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RESEARCH ARTICLE

An Implicit Processing Mechanism for Interpretation: Effects of Semantic and Syntactic Priming

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Priming refers to an increased sensitivity to certain stimuli due to prior experience. This study tested the hypothesis that priming occurred during interpreting, greatly promotes and speeds up the processing procedure at both the semantic and syntactic level, thereby improves the interpreter's performance. Based on the analysis of real simultaneous interpreting data, it is suggested that priming exerts negative impacts such as frequent self-correction and inappropriate literal translations due to the semantic priming of the dominant first language (L1). In order to verify the conclusions of text analysis, the researchers designed two experiments. In the first experiment, a sentence-based semantic category judgment task was used to test the priming effect between prime (last word of the sentence) and target. Priming effects were confirmed to exist in second language (L2) lexical representation and processing. Meanwhile, the effects of cross-language semantic priming from dominant L1 to L2 were unequal in different proficiency level groups with more marked effects occurring in the more advanced group. The results support the semantic spreading activation model of semantic priming. The second experiment was designed to probe the long-term effects of structural priming by means of sentence recall and translation tasks. Primes consisted of transitive sentences in either an active or passive voice and sentences in either a prepositional-object or double-object form. The results suggested a stronger priming effect if the key verb in the source language had an equivalent in the target language due to the lexical priming effect or the translate-boost effect, with no robust priming effect being observed if the target language has no structural counterparts. The advanced interpreting students were found to be more accessible to the positive effects of cross-linguistic structural priming, suggesting it is asymmetrical but developmental as proficiency increases.

Keywords: Interpreting studies, priming effect, implicit memory

Interpreting, as a high-skill occupation, requires profound background knowledge in language and comprehensive cognitive skills to ensure smooth language transfer under severe time pressure. Gile (1995) noted that interpreting involves four distinct processes: listening to the original speech, analysis, target speech production, and output control. Interpreters must divide their attention evenly between these four processes. Using concepts from information theory, the interpreting process can be described as a multi-phase process that takes place sequentially while sender output, except in the case of pauses, is being produced, and must be processed continuously. This process involves the decoding of a source language segment, recoding, target language production and output monitoring (with self-correction if necessary). Questions to be addressed here are: do professional interpreters possess special cognitive skills that guarantee their success in interpreting tasks? Does the interpreters' memory outperform the memories of ordinary people? Could it be possible that interpreting experiences alter language processing? These questions have not been fully answered due to the limitations of previously used research methods, which were derived from translation studies. Interpreting studies are unique compared to traditional translation studies describing human performance in which cognitive activity is first and foremost (Lederer, 2003).

Among the highly demanding cognitive skills of interpretation, memory remains undoubtedly the most controversial issue being observed and examined by researchers. Baddeley's (2000) model of working memory, for instance, is widely used in interpreting studies to test interpreters' short-term capacity, reading span, and memory span. The methods and research paradigms of cognitive psychology and neuroscience have brought new insights into interpreting research. In interpreting studies, however, the only memory measured has been explicit memory. Some studies show that it is implicit, automated memory factors that may have a more direct impact on the effect of interpretation and are more likely to explain clearly the automatic operation of interpretation. Therefore, the implicit memory should be the object of future interpreting and memory studies.

Implicit memory is a type of memory in which previous experiences aid in the performance of a task without conscious awareness. Evidence for implicit memory arises in priming, a process whereby subjects are measured by how they have improved their performance on tasks for which they have been subconsciously prepared. In the interpreting process, especially consecutive interpreting, interpreters can retain more information than they realize because they implicitly make a strong associative connection among the information chunks, which a normal working memory cannot achieve by consciously recalling a memory. Further study on the effect of implicit memory known as priming is extremely urgent.

Another characteristic of interpretation the researchers consider is the problem of bilingual language representation at both the semantic and syntactic level. Previous research indicates that word forms are represented separately for each language but that word meaning is shared between languages (Kroll & De Groot, 1997; Kroll & Stewart, 1994; Potter, So, Von Eckardt & Feldman, 1984; Smith, 1997). There are also studies that suggest information about word forms in both of the bilingual's languages is activated when processing in one language. The most recent evidence proved the impossibility of shutting off a language whether or not it is beneficial for task performance (e.g., De Groot, Delmaar, & Lupker, 2000; Dijkstra, Van Jaarsveld, & Ten Brinke, 1998; Jared & Kroll, 2001; Van Heuven, Dijkstra, & Grainger, 1998). This characteristic of non-selectivity is another manifestation of the priming effect in language processing. Evidence for cross-language syntactic priming indicates non-selectivity or

integration between languages also occurs at the syntactical level (Hartsuiker, Pickering, & Veltkamp, 2004; Loebell & Bock, 2003).

Therefore, to address the problems mentioned above, the researchers propose applying the priming paradigm to interpreting studies. So far there has been little empirical research on interpreting. This study attempts to fill the gap by combining the descriptive analysis of the interpreting transcript with semantic and syntactic priming experiments. Priming methods have potential to contribute to our understanding of how linguistic knowledge becomes procedure and automatized. Neuropsychological studies of priming have also provided a theoretical ground for the study, including the effect of declarative (explicit) memory on priming, the influence of processing tasks on priming, the interaction between automatic and conscious aspects of memory, and the neurological underpinnings of episodic encoding and retrieval.

In the context of language use, priming refers to the phenomenon in which prior exposure to language influences subsequent language processing, which may occur in the form of recognition or production. Priming is believed to be an implicit process that occurs with little awareness on the part of individual language users. Its implicit nature makes priming one manifestation of a larger system of human memory – implicit memory.

This research aims at investigating the cognitive process of interpreting by designing a priming experiment and using a descriptive analysis of real interpreting materials to provide evidence for the existence of priming in interpretation. The data collected from the study allow us to examine the cognitive mechanism of within and cross-language semantic and structural priming in bilingual language processing.

While focusing on the micro level cognitive processes "inside" the interpreter, the study examines the specific contributions of priming in interpreting performance. Some of the positive priming effects could speed up the language transfer, simplify the processing procedure, avoid the overload of memory, and reduce the reaction time, while negative priming would lead to the slow and error-prone reaction to a stimulus that is previously ignored, which falls under the category of priming also.

