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語義優勢性對語法語境中詞彙歧義解析之影響—中文歧義詞處理的事件相關電位研究

Effects of Meaning Dominance on Lexical Ambiguity Resolution in Syntactic Context— An ERP Study of Homograph Processing in Chinese

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口試委員會審定書

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本論文係曹景瑄君（R03142016）在國立臺灣大學語言學研究所完成之碩士學位論文，於民國 108 年 3 月 8 日承下列考試委員審查通過及口試及格，特此證明

口試委員：李佳霖（簽名）

（指導教授）

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致謝

莫泊桑在小說中寫道：「人的脆弱和堅強都超乎自己的想像。有時，可能脆弱得一句話就淚流滿面；有時，也發現自己咬著牙走了很長的路。」

回首這一千多個日子，走在滿是荊棘的漫漫長路，我常常想，真的會看見盡頭嗎？在見到曙光的那一刻，卻又覺得渺如夢境一般…我總算也踉蹌地抵達終點了。

完成論文的歷程，只有自己才能了解箇中滋味。想起那年為了追逐理想，亦不甘安於舒適圈的性格，決定放下手中握有的安穩，踏入心目中的學術殿堂。而研究生活除了投入感興趣的領域琢磨外，大部分的時間更像是在進行自我對話的過程。尤其在將自己丟入一個不甚熟悉的領域，如同在迷霧中摸索，必須抱持堅強的信念，才能在一次次的試錯中跌倒爬起進而茁壯。期間少不了自我懷疑、自我否定，甚至近乎失去自我的真空狀態。或許，這就是走出舒適圈的成長代價。也只能憑著一股執持加上飛蛾撲火的義無反顧，學習去調整慣有的思維，平心靜氣地審視每道關卡與挑戰，思考自我選擇和取捨。更重要的是，這一路上若沒有身旁珍貴的事物給予力量，不敢想像自己是否能完成現在這小小的一步。

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更像是姊姊一樣常叮嚀著我的身體健康，不時搞笑讓苦悶的我一解憂愁。每每看到家人來台北看我，所有的倦怠和無力都暫拋腦後，使我重新有勇氣面對眼前的課題。最後，要感謝一直陪在我身邊的祐承。研究所大半的時間都是你陪我度過的，對於無數個陪我寫論文的周末從無怨言，還得忍受我的各種情緒起伏；你總是選擇耐心包容，樂觀正向地帶我找回生活中美好的點滴，解開我緊鎖的眉頭，無條件予我鼓勵與支持。是你教會我如何與不完美共存，如何優雅地面對人生的輕重緩急。

寫下這篇扉頁的同時，代表對自己的選擇和追求負責，也意謂開啟了人生下一個篇章。願自己能將在語言所的這些經歷所得，謙卑的帶上人生未來的旅途。得之於人者太多了，點滴在心頭，願自己時時刻刻謹記付出的智慧，成為幫助他人的人。

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中文摘要

過去的文獻指出，能夠影響詞彙歧義解困(lexical ambiguity resolution)的兩大主因為語義頻率(meaning frequency)和語境訊息(context)。過去研究皆認為語境訊息的存在能有效地幫助選擇適當的語義進而達成語義消歧，然而語法和語義語境是否皆能影響一開始語義的提取似乎仍未明朗。單純操弄語法語境的研究多半未特別區分同形異義詞(homograph)中主要語義及次要語義的語義頻率，而且實驗間採用不同的典範如促發典範(priming paradigm)的詞彙判斷作業(lexical decision task)以及方法如眼動追蹤技術(eye-tracking)、事件相關電位(Event-Related Potential, ERP)有可能引發不同的反應策略。有鑑於此，本篇論文欲以中文為媒介來探討兩項議題：（一）語法語境是否能影響中文非均勢同形異義詞(biased homograph)中語義之提取；（二）語義優勢性在中文詞彙歧義解困處理歷程中是否能與語法語境互動。並以事件相關電位(Event-Related Potential, ERP)技術來做為此議題的實證。

詞類歧義詞提供一個媒介來檢驗語義優勢性在語法單獨存在之語境下進行詞彙歧義解困的作用。實驗一我們將兩種不同類型的中文非均勢同形異義詞置於只有語法訊息但語意短缺的中文短語內，僅根據語法提示(syntactic cue)來提取非均勢同形異義詞中的主要語義或次要語義為最適當的語義解讀。由於實驗一整體效果不如預期顯著，實驗二為實驗一之改良，沿用相同材料，並搭配語義關聯性測驗(semantic relatedness judgement task) 使受試者更需要整合語境以及歧異詞，同時受試者須做兩個實驗列表以利檢視實驗一中觀察到的個體差異。

研究結果顯示，過往文獻中提到涉及詞彙歧義時會引發在前區持續的負向效果(frontal negativity)在整體的受試者中效果並不明顯，但在閱讀經驗較高的受試者上較為突出。此結果可能表示個體對於解歧語境有反應差異且體現於閱讀能力之指標。根據中位數分組的結果顯示，閱讀經驗較高的受試者在歧義詞上引發負向腦電位變化，另一半閱讀經驗較低的則引發正向腦電位變化，因而造成整體腦電位效果的相互抵消。另外，我們也在閱讀能力較高的組別中發現負向的歧異效果主要出現在當語法語境導向中文非均勢同形異義詞的次要語義，範圍由頭皮前區延續到中後區。然而當語法語境導向主要語義時，除了與語義關聯的 N400 短暫出現外，負向的效果似乎較不明顯。整體而言，本研究的結果顯示，語法訊息語境能夠提供促進語義提取進而幫助解歧，且其受到語意優勢性的影響。當語境導向主要語義時，主要語意可以被迅速且強烈的提取，次要語意即便有被提取，其所形成的語義競爭甚小，意義選擇不須額外的上到下的資源即可語義競爭透過較為自動化的意義模式（顯示在 N400 的效果）順利完成解歧。然而，當語境導向次要語意時，由於次要語意的提取受到語境的支持，且主要語意的提取還是非常強烈，因而形成強烈的語義競爭，需要由一上而下的處理歷程來幫助解歧。過去文獻顯示動用此資源的能力有個體化的差異，本研究的結果與此一致，顯示擁有較好的閱讀能力者較容易啟動此協助解歧的機制。

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關鍵字：一詞多義、詞類歧義、語境、語意優勢性、詞彙歧義解困、個體差異、事件相關電位

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Abstract

In general, past literature has indicated that meaning dominance and context are the two main factors influencing lexical ambiguity resolution. Prior research suggested that context can help select contextually-appropriate meaning effectively, and thus succeed with lexical ambiguity resolution. However, it seems less evident whether the initial meaning access could be influenced by the context with only syntactic information. For one thing, most studies manipulating the syntactic information context alone did not distinguish the meaning dominance of the dominant and subordinate meaning of homographs specifically. For another, various paradigms adopted in different experiments such as priming with lexical decision task, eye-tracking, and event-related potential were likely to reflect different response strategies. In view of the above-mentioned facts, the present study targeted Chinese native speaker to investigate (1) does syntactic context affect meaning access of Chinese biased homographs, and (2) does syntactic context effect interact with meaning dominance. We used Event-Related Potential (ERPs) to examine the brain responses and attempt to make an empirical study.

Syntactic category ambiguous words, whose alternative meanings differ in syntactic categories (e.g., *trip* in English), serve as a means of examining this issue. In Experiment 1, two types of Chinese biased homographs (i.e., NV and VN homographs) were embedded into phrases in which syntactic information provided but lack of semantic. That is, either the dominant or the subordinate meaning of homographs would be extracted to be the contextual-appropriate meaning depending only on syntactic cues. On account of the more insignificant overall effect than predicted in Experiment 1, Experiment 2 adopted the same materials but replaced with the semantic relatedness judgement task to make participants further integrate the contexts and homographs. Meanwhile, all participants were required to do two experimental lists to examine the individual difference observed in Experiment 1.

Our results showed that the overall ambiguity effect was not as prominent as that in the previous studies which have found an ambiguity-related sustained negativity at frontal regions, the effect was more obvious in the subjects with high score of reading experience instead. It might indicate that individual differed in reaction to the disambiguated context, and such an individual difference may manifest on reading abilities. Based on the result of grouping data with median split, participants with higher scores on reading experience showed a sustained negativity relative to unambiguous words, and half with low scores showed a positivity, and thus cancelled out the overall ambiguity effect.

