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*Original Paper*

# Exploring Strategy Use in Chinese-English Translation: Insights from Think-Aloud Data

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***Abstract***

*This study investigates the cognitive processes and translation strategies of Chinese student translators by integrating Think-Aloud Protocols (TAP) and Translog data. It aims to uncover how translators with different proficiency levels employ strategies, allocate cognitive effort, and monitor their translation behavior in Chinese-English translation tasks. A comprehensive translation strategy model was proposed to label the data and to interpret the findings. Results indicate that high-performing translators exhibited more balanced cognitive effort, stronger problem diagnosis, and multi-level monitoring, while low-performing translators showed surface-level processing and reactive revisions. The study concludes that translation expertise is characterized by deeper source-text analysis, strategic decision-making, and proactive monitoring. Pedagogically, the findings suggest the need to cultivate students' metacognitive awareness through think-aloud practice, guided resource use, and structured revision training to enhance translation competence.*

***Keywords***

*Translation Strategies, Think-Aloud Protocols (TAP), Translog, Chinese-English Translation*

## 1. Introduction

Over the past decades, translation studies have increasingly embraced concepts and methodologies from cognitive science to investigate the mental processes underlying translation. Cognitive science has provided translation researchers with valuable perspectives and inspiration, enabling them to explore how translators process information and make decisions during translation. This interdisciplinary trend has expanded the boundaries of translation studies, integrating insights from linguistics, psychology, psycholinguistics, and cognitive psychology (Lu & Wang, 2013).

*1.1 Cognitive Approaches to Translation Process Research*

With the growing convergence of disciplines, cognitive translation research has developed rapidly, achieving significant theoretical and methodological advances. New perspectives emphasize translation as a complex cognitive activity involving various mental operations and problem-solving behaviors. As Shreve and Angelone (2010) note in *Translation and Cognition*, research grounded in cognitive science has expanded to both translation and interpreting studies, which demonstrate the innovative and promising potential of interdisciplinary approaches to translation cognition.

Chinese scholars have also contributed to this field (Wang & Chen, 2013; Wang, 2017; Su & Li, 2018), further advancing empirical and theoretical research on translators' cognitive processes. As Deng (2011) observed, the study of cognitive translation has entered a new stage of interdisciplinary integration, attracting increasing attention from scholars in cognitive linguistics, psychology, and psycholinguistics.

*1.2 Think-Aloud Protocols (TAPs) in Translation Research*

Among the empirical methods applied in cognitive translation studies, the Think-Aloud Protocol (TAP) has played a pivotal role. First introduced into translation studies in the 1980s (Lörscher, 1989; Gerloff, 1987), TAPs allow researchers to gain access to translators' mental activities—the so-called black box of translation (Li, 2004). By asking translators to verbalize their thoughts during translation, researchers can trace their reasoning, problem-solving, and decision-making processes in real time.

However, as scholars have pointed out, TAPs have limitations. Not all cognitive processes can be verbalized, as much of human cognition occurs unconsciously. To address this, since the late 1990s, researchers have increasingly adopted multi-method approaches combining soft methods (e.g., TAPs, retrospection, interviews) with hard methods (e.g., keystroke logging, eye-tracking, EEG, fMRI). For example, Angelone (2010) integrated video recording and TAPs to examine translators' problem-solving behaviors, while Dragsted (2010) and Shreve et al. (2010) combined Translog and eye-tracking to analyze coordination between comprehension and production processes. Such approaches yield more comprehensive and reliable insights into translators' cognitive efforts and behaviors. As Liu & Tao (2021) noted, a comprehensive analysis of TAPs, Translog data, and interview records can reveal translators' cognitive modes—intuitive, analytical, and instrumental—and show how advanced learners employ a wider range of strategies than beginners.

*1.3 Translation Strategy Research in Cognitive Perspective*

Translation strategies have long been central to translation studies. Within cognitive process research, strategies are typically defined as translators' conscious or subconscious problem-solving procedures during language transfer (Lörscher, 1991). Earlier studies mainly compared general performance across translators of different proficiency level. More recent work has shifted toward specific strategies, such as lexical search and dictionary use, and the influence of affective factors on strategic behavior (Liu & Tao, 2021). These findings collectively indicate that translation strategy use is closely linked to translators' cognitive awareness and monitoring behaviors during the translation process.