Although several paradigms (i.e., the masked priming paradigm, the semantic priming paradigm, and the syntactic priming paradigm) of priming suggest that semantic information or syntax plays a role in language processing, little is known about how it interacts with interpreting. In the current study, semantic and syntactic activation are both studied in online interpreting tasks, which provides a good opportunity to observe the relative contributions of priming in the interpreting process and to propose a new paradigm for interpreting studies.

The study also challenges the traditional interpreting training program in which linguistic training and interpreting or translation skills play major roles. More complex tasks involving cognitive processes (control of attention, simultaneity of comprehension and production, word retrieval practice) are highly demanded and more valuable. Under the same premise, interpreting education would also benefit from this proposal in adjusting its criteria, designing the curriculum, and especially in preparing classes for interpreting practices.

This study is designed to assess the hypothesis that priming which has occurred in interpreting will greatly promote and speed up the processing procedure at the semantic level, thereby improving the interpreting performance. Priming also occurs at the bilingual syntactic processing level, either within language or from dominant L1 to L2 translation, but limited to proficient L2 speakers. However, as L2 proficiency increases, bilingual syntactic processing can be shared and the procedural knowledge of two languages can interact, suggesting that it is asymmetrical but developmental as proficiency increases.

LITERATURE REVIEW

The study of interpreting in the 21st century features, on the one hand, the emerging of new paradigms of interdisciplinary empirical studies; on the other, the overriding concern in conference interpreting (Pöchhacker, 2004). It seems that interpretation study is advancing towards an independent discipline.

The influential publications *The Interpreting Studies Reader* and *Introducing Interpreting Studies* (Pöchhacker, 2004, 2016) are the definitive guides to the growing area of interpreting studies, spanning the multiple and diverse approaches to interpreting. With the contributions of significant research on interpreting pieced together, the works deliver a clear message: Interpreting studies is making strides towards a full-fledged discipline in its own right. Gile (2002) made a systematic review and analysis of the research in this period. He reveals some striking asymmetry in translation studies by a cross-citation analysis. (1) In the discipline of interpreting studies, there are more cited translation theories than the amount of interpreting theories being cited by the translation works. (2) Sign language and community interpreting researchers cite more from conference interpreting than the other way around. (3) According to cross-citation rates of translation studies and other relative disciplines, ideas and theories of translation studies are cited more frequently than the research methods and findings. This analysis reviews the structural problem of interpreting studies; the methodology and paradigm of interpreting studies are far from being mature and systematic. The future development of interpretation as an independent discipline remains.

Some of the leading scholars reflected on research paradigm, claiming it to be the core issue of interpreting. Pöchhacker (2010) discussed the paradigm of interpreting studies from the ontological and epistemological perspectives. He pointed out that interpreting studies began to adopt scientific paradigm and speculative paradigm since the First International Symposium in Triest in 1986 (Pöchhacker, 2010, p.11). From a view of constructivist epistemology, he urged that interpreting research should adopt an empirical-interpretive paradigm, a combination of rigorous quantitative design with flexible qualitative design. As to implementation, Pöchhacker recommended the optimized model of "Fieldwork + Survey + Experiment" (2016, p. 75).

In China, Liu (2011) made a classified evaluation and review of research methods in 48 empirical research papers published on interpreting: *International Journal of Research and Practice in Interpreting* for the period of 2004 - 2009. The main findings are: (1) Research papers in the field of community interpreting accounted for nearly half of the proportion, while less than a third of the papers were for conference interpretation, which reflected a constantly expanding field of interpreting study. (2) Extensive use of case analysis was found in the research of community interpreting, reflecting a "sociological turn" of the research paradigm and qualitative-based method orientation. Meanwhile, some new methods of approaching subjects, such as the grounded theory method, probed into the main themes of interpreting study. (3) Quantitative research design and procedures became more sophisticated. New methods like pilot testing, reliability analysis methods among multiple evaluators, and methods of statistical inference are successfully applied to interpreting study (Zhang, 2011; Xu, 2008). But Liu (2011) also listed the main obstacles of interpreting studies, the small sample sizes and a lack of real-time data for instance (also see the review of Bao, 2005; Le, 2002).

Types of Priming

Priming, in the context of language use, is "the phenomenon in which prior exposure to language somehow influences subsequent language processing, which may occur in the form of recognition or production" (McDonough & Trofimovich, 2009, p.2). The most intriguing feature of priming is the implicit nature of language processing, of which language users are not fully aware. The implicit nature makes priming a part of implicit memory. According to McDonough & Trofimovich (2009), implicit memory involves memory for cognitive operations or procedures that is learned through repeated use, and includes memory for skills and habits, and priming.

Whereas, interpreting is a human performance in which cognitive activity is first and foremost (Lederer & Seleskovitch, 1978), the exact forms and meanings that speakers use can be affected by the language that occurred in discourse they recently engaged in. This is represented in discourse interpreting.

Semantic Priming. Facilitation cannot be explained by a simple process of response preparation triggered by the prime event. It must be related to processes within the memory system, a feature that reveals the semantic priming paradigm as one of the most important windows to the mind. Semantic priming refers to the tendency for people to process a word more quickly and more accurately when they have been previously exposed to a word that is related in meaning. Semantic priming is said to reflect some fundamental properties of the way speakers organize their knowledge of the lexicon and the way they retrieve and use this knowledge. While semantic priming shares many features with repetition priming, it does not involve repeated exposure to the same form. Semantic priming includes associative priming, category priming, and mediated priming. One of the concerns of semantic priming is to judge whether it occurs automatically or is governed by intentional, strategic processes. Automatic processing is typically defined as one that is fast, ballistic (unstoppable), and that proceeds without conscious intention or awareness. What's more, strategic (controlled) processing is slower, it requires conscious intention and awareness, and it is driven by specific, often conscious, processing strategies (Schnieider & Chein, 2003; Segalowitz & Hulstijn, 2005). Semantic priming could be accessed when prime and target words are separated by a fraction of a second, at stimulus-onset-asynchrony (SOA) intervals of merely 200 milliseconds, or much less (Neely, 1991). This automatic process of semantic priming is not affected by task instructions or expectations.