On the other hand, in the high score group of reading experience, we found a clear negativity showed when the syntactic context favored the subordinate meaning of homographs, ranging from frontal scalp to central-posterior, whereas when the syntactic

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context picked out the dominant meaning of homographs, except for the transient N400 effect related to semantic access, it seemed an absent sustained negativity. In sum, this current study indicated that the syntactic context is able to affect the meaning access and help disambiguation, yet such context effect is modulated by meaning dominance. In the dominant-biasing context, the dominant meaning could be accessed intensely and rapidly, and the meaning competition is thus very small even if the subordinate meaning is activated. Such a process of meaning selection can be accomplished through a model of meaning automation (displayed on the N400) and thus reach disambiguation successfully. On the contrary, despite the fact that the subordinate-biasing context supports the activation of subordinate meaning, the access of dominant meaning is still robust at the same time. Hence, a strong meaning competition is generated, and an additional mechanism is necessary to be involved to help. As suggested by past literature, there is an individual difference for mobilizing the top-down resources, which is consistent with our result that those who have better reading abilities are more likely to initiate the kind of mechanism.

Key words: homograph, syntactic category ambiguity, context, meaning dominance, lexical ambiguity resolution, individual difference, Event-Related Potential

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Chapter 1 Introduction

1.1 General background

Language, admittedly, is ubiquitous and plays a crucial role in our life. People may suppose that comprehending words or sentences is an inherent ability, which is quick and effortless most of the time. However, the complex underlying mechanism about how syntactic and semantic information interact and integrate in human's brain have always been discussed.

Ambiguity is one of the robust examples since it is so prevalent at either word or sentence level in language. In English, for example, it is estimated that over 80 percent of high-frequency words have more than one meaning (Twilley, Dixon, Taylor & Clark, 1994; Rodd et al., 2002). Chinese, likewise, has a large number of word-class ambiguous words. According to the Modern Chinese Dictionary, nearly 80% of the monosyllables in Chinese are ambiguous between various meanings, and 55% have five or more homophones. Moreover, an estimate indicated that regardless of frequency, between 13% and 29% of Chinese monosyllabic and disyllabic words can be used as nouns and as verbs (Hu, 1996). On the one hand lexical ambiguity makes language rich and flexible, but on the other hand it complicates language, creates processing load and somehow increases the chance of confusion or misunderstanding. With such distinctive feature that one-to-many meaning mapping, how to pick out the most appropriate meaning swiftly among many possible interpretations and thus reach an effective communication is a primary issue for psycholinguists and neuropsychologists.

When it comes to lexical ambiguity, most of the time, it can refer to either polysemy or homonymy. To be specific, polysemy denotes a word possesses multiple different but related meanings as shown in the case of *foot* (e.g., "my left foot" and "at the foot of the mountain"), while homonymy contains several meanings which are semantically

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unrelated like *bank* (river bank and financial bank). As for the former, both meanings are related but not literally the same; for the latter, both meanings share a single orthographic form but semantically unrelated concepts. According to a number of prior neurolinguistic studies, homonymy and polysemy are vindicated psychological distinct and being processed differently (Frazier & Rayner, 1990; Pickering & Frisson, 2001; Rodd, Gaskell, & Marslen-Wilson, 2002). Due to the distinctiveness, the present study is exclusively concerned with homonymy, the so-called homophonic homographs, to avoid making confounding (Cruse, 1986; Lyons, 1977).

Two competing hypotheses of lexical ambiguity resolution have been proposed in the past decades from psychological and linguistic perspectives. Context-dependent account declares that the context that precedes an ambiguous word can offer help to access only the contextually appropriate meaning, assuming that language processing is operated by an interactive mechanism in which information among different linguistic subsystems like lexical or grammatical levels can flow both bottom-up and top-down simultaneously in ongoing language processing (McClelland, 1987). In contrast, context-independent account postulates that language subsystems are operated independently of other cognitive systems; namely, language processing must be completed in each language subsystem before information is transferred. This view is based upon the premise that language processing is a modular, bottom-up approach in which non-lexical, sentential information does not penetrate lexical access (Fodor, 1983). These hypotheses, in fact, provide a basis for researchers to extend various models of language processing as well as highlight the importance of underlying cognitive architecture of language processing.

To demonstrate the influence of contextual information, a great many researchers have investigated it across languages via various experimental paradigms, and most focus on either semantic or syntactic constraints. A majority of findings suggest that semantic

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information of context is able to facilitate word processing (Marslen-Wilson & Tyler, 1980; Van Petten & Kutas, 1990; Van Petten & Kutas, 1991), help access appropriate meaning and even reduce selection demands related to ambiguity though it seems not to operate independently but interact with meaning frequency (Duffy, Morris, & Rayner, 1988; Rayner & Frazier, 1989; Rayner, Pacht, & Duffy, 1994; Lee & Federmeier, 2009). On the other hand, past research into the effects of syntactic context on word processing has also been studied yet yielded inconsistent results (Marslen-Wilson & Tyler, 1980; Seidenberg et al., 1982; Tanenhaus, Leiman, & Seidenberg, 1979; Folk & Morris, 2003; Lee & Federmeier, 2006, 2009, 2011; Chen, 2014). Some support that syntactic context information can affect word processing, whereas some concludes such the information alone is insufficient to eliminate the lexical ambiguity indexed by a frontal negativity. Under discrepant basis, this issue has not reached a consensus unanimously. Moreover, previous neurolinguistic research has been widely conducted in English and other Indo-European languages such as German, Italian and French, but there are relatively few studies to explore the syntactic context information during Chinese processing.

In addition to context, the role of meaning dominance is also one of the essential factors in lexical ambiguity resolution. Meaning dominance refers to alternative meanings of an ambiguous word have different frequency of uses. In comparison to the subordinate meaning, the dominant meaning is much easier to reach a high activation level (Simpson & Burgess, 1985; Burgess & Simpson, 1988; Hogaboam & Perfetti, 1975; Simpson, 1981). However, the alternative meanings of an ambiguous word will reach a high activation level at the same time and keep competing with each other if the frequency of uses of both meanings are equal. (Duffy, Morris, & Rayner, 1988; Rayner & Duffy, 1986; Sereno, Pacht, & Rayner, 1992).

Since most of the previous research associated meaning dominance with semantic

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issue; that is, they indeed manipulated two distinct meanings of ambiguous words but seemed to overlook the distinctiveness of dominant and subordinate meanings of experimental materials respectively, especially when the alternative meanings of ambiguous words fell in different word classes. The relevant studies were much less with respect to syntactic context. Despite the fact that some have asserted to inspect the meaning dominance under only the syntactic constraint, some did not control the equal numbers of syntactic category ambiguous words, some just used balanced homographs. For example, Folk and Morris (2003) have investigated the function of syntactic context in lexical ambiguity resolution by embedding balanced NN- and NV-homographs in sentences which were syntactically instantiated either the dominant or the subordinate meaning of the homographs. Yet, the prior context contained syntactic information that disambiguated the NV ambiguous words, specifying the noun interpretation was intended only. Under the circumstance, meaning dominance did not be examined comprehensively.

Therefore, the current study is regarded as a pilot study, aiming to not only organize the materials in Chinese homographs but set up a protocol to approach the following issues regarding how syntactic information affect meaning access and aid lexical ambiguity resolution in Chinese biased homographs as well as what the role of meaning dominance is under such a context. Based on this consideration, a large body of this study will emphasize the material selection, in which we made efforts to verify the validity of the materials on various linguistic features. Despite the fact that we have done preliminary experiments through the established design by using the materials, the numbers of participants in this experiment was relatively small. In addition, the data was unexpectedly variable among participants. As the variation among participants was quite salient, we conducted a simple group-level statistical analysis, and most part of the current study focused on explaining the source of the inter-individual variance. Follow-up

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analysis and testing was conducted to verify these speculations. Although the results of the present study are not conclusive, we hope that the stimuli and testing protocol would provide a basis for future research.

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Chapter 2 Literature review

2.1 Hypotheses of lexical ambiguity resolution

Whether ambiguous words are accessed and integrated into comprehension through a bottom-up or a top-down mechanism has long been debated by a raft of researchers. In general, prior studies attempted to explain the phenomena found in lexical ambiguity from either the modularity hypothesis or the interactive hypothesis. Of great interest is whether the access and selection of a contextually appropriate meaning from among several possible definitions depends on the prior context.