*1.4 Significance of the Study*

Understanding the cognitive process of translation is essential for both theory and pedagogy. By integrating cognitive and psychological perspectives, translation studies have become more empirical and scientific. Exploring translators' cognitive mechanisms not only enriches translation theory but also provides insights for improving translator training, curriculum design, and translation technology development. Examining how student translators allocate cognitive effort, employ problem-solving strategies, and monitor their output can contribute to building a model of translation competence development and inform effective teaching interventions.

*1.5 Research Objectives and Questions*

This study aims to investigate the cognitive translation processes of student translators using Think-Aloud Protocols (TAPs) combined with Translog keystroke logging. Specifically, it examines the behavioral and strategic differences between high- and low-performing translators, seeking to reveal how translation competence manifests in their cognitive and problem-solving processes.

The study addresses the following research questions:

1. How does the distribution of cognitive effort (strategy frequency) differ between high- and low-performing groups across the four translation phases?
2. What are the differences in problem-solving strategies employed by high- and low-performing translators?
3. How do high- and low-performing translators differ in their focus and levels of monitoring and reviewing during the translation process?

## 2. Methodology

*2.1 Research Design*

Based on the research objectives and questions, this study will adopt a multi-method approach, primarily utilizing Think-Aloud Protocols (TAPs) supplemented by keystroke logging (Translog), to comprehensively record and analyze the translation cognitive processes of student translators. The Think-Aloud experiment will record the translator's focus of attention, translation units, and difficulties and errors in decoding and encoding, while keystroke logging will be used to record the translator's keyboard operations, translation pauses, as well as data related to translation encoding and processing. The combined use of these two research tools will allow for more comprehensive collection of detailed information on the translation cognitive process while reducing experimental bias.

*2.2 Participants*

The participants were 7 first- and second-year undergraduate students majoring in non-English fields and 7 second-year graduate students majoring in translation and interpreting. All participants were native Chinese speakers with over 12 years of English learning experience. Low-performing participants were selected based on achieving a B2.1 level on the SPEEXX placement test, which is graded according to the CEFR (Common European Framework of Reference for Language) to ensure

credible translation ability. High-performing participants were required to be at B2.2 level or above and possess over 50,000 Chinese characters of translation experience.

*2.3 Translation Materials*

The official introduction of Peking University was chosen as the source text, for it is idiomatic, features a campus-specific style, and contains Chinese four-character idioms, parallel sentences, and culturally specific vocabulary that require careful consideration during translation. The text, totaling 686 Chinese characters, is an explanatory discourse of moderate difficulty, capable of reflecting the experiment's validity and the participants' application of translation strategies. Furthermore, the researcher confirmed that none of the 14 participants had previously read this text before the experiment.

*2.4 Establishment of Translation Strategy Model*

A foundational translation strategy model was initially established based on Gerloff's translation strategy model (1987), Lörscher's proposed core translation elements (1989), and Kiraly's translation strategies (1995). Through pre-experiment corpus collection, the translation strategy indicators were optimized based on Kiraly's classic model, leading to the establishment of a translation strategy model suitable for this study (see Table 1).

**Table 1. A Four-Phase Translation Strategy Model for Cognitive Process Analysis**

| Strategies | Examples |
|---|---|
| **Phase I: Comprehension** | |
| S1:Read ST segment | When the translator reads two sentences of the source text. |
| S2:Inquire the meaning of ST | "这个词是什么意思？" |
| S3: Analyze syntax | "这个句子和前面的句子是并列关系吗？ |
| S4: Identify a problem or raise a question | "教育行政机关，这个怎么翻译啊？" |
| **Phase II: Conversion** | |
| S5: Automatic/Intuitive Drafting | "北京大学，嗯，Beijing University" |
| S6: Deferred Attempt | "这个地方实在翻译不出来，我先空着吧。" |
| S7: Consult a Dictionary | "这个词不太懂，查一下字典…" |
| S8: Adopt Online Equivalence Search | "四川盆地,查一下…OK，是 Sichuan Basin" |
| S9: Compare different translations | "这个我觉得翻的不太好，再看一下别的翻译。" |
| S10: Synonym Selection | "伟大…great？Mighty？Grandeur？在这里用 Great 感觉更合适。" |
| S11: Semantic Omission | "五彩缤纷，绚丽夺目…好麻烦，用 colorful 就可以啦。" |
| S12: Use a proper tense | "看一下这个句子，嗯，创办于用过去式 was。" |
| S13: Consider collocation | "给学生上课，是应该用 have a class，还是 give a class？或 |