Syntactic/structural priming. Syntactic priming refers to the tendency for a speaker to produce a syntactic structure that appeared in the recent discourse, as opposed to an equally acceptable alternative, for example, double-object dative vs prepositional dative. It is also called structural priming, a tendency to repeat or better process a current sentence because of its structural similarity to a previously experienced ("prime") sentence (Bock, 1986). This tendency to repeat aspects of sentence structure helps researchers identify some of the representations that people construct when producing or comprehending language. As we can see, most of the structural priming is abstract, compared with meaning and sound. This is therefore informative about how people represent and use abstract structure that is not directly grounded in perceptual or conceptual knowledge.

Cross-linguistic priming. Cross-linguistic priming refers to the influence of recent language processing in one language to language processing in another language. What is especially interesting about priming is that it is not only a methodological tool for the experimental study of language processing, but also appears to be an important mechanism underlying linguistic behavior in social interaction. Cross-linguistic priming has been studied

using both experimental and corpus-based techniques, and has led to important insights in, for example, cross-language activation and shared mental representations in bilinguals, discourse alignment processes in bilingual dialogue, and cognitive processes of second language acquisition. Recently, cross-linguistic priming is also explored as a potential mechanism of contact-induced language change.

Research Models in Interpreting Studies

The interpreter who most famously ventured into a more cognitive analysis of the task was Seleskovitch (1978), who posited that the mechanism of (consecutive as well as simultaneous) interpreting was a triangular process, at the pinnacle of which was the construct of sense.

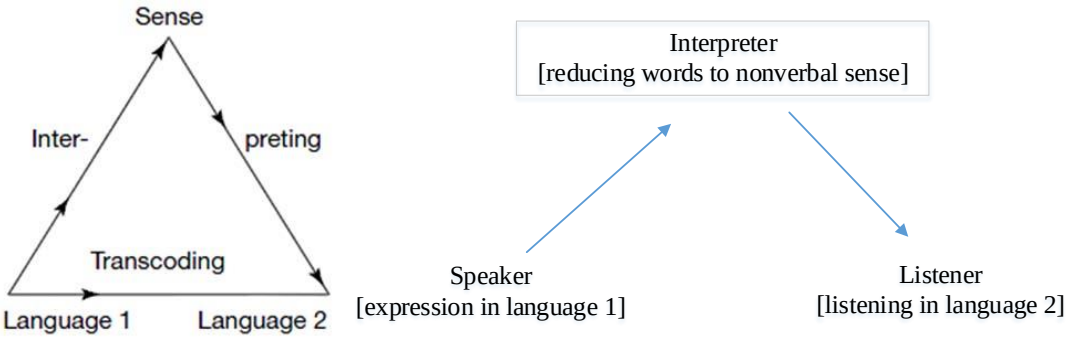

Figure 1. Seleskovitch's Triangular Model

According to this model, the essential process at work in translation is not linguistic "transcoding" (which is limited to items with fixed correspondences like proper names, numbers, and specialized terms) but the interpreter's understanding and expression of "sense". "Sense," according to Seleskovitch (1978, p. 336), is (1) "conscious", (2) "made up of the linguistic meaning aroused by speech sounds and of a cognitive addition to it", and (3) "nonverbal", that is, dissociated from any linguistic form in cognitive memory. The idea that translational processes are essentially based on language-free ("deverbalized") utterance meaning rather than linguistic conversion procedures ("transcoding") is the cornerstone of the interpretive theory of translation championed by the Paris School (Pöchhacker, 2004).

With reference to psycholinguistic research, the triangular process model by Seleskovitch (1978) left ample room for further elaboration. Priming data of this empirical study could provide more scientific evidence to verify the interpreting theoretical models.

Text Analysis

Semantic priming. Carroll (1978) already noted the importance of fast word retrieval for simultaneous interpreting in particular. If a concept to be expressed in the target language does not activate the corresponding word (or string of words) rapidly and automatically, a search of memory for the appropriate name or an attempt to paraphrase will

consume precious time and resources, and the interpreter runs a serious risk of a breakdown. The following case is an example of fast retrieval of a matching word.

> **Speaker:** 这时候这天好像是下雨天，反正，外边天气又不热，我就看它一直在跳。
> **Interpreter:** And but on that day it was rainy. But [it is so] it is not so hot. You can see it is continuing flashing.

Semantic priming which has occurred naturally in interpretation is self-evident in the above sample. The interpreter is not only a listener, he/she is also a speaker and while his/her words are determined by his/her understanding of the speaker's intended meaning.

In this case, the word "跳" is interpreted as the word "flash" instead of "click" or "jump". Because the prime word "meter" has swiftly stimulated the matching verb "flash" although the two interconnected concepts are not contained in one sentence, the fast retrieval of a perfect matching word may happen automatically without extra effort or attention to it. This automatic processing is fast, ballistic, and proceeding without conscious intention or awareness. On the contrary, strategic processing is much slower because it consumes the interpreter's limited cognitive capacity to brain-scan the correct matching word, which may lead to inappropriate substitute, redundant time lag between speaker and interpreter, or even the loss of adjacent information.

Syntactic priming. Syntactic priming can facilitate the production of the developmentally-advanced structure and discourage the production of the interlanguage alternative (McDonough & Trofimovich, 2009) according to Pienemann and Johnston's developmental sequence (1986).

> **Speaker:** 我给我的车悉心保养，它也给我最好的回报。
> **Interpreter:** I give the best care for my car, and my car will reward give me the best reward.

From this self-error correction process, we notice that the earlier utterance of "my car will reward" is effective with an object added. The interpreter switched to a direct object (DO) structure which coincided with the source language because it required the least effort to interpret the sentence with a consistent double object structure, rather than the other object structure "the best rewards". This type of self-modification can help interpreters to accelerate the pace of language processing and optimize the quality of the target language.

EXPERIMENT ONE: CATEGORY JUDGEMENT TASKS

According to the sense model, the category restriction hypothesis implies that L2–L1 priming should be observed for exemplars, but not for non-exemplars, because the category would not restrict the semantic senses of L1 targets that are non-exemplars. If translation priming is observed for non-exemplars as well as for exemplars, then some other explanation for the task effect must be found. This issue was not specifically addressed in Finkbeiner, Forster, Nicol and Nakamura (2004).