2.1.1 Modular access hypothesis

According to Modularity hypothesis, a general theory of cognitive processing, the lexical processor is an autonomous, informationally encapsulated module, and occurs independently of processing in any other module, especially when language is being processed under natural conditions (Fodor, 1983; Forster, 1979; Simpson, G. B., & Kang, H., 1994). That is to say, a particular component process of comprehension is able to operate autonomously of the other processes. In the level of language comprehension, researchers postulated all meanings of an ambiguous word were accessed independently irrespective of the sentential context, which certainly did not penetrate lexical access. Such notion has been considered that lexical access is completely a process driven by bottom-up inputs and is thus autonomous from the top-down, contextual influence.

2.1.2 Interactive access hypothesis

A contrasting viewpoint, Interactive access hypothesis, however, assumes that all subsystems of cognitive architecture might be interactive, unceasingly counting in any relevant information, making outputs available to other subsystems as soon as they are

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developed. This hypothesis in favor of the contextual dependency argues that the contextually appropriate meaning of an ambiguous word can be selectively accessed early on, it thus an interactive process in which lexical and contextual information can mutually influence each other at a very early stage (Marslen-Wilson & Tyler, 1980; McClelland & Elman, 1986). Since different levels of information can interact with each other earlier, it is regarded as a disambiguating processing between bottom-up and top-down mechanisms. The hypothesis therefore supports immediate effects of context, showing that a biasing context can lead to either the facilitation of the contextually-appropriate meaning or a competition between multiple meanings when they were equally available.

Although the two hypotheses have been extensively tested in numerous studies, there still remained discrepant conclusions. What only can be confirmed is that— both contextual and lexical features do play crucial roles in ambiguity resolution.

2.2 Issues of ambiguity resolution

In order to figure out how the two primary factors influence the processing of ambiguity resolution, a great number of prior studies have probed into this issue not only through various approaches but also across different languages. A few models based on either modular or interactive view thus were generated, aiming at providing the empirical evidence to examine the role of meaning dominance and context in ambiguity resolution.

2.2.1 Meaning dominance

For ambiguous words, it has been proved that the accessibility of the meaning is determined by its frequency of usage. Accordingly, the term *meaning dominance* is used to account for the relationship between the alternative meanings of an ambiguous word. To assess the meaning dominance effectively, free-association was a common technique

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which asked participants to write down the first meaning that came to mind when given the ambiguous word in isolation (Gawlickgrendell & Woltz, 1994; Hogaboam & Perfetti, 1975). Balanced homographs refer to the multiple meanings of the homograph have the equal frequencies of usage (equally dominant meanings), whereas biased homographs represent one meaning of the homograph is used most frequently (dominant meaning), and the other is used relatively low (subordinate meaning). The two types of homographs, in fact, are qualitatively distinct from each other after being studied through a variety of paradigms over the past few decades.

Depending on whether or not meaning dominance is taken into account, models of discrepant views were developed. Both *Multiple access* (Onifer & Swinney, 1981; Swinney, 1979; Tanenhaus et al., 1979) and *Selective access model* (G.B. Simpson, 1981; Tabossi et al., 1987; Tabossi & Zardon, 1993) supported that the process of disambiguation had nothing to do with meaning dominance, while *Ordered access model* (Hogaboam & Perfetti, 1975; Simpson, 1981; Simpson& Burgess,1985; Holmes, 1979) and *Reordered access model* (Simpson & Burgess, 1985; Simpson & Kreuger, 1991; Rayner & Frazier 1989; Rayner, Pacht & Duffy, 1994) were proposed with the consideration for meaning dominance.

According to *Multiple access model*, all meanings of an ambiguous word were accessed momentarily and automatically following the occurrence of the word, without regard to the frequencies of use. Much of the ground-breaking research also led to the conclusion that multiple meanings were accessed simultaneously even in biasing context by using spoken homophones as stimuli (e.g., Onifer & Swinney, 1981; Swinney, 1979; Tabossi & Zardon, 1993; Tabossi, Colombo & Job, 1987; Tanenhaus et al., 1979). For instance, in the cross-modal priming paradigm, Swinney (1979) combined auditory and visual stimuli, aiming to measure activation of each meaning of balanced homographs.

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The result revealed that both meanings are accessed simultaneously and automatically. Swaab et al. (2003) used ERPs to further explore if and when lexical factors such as relative meaning frequency of ambiguous words influence lexical ambiguity resolution during spoken sentence comprehension in Dutch, finding that both dominant and subordinate meaning are partly activated initially, regardless context. Sharing the similar views, *Selective access model* claimed that the key point determining the meaning access depended on contextual information rather than meaning dominance. Only when the context provided a strong bias was the contextually appropriate meaning of ambiguous words accessed (Simpson, 1981; Tabossi, Colombo & Job, 1987; Tabossi & Zardon, 1993). Therefore, neither of the two models saw the meaning dominance as a pivotal role in lexical ambiguity resolution.

However, the other two competing models believed that the importance of meaning dominance cannot be ruled out. When it comes to *Ordered access model*, findings showed that biased homographs were resolved based on the relative frequency of alternative meanings in the absence of disambiguating information, with more frequent meanings being accessed faster and less influence of the context. (Hogaboam & Perfetti, 1975; Simpson, 1981; Simpson & Burgess, 1985; Holmes, 1979). Simpson (1981) investigated the order of meaning access by using biased homographs in one of the experiments, which revealed that the dominant meaning of a biased homograph became available prior to the subordinate meaning in the neutral context. In other words, lexical meanings are retrieved in the light of frequency rankings. *Reordered access model*, similarly, assumed that meaning frequency can make a great impact in lexical ambiguity resolution. However, the preceding contextual information can also influence ambiguous word processing at the same time (Rayner, Pacht & Duffy, 1994; Simpson & Burgess, 1985; Simpson & Kreuger, 1991; Rayner & Frazier 1989; Rayner et al, 2006). Based on their evidence,

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lexical access was exhaustive but the meaning activation was determined by not only contextual information but also meaning dominance, and thus engendered a competition.

2.2.2 Context

Despite the fact that the influence of contexts in lexical ambiguity resolution has been vindicated in voluminous studies, it has not yielded an agreed-upon statement over the past few decades. The more controversial issue is when contexts get involved in the process of ambiguity resolution as well as how it determines which meanings of ambiguous words are activated first. Findings in different experiments have led to conflicting perspectives on the timing of contextual information.

Based on the assumptions of modular access hypothesis, *Multiple access model* and *Ordered access model* state that the preceding context cannot exert any influence on lexical access until the post-access selection stage. Onifer & Swinney (1981) utilized the cross modal priming technique in which subjects listened to and apprehended a series of sentences containing ambiguous words whose meanings biased to either dominant or subordinate meaning. After that, the participants had to make a lexical decision concerning whether the letter strings were words or non-words. Decisions to words related to both dominant meaning and subordinate meaning were occurred to facilitation irrespective of contexts when presented immediately. When the visual probes were presented 1500ms delay, however, the facilitation was only limited to the contextual-related probes. Their result thus supported that the contextual information can only help to select the most appropriate meaning in the post-lexical stage since every meaning of an ambiguous word were activated initially. Similar to their result, Simpson and Burgess (1985) conducted a series of experiments by using the method of priming, which also exemplified that lexical access is considered to be independent of the context in the very

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beginning of lexical processing.

On the contrary, *Selective access model* and *Reordered access model* are regarded as context-dependent processing. Their core idea is that the contextually- appropriate meaning of an ambiguous word can be selectively accessed early on if the preceding sentence context provides a strong bias to the appropriate meaning. In other words, language processing is operated by an interactive mechanism in which both top-down (contexts) and bottom-up (linguistic features) information can flow and mutually influence one another at a very early stage. According to Simpson (1984),
the ambiguous nature of the word did not have to be resolved because the context primes only the appropriate meaning. Moreover, the experiments of Tabossi & Zardon (1993) successfully reflected genuine context effects and introduced the issue of the time-course of context in their experiments. Having examined the data on lexical ambiguity resolution in Italian, they found that only the dominate meaning was activated when the sentential context biased was toward the dominate meaning. It indicated that lexical access, to some extent, might be early restricted to the information derived from contextual information. Also, there were other research suggested that contextual information can mediate in lexical ambiguity resolution, and even render a competition between the most frequent meaning and the context-appropriate meaning (Simpson, 1981; Simpson & Kreuger, 1991; Rayner & Frazier 1989; Rayner, Pacht & Duffy, 1994).