| | |
|---|---|
| | 者用 deliver？” |
| S14: Construct a structure | “开头这里是两个分句，那我就用一个 not only but also 的句式。” |
| **Phase III: Reconstruction** | |
| S15: Refer to author intent | “在这里生生不息、代代相传” the spirit will never end and continue to…这里应该有排比的感觉。 |
| S16: Use memory aids | “北京大学，Beijing 还是 Peking？我记得老师讲过专有名词要以官方网站的译法为主，等下去官网看一下。” |
| S17: Refer to the context & style of ST | “这样翻译太口语化了，原文是一篇官网介绍，我应该用更正式一些的语气。” |
| S18: Monitor the accuracy of wording | “工作状态下，under the waking state。嗯，但是 state 在这里不合适吧？” |
| S19: Back Translation | “top-notch university，嗯，顶尖大学，原文是一流大学，应该差不多。” |
| **Phase IV: Review** | |
| S20: Correct word choice | “…cheap? 不好，还是改为 inexpensive” |
| S21: Correct the sentence structure | “…这里应该把前半句删去，放在后面做一个定语从句。” |
| S22: Correct grammar | “Principle，少打了个 s， principles” |
| S23: Punctuation Check | “嗯，这里应该用句号。” |

The translation process can be categorized into four sequential phases (including 23 strategies), progressing from textual analysis to final quality control. This model serves as a framework for analyzing the translator’s cognitive workflow. The process begins with Phase I Comprehension, which is dedicated to the thorough understanding of the Source Text (ST). During this initial step, the translator absorbs the literal meaning, context, tone, and intent of ST. Following comprehension, the process moves to Phase II Conversion. This phase acts as the essential bridge between abstract understanding and linguistic realization. The translator actively resolves specific lexical ambiguities through resource consultation and hypothesis testing, beginning the construction of the initial draft segment. The draft is then polished in Phase III Reconstruction, where the focus is to produce a Target Text (TT) that is not only accurate but also flows naturally. Finally, Phase IV Review concludes the process with a quality control check. The translator compares the TT against the ST to ensure accuracy, completeness, and coherence.

## 3. Results and Discussion

Building on the established translation strategy model, the following part reports the observed patterns of strategic behavior and cognitive effort. The discussion that follows further interprets these findings in light of the model, highlighting the similarities and contrasts between high- and low-performing translators in their translation processes.

### *3.1 Overall Performance*

This section first presents an overview of the Translog data collected from both groups. The data analysis focuses on keystroke records, including total task time, pause duration, and revision frequency, to reveal the general behavioral patterns of the participants during the translation process.

According to the Translog data shown in Table 2, the high-performing group demonstrated a more efficient translation process compared with the low-performing group. Their average typing speed was significantly higher, while their total translation time was notably shorter. In terms of pausing behavior, the high-performing group paused less frequently and for shorter durations than the low-performing group. This suggests that high-performing translators processed source text information more fluently and required less time to search for equivalence. Regarding revision behavior, the low-performing group made almost twice as many revisions and deletions. Such excessive backtracking indicates uncertainty and local problem-solving, whereas the high-performing group tended to make fewer but more purposeful revisions, reflecting more global monitoring and better planning.

**Table 2. Keystroke-logging Results by High- and Low-performing Groups**

| Indicator | High-performing (n = 7) | Low-performing (n = 7) |
|---|---|---|
| Mean typing speed (characters/min) | 140 | 112 |
| Mean pause duration (s) | 2.0 | 3.1 |
| Pause frequency (per 100 words) | 21 | 29 |
| Revision episodes (count) | 71 | 119 |
| Backspace keystrokes (count) | 389 | 587 |
| Total translation time (min) | 38 | 47 |
| Final translation score (max 10) | 8.7 | 6.8 |

Overall, the keyboard behavior patterns reveal that high-performing translators exhibited greater translation fluency, lower cognitive load, and more strategic self-monitoring, while low-performing translators relied on error editing and showed higher disfluency in both production and revision stages.

### *3.2 Distribution of Cognitive Effort Across Translation Phases*

This section addresses research question 1, which investigates how the distribution of cognitive effort—reflected in the frequency of translation strategies—differs between high- and low-performing translators across the four translation phases. By comparing strategy frequency in each phase, this

analysis aims to uncover how proficiency influences translators' cognitive focus and overall process management.

As can be seen from Table 3, for both groups, Phase II (Conversion) consumed the majority of cognitive effort, accounting for 56.24% (HPG) and 61.12% (LPG) of all recorded strategies. This is because Phase II includes the critical steps of lexical retrieval, hypothesis testing, and the transformation of meaning into the target language structure. The large volume of strategies in this phase confirms it as the most demanding stage for problem-solving and initial drafting.