Therefore, the purpose of the first experiment is: (1) to confirm the results predicted by the sense model, testing a different group of bilinguals (Chinese–English), and (2) to examine how the priming forces from L1 to L2 are implemented upon different proficiency groups. The research questions that guided this experiment are:

1. Do interpreters or L2 learners activate multiple sources of semantic information in both their languages simultaneously?
2. How does the activation of semantic information unfold as interpreters comprehend and produce sentences in their two languages?

Subjects

The participants in this research were 15 Chinese graduate students majoring in interpretation (their mean age was 20 years old) and 15 non-major freshmen (mean age 18 years old). They were recruited from the School of Foreign Studies at Xi'an Jiaotong University in China. All the subjects had learned Chinese as their first language and received a minimum of 10 years of English instruction at school. They all had normal or corrected-to-normal vision.

Materials

The critical items were exemplars of the same category and belonged to 7 different semantic categories: (1) part of a building, (2) unit of time, (3) profession, (4) scientific discipline, (5) part of the body, 6) kind of material, (7) reading material. To simulate the interpreting scenario, the prime is embedded and highlighted in a sentence, which is carefully selected from the category of newspaper in the Corpus of Contemporary American English (COCA). The items for target and prime words are from the University of South Florida Free Association Norms (http://www.usf.edu/FreeAssociation/), and we use the empirical association data from the Edinburgh Word Association Thesaurus (EAT) of MRC Psycholinguistic Database (Wilson, 1988) to test the associative relations between the prime and target. The word frequency of primes and targets are restricted and controlled. All the words were concrete nouns.

Care was taken to ensure that (1) the meaning of every prime word in the sentences is the most basic sense, (2) all words in the sentences (except the prime) should have no similarity in meaning, pronunciation, or spelling with the target word, (3) the meaning of the whole sentence does not offer any hints about the target word.

There are 30 sets of prime-target pairs, divided into four conditions: (1) the semantically distant pairs (the control trials I), (2) the semantically related (the experimental trials), (3) semantically unrelated pairs (filters), and (4) cross semantic-priming pairs (the control trials II). In order to investigate the L1-L2 lexical-boost effects as compared with the L2 within language priming, we designed seven semantically related L1 priming sentences as another type of control trial. Additionally, seven unrelated priming sentences (non-exemplars) were chosen to serve as filters. These were chosen so as to ensure that they could not be construed as belonging to any of the seven categories. An additional 12 category names are included in the judgment questions for trials. These were unrelated to their targets but were matched with the critical categories for frequency and word-length. This resulted in a total of 30 trials, with a minimum of seven per category being critical.

Design and Procedure

Usually, semantic categorization tasks are carried out in a blocked fashion such that all the exemplars and an equal number of non-exemplars appear together. Following this procedure, word pairs in the present experiments were counterbalanced in a block according to semantic category. The practice blocks were presented prior to experimental blocks containing the seven semantic categories.

The sentence-based category judgment task is conducted on computers with using the E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Instructions were presented to the participants at beginning. The real task was preceded by some trials. The participants were instructed to respond as quickly as possible. The category names were displayed on slides to each of the participants in advance in case unfamiliarity of the terms caused a time lag.

Each trial consisted of the following sequence: first, the participant was presented with a forward mask (##########) for 500 millisecond (ms) to minimize the visibility of prime words, followed by a priming sentence with a prime word at the end of each sentence. The time between the cue and the target display (stimulus-onset asynchrony, SOA) started to count at the moment the prime word appeared. Our experiment is studying semantic priming in contexts that are larger than individual words, which is fully representative of the particular form of language processing in interpretation. When listening or speaking, interpreters activate semantic information for several words simultaneously or near-simultaneously. The designated SOA is thus a little longer than the individual words. The prime sentence was followed by a backward mask so that participants would not be aware of its presence. A semantic category judgment question for the corresponding target word appeared afterwards. The question stayed on the screen until participants pressed the "Yes" or "No" key on the keyboard. The questions continued to be displayed until the participant responded with a duration limit of 5000 ms for judgment. Figure 2 illustrates the presentation of stimuli in the sentence-based semantic category judgment task.

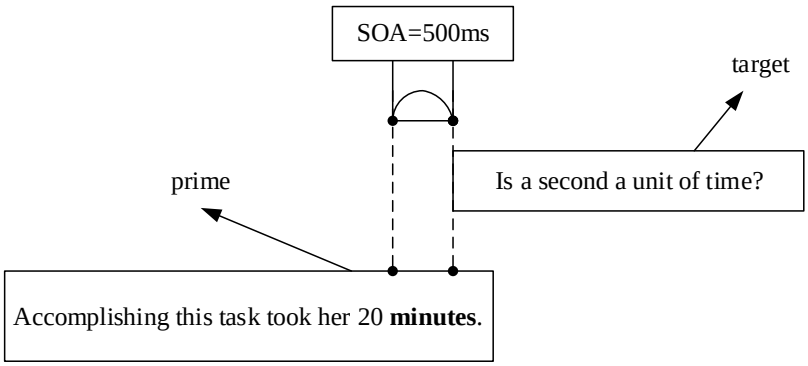

Figure 2. Semantic Category Judgment Task

Data Analysis

Besides non-exemplar prime-target pairs, all the other prime and target words were exemplars of the same category. We designed control groups and experimental groups in the category decision tasks, and care was taken to ensure that the control groups were semantically distant pairs (prime

from the targets), and the experimental group had the semantically close pairs. For example, in the BODY PART category, the target "HAND" was paired with the experimental prime "wrist" and the control prime "kidney." If participants are generating a response based on the category membership of the prime word, then there should be no difference in response times between experimental and control trials. If, though, the prime stimulus is priming the target by activating a semantic sense in common between the prime and target, participants should be significantly faster on the experimental trials.

According to previous research, we predicted that the participants would respond more quickly to the experimental prime-target groups as opposed to the control groups, although both target words belong to the same category. The unrelated pairs would receive the slowest response. The dependent measure for the task was response time (RT). The RTs in the experimental trials were compared to the RTs in the control trials and unrelated trials respectively. If RTs in experimental trials were shorter than the RTs in control and unrelated trials sequentially, a semantic priming effect was observed. This indicates that the prime type facilitated the recognition of targets.