2.3 Lexical category difference

Such linguistic distinctions raised a question that whether the lexical ambiguity resolution is also influenced by the syntactic categories of meanings. As a result, some researchers began to count word class in, using SCA words (i.e., syntactic categories ambiguous words) as an ideal vehicle for examining the role of syntactic context in lexical

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ambiguity resolution. However, the issue whether the syntactic contexts could resolve lexical ambiguous has been controversial due to the inconsistent evidence from various studies. As the variable delay naming paradigm conducted by Tanenhaus et al. (1979), they attempted to investigate the processing of noun-verb ambiguities in syntactic context sentences. In the experiment, noun-verb ambiguous words were preceded by a syntactically-biased but semantically-neutral context, and soon followed by a target word related to one of the alternative meanings. Two conditions were thus established—congruent and incongruent. (i.e. congruent: "*He bought a new saw."* – HAMMER; incongruent: "*They don't believe what they saw.*" – HAMMER). The ambiguous words in control sentences were replaced with unambiguous word whose meaning was distinct from the following target word (e.g., "*He bought a new case*."; "*They didn't believe what they felt*."). Aside from the manipulation of congruency between syntactic contexts and target words, there were three different stimulus onset asynchrony (SOA: 0 ms, 200 ms, 600 ms) for the target words. Their results supported the exhaustive access for syntactic category ambiguous words because the two meanings of SCA words were activated simultaneously even with only the precedence of syntactic constraints. The similar paradigm was then replicated by Seidenberg et al. (1982), and also in favor of the conclusion that syntactic constraints alone could determine the meaning activation and thus select the most appropriate meaning.

However, findings from electrophysiological experiments have indicated that the frontal negativity only reflected on NV-homographs in the presence of syntactic, but not semantic, constraints (Lee & Federmeier, 2006, 2009). In order to examine the effects of syntactic and semantic context on ambiguity resolution for NV-homographs, Lee and Federmeier (2009) created two types of sentences: congruent sentences and syntactic prose, respectively. They found the sustained frontal negativity (200-700 ms) was elicited

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by the NV-homographs in the syntactic prose sentences as compared with controls. Moreover, the sustained frontal negativity was significantly reduced when additional semantic information was available in contexts, suggesting that the frontal negativity reflect additional cognitive processing that is recruited when meaning selection is difficult. The inability to use syntactic information in online ambiguity resolution was again demonstrated in their following study. Using the same stimuli, Lee and Federmeier (2011) compared ERP responses to homographs and unambiguous words to examine how language processing changes with normal aging. Results showed that older adults did not exhibit the frontal negativity effect exhibited by the young adults, but older adults with higher verbal fluency showed young-like patterns. These results suggest that the frontally-mediated selection mechanism may be related to executive functions that tend to be compromised in advanced age. In brief, the series of related studies show no disagreement with the view that syntactic information alone is unable to exclusively select the context-appropriate meaning of SCA words so that fail to resolve the lexical ambiguity.

Despite the coherent results from ERP studies, findings from eye-tracking are more controversial. Fraizer and Rayner (1987) asked subjects to read sentences containing class-ambiguous phrases (e.g., *desert trains*, which can be either noun-verb or adjective-noun.) and found longer gaze durations on class-ambiguous phrases while preceded by a disambiguating determiner (e.g., *this* or *these*). Conversely, reading times on semantically disambiguating regions following the phrases were longer after the ambiguous modifier (e.g., *the*). They then proposed a delay model on the basis of the results, elucidating that when there is no enough disambiguating information, readers tend to delay assigning syntactic class until the presence of more disambiguating information is available in the sentence. Nevertheless, some studies are in favor of the view that syntactic information can guide lexical resolution online. Folk and Morris (2003) embedded biased NN-

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homographs and NV-homographs in sentences which were semantically and syntactically instantiated either the dominant or the subordinate meaning of the homographs. While the subordinate bias effect was not shown on NV-homographs but on NN-homographs. More specifically, longer gaze durations showed on the NN-homographs when preceding context favored the subordinate meaning, but no longer gaze durations were found when prior context instantiated either the dominant or subordinate meaning of the NV homographs. They further inspected the another types of syntactic ambiguous words—balanced NN- and NV-homographs in the context containing only syntactic information. The result showed that longer gaze durations on the balanced NN-homographs compared with the unambiguous controls, but for NV-homographs, there seemed no any processing loads since the contextually-appropriate meaning could be initiated and selected under the aegis of syntactic contextual information. As a consequence, they suggested that syntactic information indeed mediates the meaning resolution of ambiguous words.

Together, the issue whether or not a lack of semantic information would lead readers to process more difficulty in resolving the lexical ambiguity is still less clear, the present study therefore aims to delve into the role of syntactic contextual information by using syntactic ambiguous words which has advantage in excluding the semantic reminders from the context.

2.4 Studies of lexical ambiguity resolution in Chinese

Since the massive number of studies were conducted in English and other Indo-European languages, the research on lexical ambiguity resolution in Chinese is relatively few. Some researchers have investigated Chinese lexical ambiguity resolution to broaden the knowledge base and suggested the similar findings that context and meaning dominance both make influences (Li et al., 2002; Ahrens, 2001; Wong & Chen, 2012;

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Chen, 2014). However, by using different types of ambiguous words and paradigms, the studies of Chinese lexical ambiguity resolution showed inconsistent results and thus supported different theoretical hypotheses.

To illustrate, Li et al. (2002) used cross-modal method to examine the influence of sentence context on the meaning selection in Chinese biased homophones, finding that priming effects only elicited by the dominant meaning of the homophones when the dominant-related visual probe occurred 150 ms before the acoustic offset, but when the visual probe occurred at the acoustic offset, thee priming effect elicited by both meanings. It is thus in favor of the reordered access model, indicating the access of ambiguous words is frequency-based; that is, that dominant meaning is activated initially, and the prior contexts can influence lexical access at an early stage, implicating that language processing is highly interactive.

Another more recent eye-tracking study by Chen (2014) conducted two experiments to address the issue about the role of syntactic category constraint in Chinese lexical ambiguity. Four types of words biased homographs (NN, VV, VN, and NV) were used as stimuli and embedded into different sentence contexts. In Experiment 1, both the preceding and the succeeding sentential contexts were semantically and syntactically biased toward the subordinate meaning of the homographs. The result demonstrated a delay of SBE (i.e., subordinate biased effect: longer processing time is needed at a lexically ambiguous word, relative to an unambiguous control, when the preceding context supports the subordinate meaning of the biased homograph, see Rayner, Pacht, & Duffy, 1994 for details) on ambiguous words; that is, the SBE was not observed for syntactic category ambiguous words in the target region but found in the second-pass reading in the post-target region. It seemed as an evidence that preceding semantically and syntactically biased context both provided a strong information to guide the readers

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to activate the subordinate meaning at the beginning. In contrast, in Experiment 2, the sentence frame changed to semantically-neutral but syntactically-biased toward the subordinate meaning for the purpose of observing whether the syntactic information alone influence the SBE during lexical ambiguity resolution. This time, the SBE for VN-homographs emerged in the first-pass and second-pass reading in the target and post-target region, whereas for NV-homographs, the SBE was relatively slight but still observed in the second-pass reading in the post-target region. It revealed that the dominant meaning is still quite strongly activated and then interfere the contextual-appropriate meaning so that syntactic category constraint seemed not very influential during the meaning resolution of Chinese syntactic ambiguous words. The ambiguity effect, to some extent, was probably affected modulated by meaning dominance. It was then supposed from the two opposite findings that the semantic constraints really exerted an influence during the processing of ambiguity, but the role of syntactic constraint seemed not that obvious.

Taken together, due to the fact that there are relatively few studies on the context with syntactic information only, especially in Chinese, and the current relevant studies are still far from reaching consensus on the processing mechanisms of lexical ambiguity either, the issue is thus of great significance to be examined to provide more evidence in Chinese. The present study therefore attempts to investigate the role of syntactic contextual constraint combing with meaning dominance by using syntactic cues as the preceding context, we aspire to reduce any possible influence and make an empirical study on these issues.

2.5 Research question

The present study made an attempt to investigate the influences of meaning

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dominance within syntactic context by using the ERP technique, which is equipped with the feature of great time resolution as well as highly sensitive measure of the critical cognitive and linguistic processes that take place in real-time within a short time window. In our experiments, two types of disyllabic Chinese biased homographs (NV and VN) were used as target words, preceded by two types of cues, to generate all either dominant or subordinate context. The corresponding numbers of unambiguous nouns and verbs were taken as the control groups, with matched linguistic features as biased homographs. Specific research questions are addressed as follows:

(1) Does syntactic context affect meaning access of Chinese biased homographs?