**Table 3. Cognitive Effort Distribution Across Translation Phases**

| Phase | | HPG Count (n=665) | LPG Count (n=697) | HPG % | LPG % | Difference (HPG - LPG) |
|---|---|---|---|---|---|---|
| I. | Comprehension | 188 | 168 | 28.27% | 24.10% | 4.17% |
| II. | Conversion | 374 | 426 | 56.24% | 61.12% | -4.88% |
| III. | Reconstruction | 40 | 45 | 6.02% | 6.46% | -0.44% |
| IV. | Review | 63 | 58 | 9.47% | 8.32% | 1.15% |
| Total | | 665 | 697 | 100.00% | 100.00% | |

As for the difference, the high-performing group (HPG) invested a significantly higher proportion of their total strategies in Phase I (Comprehension), with a difference of +4.17%. This is the strongest indicator of a fundamental difference in strategic approach. The HPG adopts a proactive, analysis-first strategy. By spending more time on deep reading and syntax analysis, they establish a thorough understanding of the ST. This is crucial for preventing ambiguities and structural errors that would otherwise require more time and effort to resolve in later phases. On the other hand, the low-performing group (LPG) dedicated a larger percentage of effort to Phase II (Conversion), showing a difference of -4.88% compared to the HPG. This suggests a tendency toward premature production by the LPG. The LPG is less efficient because they move quickly into drafting, leading to structural and lexical problems that must be resolved later.

Finally, both groups had a comparable proportion of effort to the re-expression and monitoring phases (III and IV), indicating that the difference lies not in whether they monitor, but when and how effectively they analyze the input.

*3.3 Comparison of Problem-Solving Strategies Between High- and Low-Performing Translators*

To answer research Question 2, this section examines the types and functions of problem-solving strategies employed by translators. The analysis identifies the major categories of problem-solving behavior and explores how high-performing translators demonstrate greater flexibility and metacognitive awareness in addressing translation difficulties.

According to Table 4, the LPG favors accessible but unverified online resources (S8: -7.4%), while the HPG relies more on authoritative reference checking (S7: +4.4%) and internal linguistic reasoning (S3, S10). This pattern highlights a distinction between external dependency and internal regulation in cognitive effort.

**Table 4. Problem-Solving Strategies by High- and Low-Performing Groups**

| Strategy ID | Strategy Name | HPG (n=665) % | LPG (n=697) % | Difference |
|---|---|---|---|---|
| S3 | Analyze syntax | 4.9 | 1.8 | 3.1 |
| S7 | Consult a Dictionary | 16.9 | 12.5 | 4.4 |
| S8 | Adopt Online Equivalence | 3 | 10.4 | -7.4 |
| S10 | Synonym Selection | 4.7 | 3.4 | 1.3 |
| S5 | Intuitive Drafting | 18.6 | 22.3 | -3.7 |

High-performing translators display a balance between internal reasoning and strategic verification. Their frequent use of S3 (Syntactic Analysis) and S10 (Synonym Selection) demonstrates an engagement with linguistic structure and lexical meaning. Moreover, S7 (Dictionary Consultation) serves as a form of metacognitive checking, confirming accuracy through authoritative verification.

On the other hand, low-performing translators rely heavily on S8 (Online Equivalence Search) and S5 (Intuitive Drafting)—strategies that prioritize fluency and speed at the expense of precision and contextual fit. This suggests that their problem-solving is more reactive and less self-regulated.

Here are some examples from TAP data:

- Example 1 (HPG):

“国立西南联合大学，这个应该是专有名词，我查一下词霸, National Southwest Associated University。” (S7-Verification via authoritative source)

- Example 2 (LPG):

“在 1946 年 10 月，在北平，时间、地点，时间状语在前还是地点状语在前？这是个问题，让我来百度一下。” (S8 – Quick online search without syntactic analysis or contextual consideration)

- Example 3 (HPG):

“促进了思想解放和学术繁荣，这可以用一个定语从句，which promoted，嗯，which promoted the liberation of thought，繁荣？boom? 不，prosperity 好一点。” (S10 – Careful lexical refinement by evaluating lexical alternatives)

- Example 4 (LPG):

“促进了思想解放和学术繁荣，思想解放？查下百度，在这，ideological emancipation, OK, promoting ideological emancipation and 学术繁荣，对，academic prosperity” (S5/S8 – Direct transfer of dictionary results with limited contextual adjustment)

In summary, high-performing translators exhibit a balanced, self-regulated strategy pattern, combining internal reasoning with authoritative verification. Their approach is proactive, analytical, and guided by accuracy. Low-performing translators, however, rely heavily on external aids and intuitive drafting, often in response to difficulty rather than in anticipation of it.