We also divided the participants into two groups - the intermediate non-major and the advanced interpreting students, in order to investigate how the activation of semantic information unfolds as advanced and intermediate L2 learners comprehend or produce sentences in their two languages. The research design used in this experiment is a between-subjects design, in which the researchers intended to compare response latencies in a semantic priming task among two different groups of learners (intermediate, advanced). In this case, the dependent variable is response latency. The independent variable - proficiency - is a between-subjects variable that has two levels. We used a one-way analysis of variance (ANOVA) and an independent samples t-test to analyze the data.

The data was analyzed with linear mixed models using SPSS. The RTs which were smaller or larger than two standard deviations from the mean were excluded from the following data analyses. Firstly, the independent sample t-test was conducted to include all the responses stimulated from each of the four prime types (i.e., experimental prime, control prime, unrelated prime, and cross-linguistic prime). Then the paired sample t-test was employed to analyze whether the prime type and the subject groups could be combined in a further analysis to increase statistical power.

Results

As earlier studies predicted, the effects of semantic priming in directly related and distantly associated pairs are greatly differentiated. Mean response time for targets is shown in Table 1.

Table 1

RT of Targets by Prime Type

	Latencies of Prime Type			
	Distantly related	Semantic-related	Unrelated	Cross-linguistic
Advanced (n=15)	2647 ms	2140 ms	2216 ms	2164 ms
Intermediate (n=15)	3280 ms	2608 ms	2891 ms	2928 ms

As depicted in Figure 3, the findings were opposite of the previous research findings (Bueno & Frenck-Mestre, 2002; Forster, Mohan & Hector, 2003), which indicated that masked priming effects for exemplars in semantic categorization are similar in magnitude regardless of whether the control condition includes category congruent items or not. We employed the E-DataAid tool of E-Prime psychology software to analyze the 900 responses in the experiment. This analysis suggested that category congruent items could accelerate the response time while the semantically distant category items failed to prime the targets in the category judgment task.

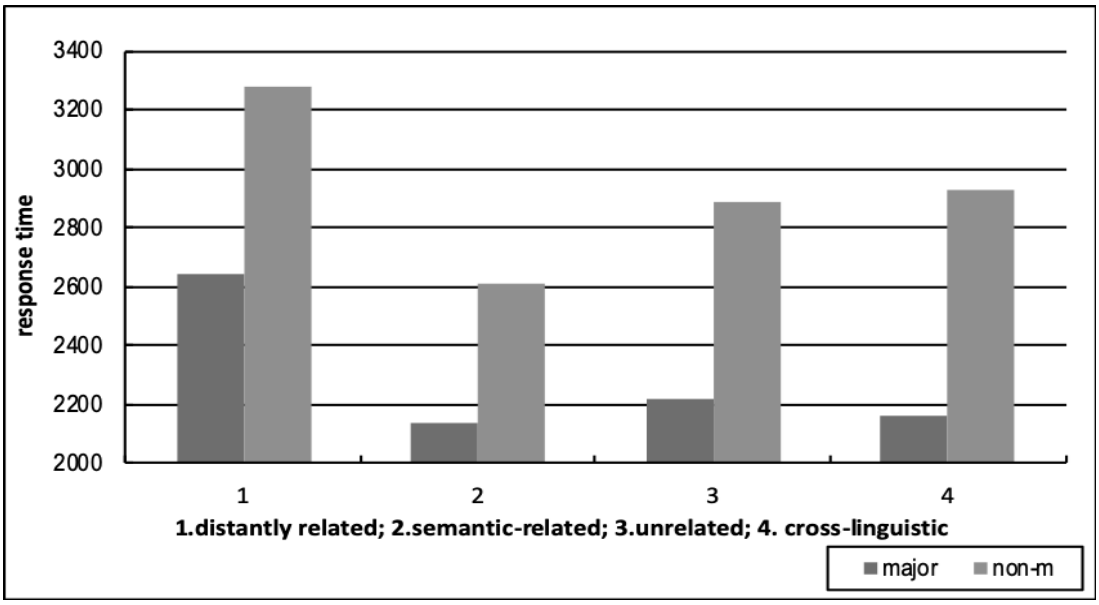

Figure 3. Production of Targets by Prime

The independent sample t-test was applied to the results. The statistical analysis suggested that the four priming types have significant differences in terms of the priming forces. The analysis will be explained in detail later.

Another finding worth noting is that the effects of cross-linguistic prime type on targets are unequal in different proficiency groups, with more marked positive effects in the advanced group (Figure 4).

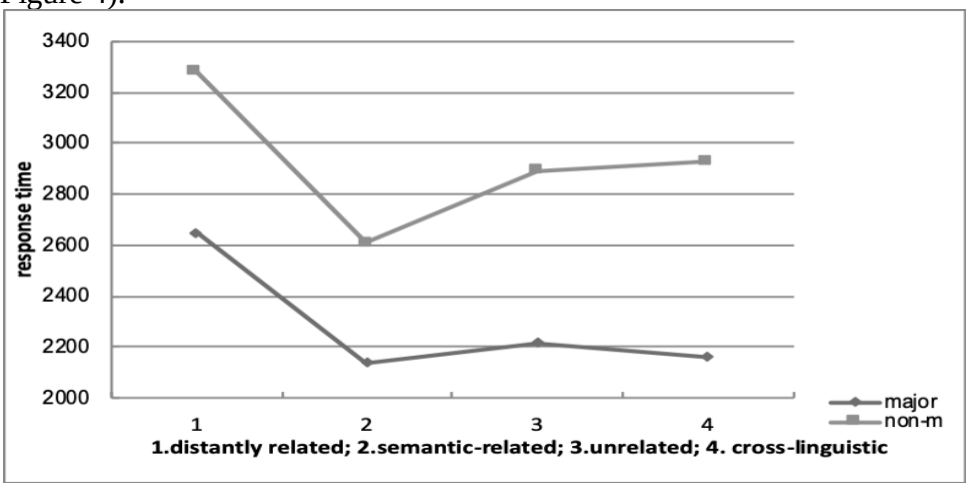

Figure 4. Interaction of Prime Type by Proficiency Level

The researchers believeΩa vb that the individual difference factors, as the working memory capacity and the ability to efficiently allocate attention between processing tasks might influence the kind of processing involved in semantic priming. Such cognitive abilities as memory, attention, and language aptitude may determine how bilinguals and L2 learners activate semantic information in their L2. This result confirmed that individual differences, such as working memory capacity and aptitudes, might predispose learners to benefit from the implicit learning processes associated with semantic priming. The results of the experiment add more evidence to the hypothesis that L2 bilingual processing can be shared and the procedural knowledge of two languages can interact, suggesting it is asymmetrical but developmental as proficiency increases.