(2) Does syntactic context effect interact with meaning dominance?

A primary goal of this study is to realize how Chinese lexical ambiguity is resolved in the brain as well as provide a perspective to explain its underlying cognitive-neural mechanisms. With this technique and manipulation, it is possible to examine whether a meaning-selecting mechanism indexed by frontal negativity mediate during Chinese biased homograph ambiguity resolution and to infer the influence of meaning dominance. We hope this updated experiment on the basis of past research helps reconcile the discrepancies among a number of prior studies conducted through various methodologies.

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Chapter 3 Experiment

Experiment 1 examined whether meaning dominance affects the processing of ambiguous words when the preceding context provides disambiguating syntactic information but very little semantic information.

3.1 Design and predictions

Two factors were manipulated, including the type of target words and preceding contexts. Target words were syntactically unambiguous words such as syntactically unambiguous nouns (*e.g., zhèngcè /政策/policy*) and syntactically unambiguous verbs (*e.g., tǎohǎo/討好/flatter*) as well as syntactic category ambiguous words. Syntactic category ambiguous words are words with very different meanings across the syntactic category noun and verb. Examples are like *"bǎoquán/保全"*, whose dominate meaning is a noun *(security guard)*, whereas the verb usage *(preserve)* was the subordinate meaning. Likewise, *"zuǒyòu/左右"* has the dominate meaning as a verb *(influences others to act,* whereas the noun usage of *"zuǒyòu/左右" (left and right side)* was the subordinate one. With respect to contexts, two sorts of syntactic cues— noun-predicting and verb-predicting cues— were used to construct either a noun-expecting context or a verb-expecting context.

These two factors were crossed, yielding the following critical conditions, including (1) syntactically and semantically unambiguous two-word phrases (UN and UV in Table 3.1), (2) phrases containing homographs with dominant-biasing context, and (3) phrases containing homographs with subordinate-biasing context. Among all phrases, half contained homographs, and the other half were unambiguous. Among the ambiguous phrases, half contained syntactic cues biasing toward the dominant meaning while the other half contained syntactic cues biasing toward the subordinate meaning.

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Based on prior literature, we expect to replicate the sustained frontal negativity (around 250-900 ms) effect to ambiguous words as compared to unambiguous words. If preceding syntactic context does not influence initial meaning access, we expect to see the frontal negativity effect not only in dominant-biasing condition but also in subordinate-biasing one because both dominant and subordinate meanings would be activated so that there is a meaning competition. In this case, the meaning dominance would play a pivotal role determining the contextually-appropriate meaning ultimately.

Extending prior literature, if preceding syntactic context does influence initial meaning access, we aim to examine whether the frontal negative ambiguity effect would be moderated by meaning dominance of the contextually-favored meaning. Under this circumstance, the results would suggest that, in dominant-biasing context, the dominant meaning would be activated rapidly and strongly and the activation of the subordinate meaning is negligible such that homographs are processed indistinguishably from unambiguous words. Only in the subordinate-biasing context when the activation level of the subordinate meaning is boosted by the context to form a meaning competition with the dominant meaning do the executive processes reflected by the sustained frontal negativity is needed.

Table 3.1. Examples of stimuli for each condition

Word type	Subtype	Context	Condition	Cue	Target
unambiguous words	UN	Noun context	Un-ambiguous	一些 yīxiē some	成員 chéngyuán members
	UV	Verb context		即時 jíshí immediately	趕到 gǎndào arrived

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homographs	NV	Noun context	Dominant-biasing	一位 yīwèi one-CL	保全 bǎoquán security guard
		Verb context	Subordinate-biasing	努力 Nǔlì industriously	保全 bǎoquán preserve
	VN	Verb context	Dominant-biasing	急著 jízhe imminently	掛號 guàhào registered mail
		Noun context	Subordinate-biasing	三封 sānfēng three-CL	掛號 guàhào registered mail

3.2 Method

3.2.1 Participants

Twenty right-handed young adults took part in this ERP experiment (10 males; mean age 23.9 years, age range 21-27) for cash. All were Chinese native speakers and were neither exposed to other languages other than Taiwanese before the age of five nor had history of neurological or psychiatric disorders or brain damage. All participants were right-handed as measured by the Chinese translated version of Edinburgh inventory (Oldfield, 1970), with the mean laterality quotient being 0.81 (SD = 0.15 range = 0.5-1.0). No participants had known left-handed blood relatives, as assessed by a familial handedness questionnaire (Lee & Federmeier, 2015). Written consent was obtained from all participants. No participants had participated in any norming studies (described below).

3.2.2 Materials

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Sixty-four unambiguous words, with equal numbers of nouns and verbs (henceforth N and V respectively), and 64 biased cross-class homographs were selected as target words in this experiment. Half of the homographs were VN homographs with verb meaning as the dominant meaning and the other half were NV homographs with the noun meaning as the dominant meaning. Henceforth, the first and the second capitalized letter for homographs indicated the syntactic category of the dominant and the subordinate meaning respectively. These Chinese disyllabic nouns and verbs that are word-class 'unambiguous' are used as that word class for over 90% of the time based on *Academia Sinica Balanced Corpus of Modern Chinese* (Academia Sinica Balanced Corpus, 2004). Conversely, if the word was not used as a certain word class for more than 90% of the time, the word would not be considered word-class unambiguous and would be excluded from the study. The two subtypes of syntactic category ambiguous words— NV-homographs and VN-homograph— were determined by rating (details are described in 3.2.3.). Examples of the stimuli and conditions could be found in Table 3.1. Contexts were established by one-word syntactic cues, which constructed either a noun- or a verb-context so that the appropriate meaning of the homograph could be well-specified. Noun-predicting cues included general classifiers (e.g., yīgè/一個/one), determiners (e.g., zhèxiē/這些/these), and possessive pronouns (e.g., tāde/他的/his), whereas Verb-predicting cues are adverbs (e.g., jíshí/即時/immediately).

NV- and VN-homographs appeared once after Noun-predicting cues and once after Verb-predicting cues across list. In other words, across list, each homograph appeared both in the dominant-biasing context as well as the subordinate context. These phrases were then split into two lists. Across the two lists, homographs appeared either as a noun and a verb, while unambiguous words appeared in the same syntactically appropriate context. Within each list, there were equal numbers of nouns and verbs across the

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homograph and unambiguous word sets so as to eliminate possible word-class influences on the ambiguity effect.

After a series of norming studies (described below), both syntactic cues and target words were matched across conditions within each list for lexical features (see Table 3.2). Participants were randomly assigned to one of the two experimental lists so that each participant saw each critical word only once in either dominant or subordinate context. Every participant read 128 minimal phrases in total, including 64 unambiguous trials, 32 dominant-biasing trials, and 32 subordinate-biasing trials. Trials were randomized within each list and presented to each participant in the same order.

Table 3.2. Mean values (with standard deviations in parentheses) of lexical features of the targets and cues for each condition in Experiment 1

Biasing Context		Unambiguous		Dominant-biasing		Subordinate-biasing	
Rating type		UN	UV	NV-homograph	VN-homograph	VN-homograph	NV-homograph
Number		32	32	32	32	32	32
Phrase	**Grammaticality** (1: very ungrammatical; 7: very grammatical)	6.4 (0.3)	6.3 (0.3)	6.3 (0.5)	5.7 (0.9)	5.3 (0.9)	6.0 (0.6)
Target	**Familiarity** (1: very unfamiliar; 7: very familiar)	5.9 (0.4)	5.9 (0.4)	6.3 (0.4)	6.0 (0.5)	5.4 (0.6)	5.6 (0.7)
	Concreteness (1: very abstract; 7: very concrete)	4.9 (0.8)	4.0 (0.7)	4.9 (1.3)	4.2 (1.1)	4.8 (1.0)	4.2 (1.0)

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	Meaning relatedness (1: very unrelated; 7: very related)	N/A	N/A	3.3 (1.1)	3.6 (0.8)	3.6 (0.8)	3.3 (1.1)
Cue	**Familiarity**	6.2 (0.4)	6.1 (0.5)	6.1 (0.6)	6.4 (0.4)	6.1 (0.8)	6.3 (0.4)
	Concreteness	4.0 (0.6)	2.8 (0.6)	4.6 (1.2)	3.3 (0.5)	4.4 (1.1)	3.2 (0.6)
Meaning frequency	**Contextual appropriate**	N/A	N/A	0.7 (0.1)	0.7 (0.1)	0.2 (0.1)	0.2 (0.1)
	Contextual inappropriate	N/A	N/A	0.2 (0.1)	0.2 (0.1)	0.7 (0.1)	0.7 (0.1)

3.2.3 Norming studies

Prior to the experiment, a series of norming tasks of subjective rating were conducted to ensure the appropriate manipulations of target words and contextual constraint. For one thing, any linguistic feature between the biased homographs and unambiguous words should correspond to one another. For another, the context should be constrained by the specific syntactic cues biasing toward either the dominant or the subordinate meaning of homographs in two lists respectively. As a result, five norming tasks— meaning dominance, meaning relatedness, familiarity, concreteness, and grammaticality judgement— were delineated as below.