*3.4 Differences in Monitoring and Reviewing Behaviors During the Translation Process*

This section responds to research question 3, focusing on how high- and low-performing translators differ in their monitoring and reviewing behaviors throughout the translation process. These differences provide insight into how translator expertise shapes the quality control mechanisms that guide decision-making during translation.

**Table 5. Translation Monitoring and Reviewing Strategies: High- vs. Low-Performing Groups**

| Strategy ID | Strategy Name | HG (n=665) % | LG (n=697) % | Difference |
|---|---|---|---|---|
| S15 | Refer to Author Intent | 3 | 1.4 | 1.6 |
| S18 | Monitor Wording Accuracy | 3 | 1.5 | 1.5 |
| S23 | Punctuation Check | 4.7 | 0.3 | 4.4 |
| S21 | Correct Sentence Structure | 2.1 | 4.2 | -2.1 |
| S20 | Correct Word Choice | 1.1 | 3 | -1.9 |

As shown in Table 5, the HPG engages in multi-level, proactive monitoring, while the LPG focuses on reactive, surface-level repair. The HPG exhibits greater attention to global meaning and target-language conventions through S15 (Author Intent), S18 (Monitor Wording Accuracy), and S23 (Punctuation Check). On the other hand, the LPG's monitoring concentrates on syntactic repair (S21) and basic word correction (S20)—typical behaviors of late-stage remedial work. Here are some examples for TAP data:

- Example 5 (HPG):

"循自由思想自由原则，取兼容并包主义。这句话要翻译得整齐，有对仗的味道。"

(S15 – Attention to rhetorical balance)

- Example 6 (HPG): "Democratic and scientific thought… 改成 the thought of democracy and science。"

(S18 – Lexical precision and stylistic adjustment)

- Example 7 (HPG): "这些名词首字母都要大写。"

(S23 – Mechanical accuracy)

- Example 8 (LPG): "我打算把它改成一个强调句 it is who open up…"

(S21 – Syntactic editing)

- Example 9 (LPG): "After the Xinhai revolution，现在的名字... current name，于 1912 年放到最后。"

(S21 – Local structural rearrangement)

- Example 10 (LPG): "先锋作用... played an important role 不对吧 played a pioneering role。"

(S20 – Basic lexical repair)

As can be seen from the examples, the HPG's monitoring hierarchy progresses from meaning to form: they start with conceptual verification (S15), refine lexical accuracy (S18), and finalize mechanical correctness (S23). In contrast, the LPG remains fixated on grammatical correctness (S20, S21), rarely engaging in higher-level conceptual or stylistic evaluation.

In summary, it becomes evident that the high-performing student translators adopt a reflective cognitive mode, while the low-performing student translators exhibit a reactive mode. High-performing translators integrate analyzing source texts, authoritative verification, and multi-level monitoring; on the other hand, low-performing translators rely on external aids, error editing, and late-stage repairs, reflecting limited and fragmented control of their translation process.

## 4. Pedagogical Implications

The findings above reveal cognitive and behavioral contrasts between high- and low-performing student translators. These differences have clear pedagogical implications for translation education, particularly in cultivating strategic awareness, metacognitive regulation, and professional revision habits.

Firstly, expert translation is grounded in deep comprehension rather than surface transfer. Thus, it is suggested that teachers may incorporate think-aloud or collaborative analysis sessions where students verbalize their reasoning before translating. Secondly, teachers can integrate corpus-based and dictionary-based translation workshops, where students compare outputs from online translation tools with authoritative sources, then discuss reliability and contextual suitability. Finally, the multi-level monitoring exhibited by high-performing translators suggests that structured revision training is essential. A three-level revision model, including conceptual coherence, linguistic and mechanical precision, can help students develop systematic self-review habits and improve translation quality.

## 5. Conclusion

This study has revealed clear cognitive and behavioral contrasts between high- and low-performing translators. The high-performing translators demonstrated proactive monitoring and greater control over target language conventions, while the low-performing translators relied heavily on late-stage, surface-level repairs. These findings underscore the importance of cultivating awareness-based monitoring skills and strategic revision routines in translation education. By guiding students to shift from reactive correction to proactive quality assurance, translation instruction can better support their progression from linguistic accuracy to communicative adequacy.

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