Data from trials in which an error occurred were discarded and outliers were replaced with values equal to cutoffs established at two standard deviations above and below the mean for each participant. Mean response times of the advanced group were 2140 milliseconds (ms) in the semantic related prime condition, and 2647 ms in the control prime condition, and 2164 ms for the cross-linguistic prime condition. The intermediate group was 2608, 3280, and 2928 ms respectively. An independent sample t-test was performed on the mean RT, in which the data of the four prime types came from the same unit was not valid ($p > 0.05$). This result implied that different distributions of the four prime types was significant. Then we conducted a paired sample t-test to compare the control prime with the experimental prime, t (29) = 9.19, $p < .001$, as well as the cross-linguistic prime with the experimental prime, t (29) = -1.71, p =.10. It turned out that the experimental prime significantly accelerated the target response, while the control prime was not able to significantly stimulate the subjects' response in category judgment tasks.

Furthermore, the effects of the cross-linguistic prime type were differentiated in RT between intermediate and advanced groups. The advanced group was affected by cross-linguistic semantic priming effects, t (14) = -2.12, $p < .05$. The intermediate group, however, was not affected, t (14) = -0.36, p = .72.

EXPERIMENT TWO: SENTENCE RECALL TASK

Syntactic priming, during tasks that require immediate recall of the sentence, influences the target language output. The purpose of the sentence recall task is to determine whether the syntactic structure of a distracter item or a prime, leads the participants to alter the syntactic structure of the target language during recall. The dative construction in English has been frequently used in structural priming research because it involves two alternate forms, the double-object and prepositional datives, in that they have the same event meaning, the same arguments, and roughly the same frequency of use in English. We also investigated transitive sentences in either an active or passive form. The experiment was designed specially to test the occurrence of cross-linguistic syntactic priming since it is more significant to interpreting studies.

Design

The materials consist of 23 sets of sentences with 2 different types of syntactic structures, prepositional dative construction (PD) and double object construction (DO), active form (AF)

and passive form (PF), and a structurally unmatched L1 priming sentence, for a total of 46 sentences. The target sentence forms were either PD or DO, AF or PF. The average number of words per sentences was 11, ranging from 10 to 13. The surface syntax of the prime's verb phrase (VP) was always mismatched with respect to the target sentence. The prime sentence was conceptually unrelated to the target sentence. A certain proportion of prime sentences had counterpart verbs from the target sentence embedded in them. No sentence (prime or target) was seen more than once by a given subject. There were 23 pictures matching the target sentences which were displayed on the screen for the recall tasks. Each target sentence was presented equally as often in each of the two dative forms (PD and DO, AF and PF) and were preceded by unmatched types of primes, within and across subjects. There were 2 or 3 (mean 2.2) filler sentences between each critical prime-target sentence sequence with no prepositional phrases or double noun phrase (NP) object. Since there was a continuous sequence of single, unrelated sentences to read and recall, the critical prime-target pairs were not marked off in any way.

Procedure

The words of the sentence were presented in the center of the screen. We did not employ the method termed RSVP for "rapid serial visual presentation" because the participants may not be able to recall the non-dominant L2 sentences with ease. The rate of reading was self-paced by participants and the whole procedure was recorded with digital recorders.

First, the participant was presented with a forward mask (##########) for 500 ms, followed by the target sentence. After the sentence being presented, participants had to do a sight interpretation from L2 target sentences to L1, and then a mask of (*****) for 100 ms. An L1 priming sentence was then presented for the participant to read out loud. Finally, the message of the target sentence had to be recalled with a reminding picture on the computer screen. Participants were instructed to recall the sentence with no hesitation and encouraged to deliver the most natural utterance of the earlier message stored in their working memory. This procedure is shown in Figure 5.

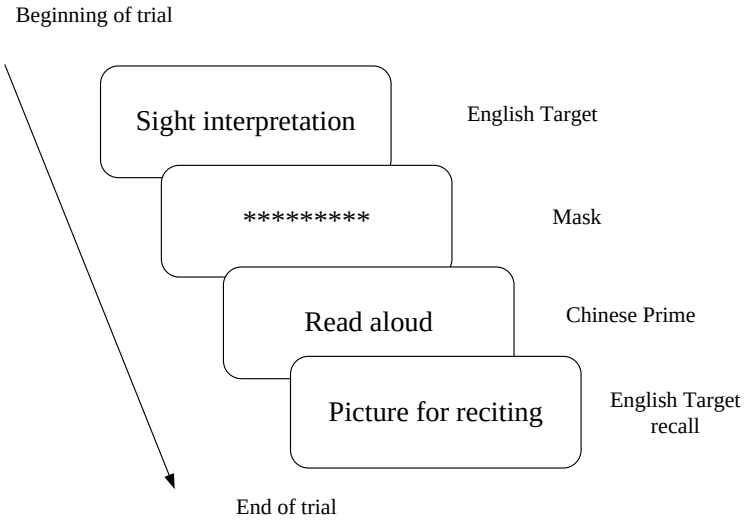

Figure 5. Sentence Recall Procedure

Data Analysis

Experimental target descriptions were scored on the basis of the transcriptions while listening to the recordings of participants' production. The transcriptions were scored as either recalled or forgotten, and 62 forgotten responses (9% of all responses) were discarded and excluded in data analysis. All recalled targets were coded into the categories of original or alternate. For the PD and DO prime-target pairs, an original production used the same sentence as the originally provided sentence, whereas an alternate production used another dative alternation instead of the one used in the original sentence. The alternate production was further coded as double-object, postpositional dative with canonical order or postpositional dative with scrambled order. Application of these criteria to the responses yielded 628 recalled responses (91% of all responses), including 372 originals and 256 alternates. Whenever participants listened to canonical postpositional datives, it is no wonder that they correctly recalled the original, canonical postpositional datives (except in three cases). Of the 256 alternate responses, 132 were canonical postpositional datives, 16 were scrambled postpositional datives, and 49 were double-object datives (197 alternates in PD and DO pairs), while there were 47 AF responses and 12 PF responses (59 alternates in AF and PF pairs). Among the 176 alternate responses, 73.1% of the target-prime pairs were embedded with counterpart verbs.