After a variety of norming tasks, both syntactic cues and target words were closely matched across conditions globally and locally within each list for lexical features that have shown to affect psycholinguistic processes such as familiarity, concreteness (Lee & Federmeier, 2008) and grammaticality based on their rating values. Rating scores of each attribute across conditions are shown in Table 3.2, and ratings scores of each list can be

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found in Appendix A. Trials were randomized within each list and presented to each participant in the same order.

3.2.3.1 Norming study 1: Meaning dominance

The critical stimuli were adopted from the database of Chen (2014). Below we described the rating study conducted in Chen (2014) to determine the meaning dominance of ambiguous words. This part of the rating was not conducted in the present study. This norming study was designed to sift out appropriate Chinese biased ambiguous words of the two types (NV and VN).

Meaning dominance was defined in Chen (2014) as the probability that a particular meaning linked with the homograph itself is given as the first response in word-association norming tasks. Meaning dominance of 108 ambiguous words were determined by 40 participants whose native language were Mandarin Chinese. These Chinese disyllabic ambiguous words were collected from various resources, including *Dictionary of Homonyms in Modern Chinese* (Yuan, 2001), *Word association for 600 Chinese homographs* (Hue et al., 1996), *The influence of syntactic category and semantic constraints on lexical ambiguity resolution: An eye-movement study of processing Chinese homographs* (Chen, 2014), and *Academia Sinica Balanced Corpus of Modern Chinese* (Academia Sinica Balanced Corpus, 2004). All ambiguous words were divided into two lists and presented in a randomized order for 20 participants to rate either one. Examples of the questionnaire were provided in Appendix B.

Participants were instructed to read the target word on the questionnaires for the meaning that firstly came to mind and then were asked to make use of each target to generate a comprehensible sentence. Participants' interpretation of each word was then categorized according to the meaning listed in the two online resources: *Revised Chinese*

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Dictionary and *Chinese Wordnet (CWN)*. Meaning dominance of each target word was calculated as proportion of the meaning used in participants' responses. For example, if all participants generated their sentences based on the noun's meaning of an ambiguous word, the meaning dominance of this noun meaning of this ambiguous word would be 1. Based on these norming results, 32 NV-homographs and 32 VN-homographs were selected as critical words. Averaged values and ranges of the usage proportion (frequency of the meaning divided by 100) are listed below for the dominant and subordinate meanings for both NV- and VN-homographs respectively (see Table 3.3). Overall, the dominant interpretations of homographs were 3.2 more frequent than the subordinate ones in this study.

Table 3.3. Dominant/subordinate meaning frequency ratio for NV- & VN- homographs (with ranges specified in the parenthesis)

Meaning / Homograph	Dominant/subordinate meaning frequency ratio
NV	3.5 (0.04-0.96)
VN	2.8 (0.04-0.96)

3.2.3.2 Norming Study 2: Meaning Relatedness

Likewise, meaning relatedness of ambiguous words were rated in Chen (2014). Here we illustrate how this norming was done. The norming was not conducted in the present norming study.

The relatedness rating done in Chen (2014) followed the protocol used in Rodd et al. (2002), and aimed to ensure that the selected ambiguous words were homographs with two unrelated meanings. Twenty undergraduate and graduate students were paid to be the

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raters, all of whom were Chinese native speakers and had not participated in the meaning dominance rating.

108 biased homographs from norming study 1 were used to construct two comprehensible sentences for dominate and subordinate meanings respectively. A questionnaire was then constructed, in which the ambiguous words, meaning definitions, and the sentences were presented. Examples of the questionnaire were provided in Appendix C. Four lists were created with randomized word orders, and each was rated by five participants. Participants were asked to rate how related the two meanings were on a 7-point scale. (1= very unrelated, 7= very related).

Sixty-four homographs with meaning relatedness ratings less than 4 were selected based on the rating results. The results confirmed that the selected ambiguous words were homographs, with an averaged rating values of 3.3 and 3.6 for NV- and VN-homographs respectively (see Table 3.2); that is, the two meanings of the homographs were strongly distinct from each other. Therefore, these sixty-four ambiguous words were retained as the homographs with two distinct meanings and used as critical words in our experiment.

3.2.3.3 Norming Study 3: Familiarity

Extensive studies have indicated that familiarity was one of the influential variables in word recognition (Connine, Mullennix, Shernoff, & Yelen, 1990; Gernsbacher, 1984). Balota, Ferraro, and Conner (1991) also pointed out that it is quite possible for familiarity ratings to mask effects of other variables. Furthermore, both Gernsbacher (1984) and Gordon (1985) have found that subjective familiarity is more predictive of response speed than is printed word frequency. As a result, familiarity rating was a necessary task which aimed to ensure the equal frequency of our stimulus items. 120 undergraduate and graduate students were paid to participate in the norming study, and all were Chinese

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native speakers.

A total of 250 words, including 108 syntactically ambiguous words and 142 syntactic cues, were rated. Four lists were constructed to avoid the potential influences among different rating properties and word classes. To illustrate, participants might tend to compare the degree of familiarity for alternative meanings of a syntactic ambiguous word if the noun and verb usages are showed at the same time, it is not a fair way to rate each independent meaning. Therefore, the noun and verb usage is separated by different questionnaires, which have reversed versions as well. The first list was 108 homographs used as nouns (30 participants, 15 males; mean age 24.8 years), another was 108 homographs used as verbs (30 participants, 15 males; mean age 23 years), still another was 66 syntactic cues for noun contexts (30 participants, 15 males; mean age 23 years), and the final one was 76 syntactic cues for verb contexts (15 males; mean age 23.3 years). Participants of each list followed the instructions to rate each word on a 7-point Likert Scale, on which 1 means very unfamiliar and 7 means very familiar (instructions and sample items can be found in Appendix D). Unambiguous words were rated for familiarity in another study (Chen, 2016) using the same protocol (39 participants, 17 males; mean age 23 years).

According to the results, only the words (32 for UN, 32 for UV, 32 for NV-homographs, and 32 for VN-homographs) with rating values above 5 were selected as our stimuli. The mean ratings and SDs for each type of target words were shown in Table 3.2. As shown, there were no large differences across each type of the target words as well as cues.

3.2.3.4 Norming Study 4: Concreteness

This norming study aimed to match the concreteness not only for the syntactic cues

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but also for the target words across four types because it has been found in many studies that event-related brain potentials (ERPs) for concrete words show a long-lasting negativity relative to abstract words (Kounios & Holcomb, 1994; West & Holcomb, 2000; Huang, et al., 2010). Moreover, previous research has indicated that the most dominant meanings tended to be the most imaginable, concrete, familiar, and earliest acquired (Gilhooly & Logie, 1980; Nelson, McEvoy, Walling, & Wheeler, 1980; Twilley, Dixon, Taylor & Clark, 1994). Such ratings were typically collected by asking participants to rate the degree of concreteness of words on a 5- or 7-point Likert scale to ensure all of the stimuli were on the same basis.

In the present study, the materials for rating were the same as those in norming study 3. 108 syntactically ambiguous words and 142 syntactic cues were rated in total. Equal numbers of participants as those in norming study 3 were paid to be the raters. Concreteness ratings were obtained on a 7-point scale, on which 1 stands for very abstract, and 7 stands for very concrete (instructions and sample items can be found in Appendix E). All participants were asked to rate all syntactically ambiguous words as well as syntactic cues, and none of participants had taken part in rating across two word classes of a homograph at the same time. As the same consideration in norming study 3, four lists were generated as follows to avoid the interactive influences of other rating properties: (1) 108 homographs used as nouns (30 participants, 15 males; mean age 24.8 years); (2) 108 homographs used as verbs (30 participants, 15 males; mean age 23 years); (3) 66 syntactic cues for noun contexts (30 participants, 15 males; mean age 23 years), and (4) 76 syntactic cues for verb contexts (30 participants, 15 males; mean age 23.3 years). Unambiguous words had also been rated in Chen (2016) (39 participants, 17 males; mean age 23 years).

