words: 112)

Text C

Source: *LiveScience*

Hanukkah, typically celebrated in late fall or early winter, is a Jewish holiday lasting eight days and eight nights. Each night as the sun sets, one branch of the Hanukkah menorah is lit. One candle is lit on the first night, two on the second and so forth. Traditionally, candles are added and lit from right to left. The "attendant" candle makes up the ninth and typically tallest branch on the menorah. Food plays an important part in many Jewish traditions, and Hanukkah is no exception. Favourite Hanukkah foods include those fried in oil, especially “latkes”, served with applesauce and sour cream, and sufganiyot.

(Number of words: 104)

Appendix II: Participant Data

Language learners

	Gender	Age	Education	IELTS Score
L01	Female	23	BA in Education	7.5
L02	Female	22	BA in Education	7.0
L03	Female	22	BA in Education	7.0
L04	Female	22	BA in Education	7.0
L05	Female	22	BA in Education	7.0
L06	Female	22	BA in Education	7.0
L07	Female	22	BA in Economy	7.0
L08	Male	22	BA in Economy	7.0
L09	Female	22	BA in Economy	7.0
L10	Female	23	BA in Economy	7.0
L11	Female	22	BA in Economy	7.0
L12	Male	22	BA in Economy	7.0
L13	Female	20	BA in Economy	7.0
L14	Female	21	BA in Economy	7.0
L15	Female	21	BA in Psychology	7.0
L16	Female	21	BA in Psychology	7.0
L17	Female	21	BA in Economy	7.0
L18	Female	21	BA in Economy	7.0
L19	Female	21	BA in Economy	7.0
L20	Female	20	BA in Economy	7.0
L21	Female	21	BA in Economy	7.0
L22	Female	21	BA in Economy	7.0

Translation students

	Gender	Age	Education	IELTS Score
S01	Female	23	MA in Translation Studies	7.5
S02	Male	23	MA in Translation Studies	7.0
S03	Female	22	MA in Translation Studies	8.0
S04	Female	24	MA in Translation Studies	7.5
S05	Female	28	MA in Translation Studies	7.0
S06	Female	26	MA in Translation Studies	7.0
S07	Female	23	MA in Translation Studies	7.5
S08	Female	22	MA in Translation Studies	8.0
S09	Female	23	MA in Translation Studies	8.0
S10	Female	23	MA in Translation Studies	7.5
S11	Female	24	MA in Translation Studies	7.0
S12	Female	23	MA in Translation Studies	7.0
S13	Female	23	MA in Translation Studies	7.0
S14	Female	22	MA in Translation Studies	7.5
S15	Female	23	MA in Translation Studies	7.0
S16	Female	23	MA in Translation Studies	7.5
S17	Female	24	MA in Translation Studies	7.5
S18	Male	24	MA in Translation Studies	7.5
S19	Female	23	MA in Translation Studies	7.5
S20	Female	24	MA in Translation Studies	7.0
S21	Female	22	MA in Translation Studies	7.5
S22	Male	24	MA in Translation Studies	8.0
S23	Female	23	MA in Translation Studies	7.0

Professional translators

	Gender	Age	Years of work
P01	Male	40	5 years
P02	Male	40	5 years
P03	Male	42	5 years
P04	Male	42	5 years
P05	Female	46	10 years
P06	Male	40	17 years
P07	Male	39	7 years
P08	Female	40	10 years
P09	Male	43	7 years
P10	Female	48	8 years
P11	Female	38	5 years
P12	Female	40	12 years
P13	Male	53	10 years
P14	Female	55	6 years
P15	Female	46	20 years
P16	Male	55	10 years
P17	Female	47	10 years
P18	Male	45	15 years
P19	Female	40	5 years
P20	Female	49	20 years
P21	Female	44	5 years
P22	Female	38	5 years
P23	Male	48	15 years

Appendix III: Questionnaire

1. Age:
2. Gender:
3. Highest Education Level:

4. Please indicate your first language and second language:

   First language: Second language:

5. At what age did you start to learn your second language?

6. Please indicate your highest IETLS score.

   Overall: Listening: Reading: Writing: Speaking:

7. How many years of translation training do you have?

8. How many years of written translation working experience do you have? Please also provide the word count.

9. Can you please rank your familiarity with the background of the source text with “1” being not familiar at all and “5” being very familiar?

   1 2 3 4 5