We then reexamined the nonequivalent verb pairs to further compare the alternate response frequencies among the two groups of learners (intermediate and advanced). An independent t-test was employed to analyze the two independent samples. In recalling the target sentences, the intermediate changed the verb phrase to the alternative form on 8% of the nonequivalent-verb trials while the advanced interpreting students changed the verb phrase 25%, which suggests that the advanced group were more accessible to the priming effects at the syntax level compared to the intermediate students.

Results

We explored syntactic priming through sentence recall and translation tasks in experiment two. Primes consisted of transitive sentences in either an active or passive voice, as well as sentences in either a prepositional-object or double-object form. The response frequency is shown in Table 3.

Table 2

Response Frequency

Target	Prime	Alternate Resp.	Observed Ratio in Alternates	Observed Ratio in Recalled Resp.
PD	DO	49 (25%)	197 (77%)	31%
DO	PD	148 (75%)		
AF	PF	12 (20%)	59 (23%)	9%
PF	AF	47 (80%)		

Table 2. Response Frequency

The results of the second experiment indicate that syntactic priming from an unrelated sentence influences immediate recall of the following sentence. When the prime mismatches the target but suggests an alternative structure to express the message of the target sentence, that alternative structure is likely to be produced in recall. The results support Bock's claim (1986; Bock & Loebell, 1990; Bock et al., 1992) that syntactic priming involves persisting activation of recently produced syntactic structures, especially in PD and DO priming pairs (see Figure 6). This hypothesis accounts for the normally accurate regeneration of syntactic structure in immediate recall without assuming that the surface syntax is retained explicitly as part of the representation of the sentence in immediate memory.

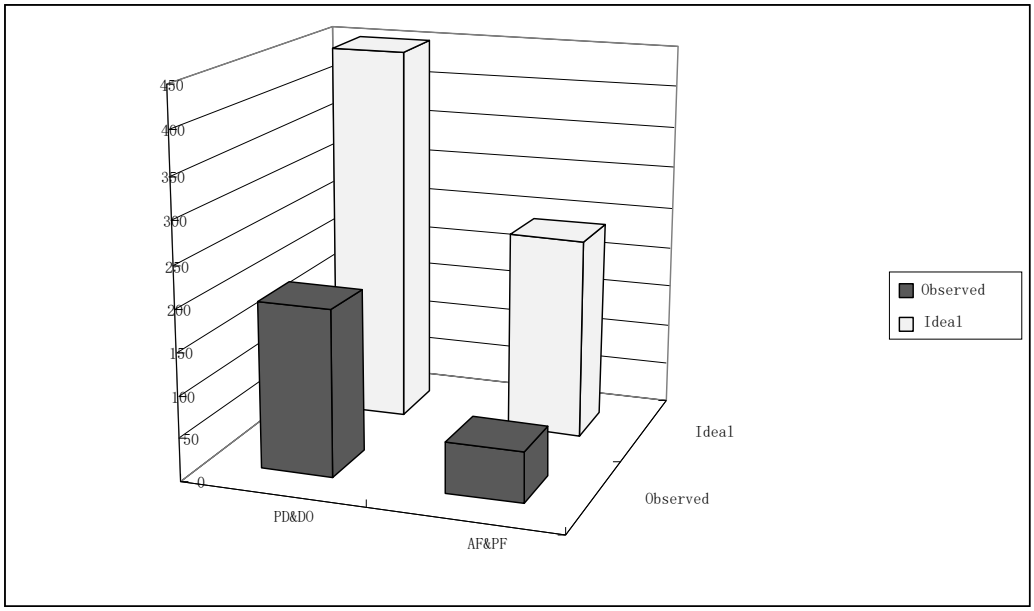

Figure 6. Production of Targets by Prime Type

Another phenomenon we observed was the constraints of lexical items upon the frequency of cross-language priming. The response frequencies in each condition are listed in Table 3. The findings suggested that a stronger priming effect was yielded if the key verb in source language had an equivalent in the target language, and there existed a robust lexical priming effect or translate-boost effect (73.1% of the alternates contain equivalent key verbs). However, when the key verbs were not equivalent, or due to unmatched word order pattern, the recalled target sentences from intermediate students remained mostly unchanged (8% primed cases), without being primed by L1 Chinese sentences. The advanced interpreting students, however, are more likely to be influenced by the effect of the Chinese prime (25% primed cases). We then conducted interviews individually to gain insight into the "subjective understanding" of priming. In other words, we were able not only to observe their behavior but to subsequently understand the meaning that underlies that behavior, and to have this meaning explained to us in the participant's own words. According to their accounts, the negative language transfer caused by dominant L1 was assumed to be restrained validly and automatically by inhibition mechanisms. The rate of language transfer was not affected by negative priming. Their interpreting performances in both directions were roughly the same. The interview provides us

with direct data set for further exploration of language transfer mechanism and implicit memory model.

CONCLUSIONS

Semantic Priming

In the sentence-based category judgment task, the activation of semantic relations of closely and distantly linked target-prime pairs are found compared to non-exemplars, reflected in the mean response time measured by E-prime. The prime type facilitated the recognition of targets when the semantic relation is closely and directly related, but less robust in distantly associated exemplars. This result extends previous findings for this type of relationship and demonstrates that the semantic network can be activated, even at very brief presentations, given sufficient semantic similarity. The results support the semantic spreading activation model of semantic priming, where the prime spreads its activation to another concept with which it is closely connected, and this consequently shortens the recognition time of the activated target. Priming effects were confirmed to exist in L2 lexical representation and processing.