In Table 3.2, the rating values of all targets words were around 4, with slightly higher

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rating for nouns than for verbs. In fact, it was not unexpected that nouns in general would be rated as more concrete than verbs, as words related to objects, materials, or persons would receive a high concreteness rating, while words referring to abstract concepts which were less likely to be experienced by the senses tend to receive a low concreteness rating (Paivio, Yuille and Madigan, 1968). However, as we have equal numbers of nouns and verbs for both unambiguous and ambiguous words, overall concreteness values were matched among the unambiguous, dominant-biasing, and subordinate-biasing conditions.

3.2.3.5 Norming Study 5: Grammaticality judgement task

The norming study was conducted to ensure all the phrases made up from the syntactic cues and target words (see Table 3.1 for examples) were all grammatical. Critically, in order to compare the ambiguity effect between homographs and unambiguous words, it was important to reduce contributions from confounding factors that may create responses differences between these conditions.

A total of 120 minimal phrases comprised of syntactic cues and target words were all combined into grammatical phrases for grammaticality judgement, including 54 ending with homographs used as nouns, 54 ending with the same homographs used as verbs, and 12 implausible fillers. The grammaticality judgement of all unambiguous words had been rated in Chen (2016). These paper-and-pencil normings were completed by 60 native speakers of Mandarin Chinese (30 males; mean age 23.5 years, range 18-30 years).

Two experimental lists were generated to allow homographs to be shown in both dominant-biasing and subordinate-biasing contexts, with each participant seeing each critical word only once. Thirty participants completed one list (30 males; mean age 23.9 years, range 19-30 years) and another 30 completed the other (30 males; mean age 23.2 years, range 18-28 years). Participants were asked to rate the grammaticality of each

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minimal phrase with a seven-point Likert Scale on the basis of the instructions on the questionnaire, where 1 indicates very ungrammatical and 7 indicates very grammatical (instructions and sample items can be found in Appendix F).

Results showed that, the average grammaticality scores not only obtained above 5 across four types of target words, but also matched locally between each type of syntactic ambiguous words (see Table 3.2).

3.2.4 Procedure for the ERP session

Participants were seated 100 cm from the computer screen in a quiet testing room. The experiment began with a written instruction along with an 8-trial practice session for the purpose of familiarizing subjects with the task and the experimental environment. The trial procedure is shown in Figure 3.1. At the beginning of each trial, a plus sign appeared in the center of the computer screen for 500 ms to announce an upcoming word pairs. After a stimulus onset asynchrony (SOA) ranging randomly between 1000 and 1500 ms, each syntactic cue appeared in the center of the screen for 200 ms. The offset of the cue was followed by a 300 ms inter-stimulus interval (ISI) and then the target word was presented for 200ms. After a 1000 ms blank from the offset of the target word, a message xiàyītí /下一題/NEXT TRIAL was presented centrally on the screen. The message remained on the screen for 2500 ms, and the next trial started after a delay of 1500ms.

The whole experiment was divided into 4 blocks, each lasting about 3.5 min. Participants were asked to finish a paper-and-pencil word recognition task at the end of each block to ensure they were focused during the experiment. The word recognition task consisted of 12 old phrases appeared in each block, as well as 12 pseudo phrases in which half were ambiguous phrases. Participants were asked to check off each phrase that they thought they had seen in the previous block.

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Two neuropsychological tests were conducted separately following the ERP recording session, including assessments of reading ability (Reading experience test: Acheson & MacDonald, 2008) and executive function (Verbal fluency test: Benton & Hamsher, 1978).

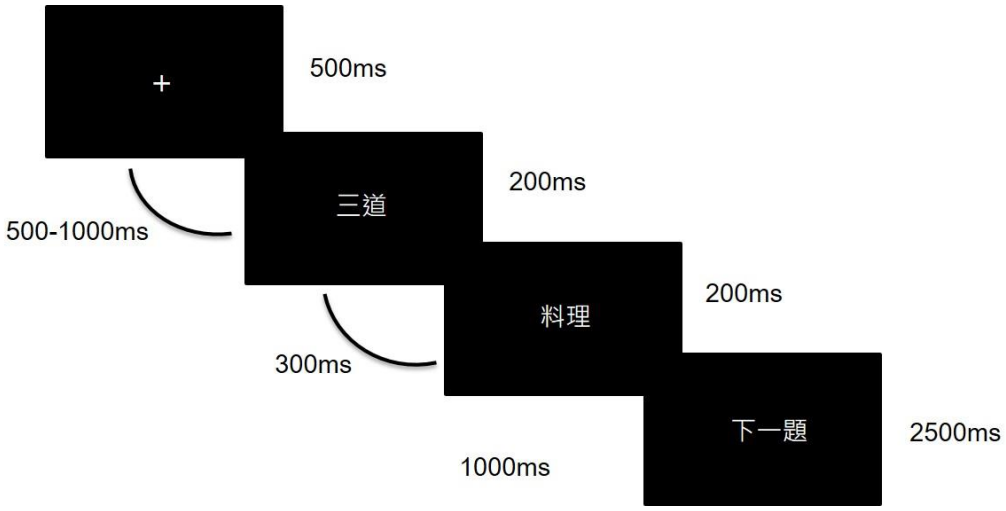

Figure 3.1. A diagram of trial procedure in Experiment 1

3.3 EEG recording parameters and data analysis

The electroencephalogram (EEG) was recorded using 32 sintered Ag/AgCL electrodes from the 10-20 system (QuickCap, Neuromedical Supplies, Sterling, TX, USA) (see Figure 3.2). All scalp electrodes were referenced to a common vertex reference located between Cz and CPz online, and re-referenced to the average of the right (M1) and left (M2) mastoids offline. Vertical eye movements were recorded via a pair of electrodes placed on the supraorbital and infraorbital ridge of the left eye, and horizontal eye movements were recorded via electrodes placed at the outer canthus of each eye in a bipolar montage. Impedance was kept below 5kΩ for all electrodes. The continuous EEG was amplified by the SYNAMPS2 amplifiers (Neuroscan, Inc., EL Paso, Texas, USA) with a bandpass of 0.05-100 Hz and digitized online with a 1000 Hz sampling rate.

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The EEG data were segmented offline into 1400 ms epochs, spanning 200 ms pre-stimulus to 1200 ms post-stimulus. Trials contaminated by artifacts from amplifier blocking, signal drifting, muscle activity, eye blinks and movements were rejected offline before averaging. The averaged ERPs had the baseline corrected over the 200 ms pre-stimulus period, and were digitally filtered with a band-pass of 0.1-30 Hz. Only corrected trials were included in the following analysis. Overall, trial loss due to artifacts and incorrect responses averaged 27%. For all participants there were at least 15 trials in each condition.

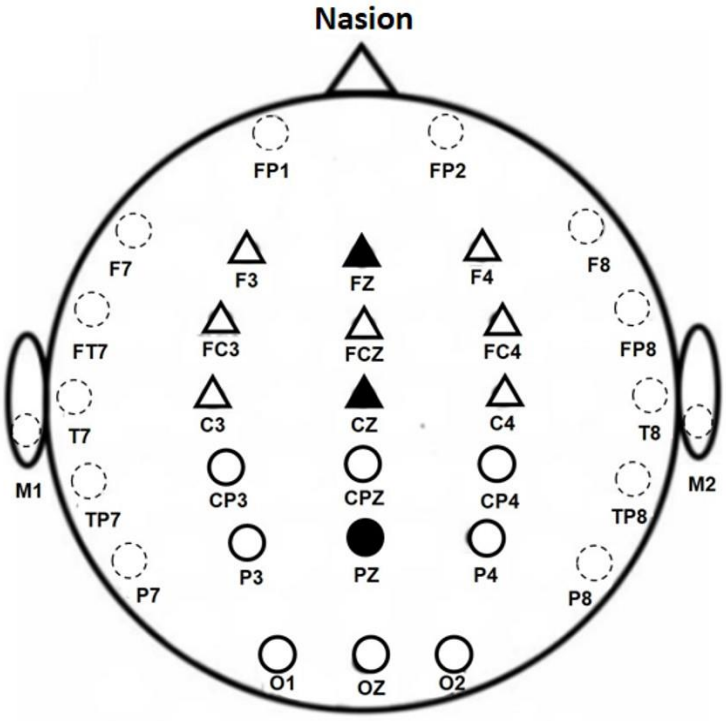

Figure 3.2. Shown are the locations of the 30 scalp electrodes on the QuickCap used in the present study. The electrodes used for statistical analysis are triangles for frontal electrodes, and circles for central/posterior electrodes. For those electrodes filled in shapes are used for showing the representative waveforms.