Meanwhile, the effect of semantic distance was remarkable in semantic categorization experiments. The effects of cross-language semantic priming from L1 (dominant language) to L2 are unequal among different proficiency groups with more marked effects occurring in the advanced group. We believed that the individual difference factors, such as the working memory capacity and the ability to efficiently allocate attention between processing tasks might influence the kind of processing involved in semantic priming. Such cognitive abilities as memory, attention, and language aptitude may determine how bilinguals and L2 learners activate semantic information in their L2. This result can confirm that individual differences, such as working memory capacity and aptitudes, might predispose learners to benefit from the implicit learning processes associated with semantic priming. The results of the experiment add more evidence to the hypothesis that L2 bilingual processing can be shared and the procedural knowledge of two languages can interact, suggesting it is asymmetrical but developmental as proficiency increases.

Syntactic Priming

In the sentence recall task, syntactic priming from an unrelated sentence influences immediate recall of the following sentence. When the prime mismatches the target but suggests an alternative structure to express the message of the target sentence, that alternative structure is more likely to be produced in recall. The results support Bock's claim (1986; Bock & Loebell, 1992) that syntactic priming involves persisting activation of recently produced syntactic structures, independent of other levels of processing. It is also indicated that the syntactic priming effect is manifested in sentence recall without much involvement of semantic retrieval.

The present study also suggests that a stronger priming effect was yielded if the key verb in source language had an equivalent in the target language due to the lexical priming effect or the translate-boost effect, with no robust priming effect being observed if the target language has no structural counterparts. The advanced interpreting students were found more affected by the positive effects of cross-linguistic structural priming. According to the follow-up interview, the

negative language transfer caused by dominant L1 was assumed to be restrained validly and automatically by inhibition mechanisms.

With quantitative research and qualitative analysis, the data obtained from the experiments confirmed that priming enhances recall and increases retention of information. Priming effects were found to be robust in assisting the interpreter to reactivate encoded memory, to recall the interpreted message, and even the original sentence structure, to promptly process the readily accessible items residing in the short-term memory, to allocate the attention to the processing of new information with ease, thus greatly improving the quality of interpretation. The results also support the semantic spreading activation model of semantic priming, where the prime spreads its activation to another concept with which it is closely connected, and this consequently shortens the recognition time of the activated target. The subsequent interview also indicated that the semantic activation of the concepts within or across language contributes to the automaticity of memory and information retrieval during interpretation.

We may conclude that in the early stage of learning interpreting when students rely more heavily on source language rather than making full use of their cognitive ability, the positive force of priming is weak but still helpful in accelerating the response time and reducing memory load, especially within a language. With increased interpreting competence and L2 language ability, bilingual lexical and syntactic processing interact further. The priming effects will exert more power in speeding up bilingual processing during interpretation. For interpreters, the gap in performance in both directions will disappear. Therefore, an attempt to identify the priming effect in interpreting is significant to such synthetic bilinguals as interpreters in China.

The value of the study of is to show how priming takes effect in information retention and influences the speed of language processing by combining real interpreting data analysis with priming experiments. Secondly, the researchers discuss the positive roles priming plays in interpreting and attempt to develop a new interpreting research paradigm which stresses automatic cognitive processes. The proposed interdisciplinary research method offers new insights into interpreting study. Finally, the study poses challenges to current interpreting teaching and training models. Besides language ability and interpreting skills, cognitive mechanisms underlying language processing in the bilingual mind, cognitive factors like automatic information retrieval and attention control should be considered in the screening, training, and evaluation of interpreting practitioners. The results of this study can provide a more objective empirical basis for the implementation of the curriculum and teaching programs, so as to enhance the overall interpreting teaching and practice.

This study provided strong evidence for the impact of priming effects on the interpreting process and revealed an implicit driving force hidden in the cognitive processing procedure. A further exploration on this perspective would benefit interpreting theoretical foundation as a whole. The role of implicit memory should be introduced into interpreting practice. Coordination between the implicit memory and other interpreting skills could be achieved with increasingly enhanced semantic and syntactic priming in interpreting performance. Accordingly, the memory practice is suggested to be modified in both content and form to better the interpreting pedagogy. By including implicit memory and these other interpreting skills, an empiricist criteria of cognitive significance for selecting and evaluating interpreter would take shape.

LIMITATIONS

The research subjects are limited to interpreting trainees involved in a one or two year postgraduate project (cf. Master of Arts in Interpreting at foreign language school) since it is very difficult to collect data from professional interpreters. The experiment would be more reliable if the scope of investigation extends to interpreting practitioners and professionals.

Representative sampling is a type of statistical sampling in which a researcher attempts to select individuals which are representative of a larger population, but truly representative sampling is extremely hard to accomplish, especially for the interpreting data due to commercial confidentiality. We dedicated a great deal of time and funding to collecting and transcribing the data. Priming effect that can be observed is still quite limited from the samples.

The test materials that we used were partly chosen from appendix of previous studies since they are more sensitive to test targets. We also consult word norm database and the WordNet database for the word's properties, frequencies and degree of association. Some of the self-edited test materials may not conform to the real interpreting scenario, with the same issue to lab environment. Because of the time span of the experiments, we did not carry out our own word-norming study prior to conducting the experiment.

"How is the interpreting process shaped by the manners in which massive linguistic information is efficiently encoded in and retrieved from the memory?" is an intriguing research topic worth further exploration. One way to extend the current work is to adopt neuroimaging techniques such as Event Related Potential (ERP) and Functional Magnetic Resonance Imaging (fMRI). ERP will reveal a more precise time course of the activation of semantic and syntactic information, while fMRI will manifest whether different brain regions are activated when interpreting.

Another way to extend this present work is to explore and create new paradigms of semantic and syntactic priming for interpreting study. If paradigms are being developed, the inexplicit multitasking process is expected to be illuminated by further empirical studies. This investigation will also provide insights in second language acquisition. It would be very useful to find out whether the influence of L1-L2 and L2-L1 priming at the semantic and syntactic level in second language learning decreases as the L2 proficiency increases. This will inform us whether the patterns of semantic and syntactic activation can be modified to adapt to L2 learning and interpreting practice.

A more complex memory systems model relevant to implicit cognition is also expected to be advanced in the future research. Our analysis focused on very basic aspects of learning and memory, yet an important goal for future research is to understand how these basic mechanisms give rise to the more complex cognitive and language processes often involved in interpreting and translation studies. Future interpreting research will gain more weight form interdisciplinary studies such as neuroscience and psychology.

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