3.4 Result

Twenty participants took part in Experiment 1; all have at least 15 valid ERP trials in each condition. Data from these twenty participants are represented as follows.

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3.4.1 Behavioral data

Participants' overall accuracy rate for the word recognition task was 74.4% (SD = 0.07), As this is a very simple task, this relatively low performance suggest that participants might not be fully attending to the stimuli.

3.4.2 ERPs data

Figure 3.3 shows overall ambiguity effect that the ERP responses to unambiguous and ambiguous words at three representative midline electrode sites (FZ, CZ, PZ). An ANOVA with 3 levels of Ambiguity (UA vs. AAD vs. AAS) and 2 levels of Electrode site (anterior: F3, FZ, F4, FC3, FCZ, FC4, C3, CZ, and C4; central/posterior: CP3, CPZ, CP4, P3, PZ, P4, OZ, O1 and O2) was conducted on mean amplitudes of data measured between 250-900 ms after the onset of target words. Analyses were first performed on the overall ambiguity effect. There was no difference in mean amplitude response between 250-900 ms for AAD (ambiguous in dominant-biasing context) and AAS (ambiguous in subordinate-biasing contexts) as compared with unambiguous words [$F(2, 38) = 2.48$; $p = .09$]. To examine whether the ambiguity effect was modulated by biasing context, we then conducted a follow-up comparison. The result revealed the effect of Ambiguity was marginally significant only for the AAS (subordinate-biasing context) [$F(1,19)= 3.62$, $p=.07$], but not for AAD (dominant-biasing context) (p values=.89).

To know if this ambiguity effect manifests on two behavioral indexes, mean amplitudes between 250-900 ms were subjected to an ANOVA with 3 levels of Ambiguity (UA vs. AAD vs. AAS), 2 levels of Electrode site (anterior vs. central/posterior), and 2 levels of Group (high vs. low). The results showed a significant main effect of Ambiguity in reading experience test [$F(2,36)= 2.81$, $p=.04$], but not in verbal fluency test. We then conducted 2 ANOVAs within the high reading experience

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group. One with 2 levels of Ambiguity (UA vs. AAD) and 1 level of Electrode site (F3, FZ, F4, FC3, FCZ, FC4, C3, CZ, C4, CP3, CPZ, CP4, P3, PZ, P4, OZ, O1 and O2), and the other with 2 levels of Ambiguity (UA vs. AAS) and the same Electrode site. There is a significant main effect of AAS [F(1, 8) = 7.46; p = <.05], but not for AAD (p=.44).

Previous studies have shown a slow frontal negativity was observed for syntactically and semantically ambiguous words relative to their unambiguous counterparts beginning around 250 ms when preceding context provides well-specified syntactic information but very little semantic information (Lee & Federmeier, 2006, 2009, 2012) that indicated. As shown in Figure 3.3, the ERP responses were more negative to ambiguous relative to unambiguous words. The difference emerged at around 250 ms post stimuli onset and lasted to the end of the epoch.

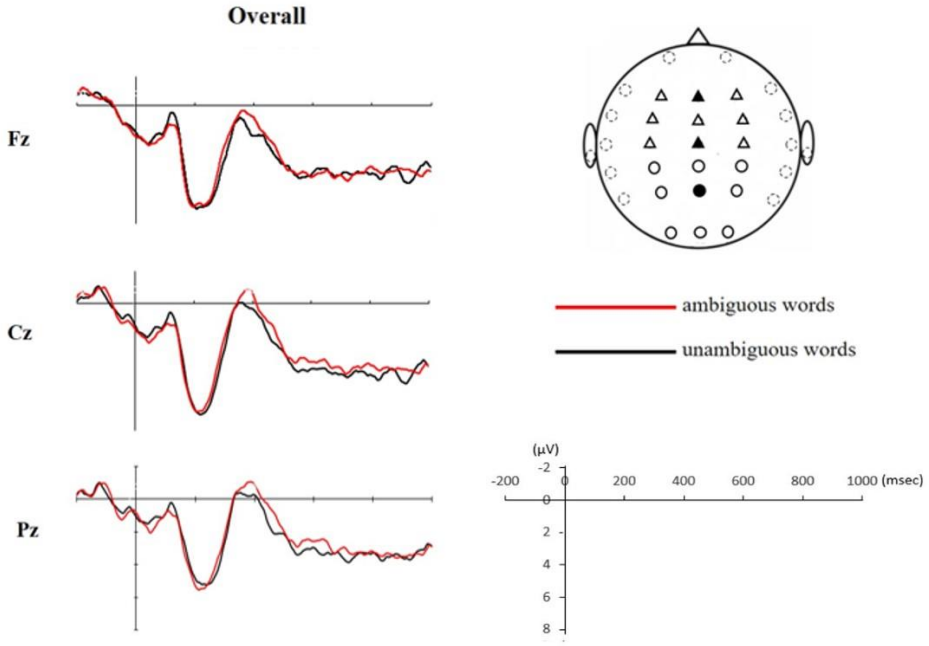

Figure 3.3. Grand average ERPs at three midline electrode sites for unambiguous words (black line) and ambiguous words (red line) in Experiment 1

Compared with the result that NV-homographs embedded in syntactically well-

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specified contexts elicited a sustained frontal negativity between 250 and 900 ms post-stimulus-onset in prior studies (Lee & Federmeier, 2006; Lee & Federmeier, 2009), the present study, however, displayed a relatively small effect. However, in Figure 3.4, the result of follow-up comparison showed that the slight frontal negativity was only in the subordinate-biasing context but not in the dominant-biasing context. The preliminary findings might correspond to our prediction that the preceding context indeed affects meaning access on Chinese biased homographs, and meaning dominance can interact with the syntactic context effect.

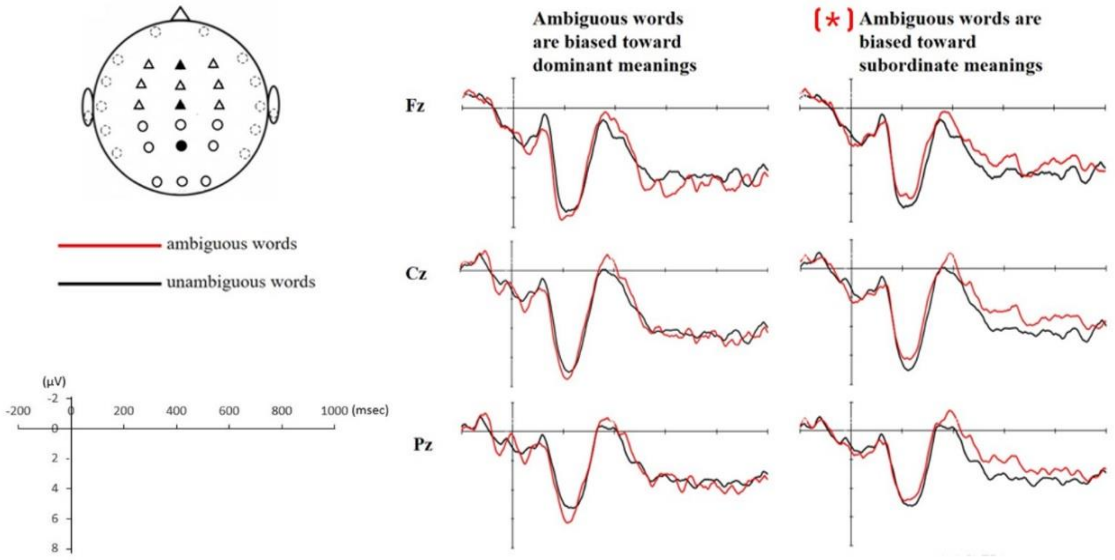

Figure 3.4. Grand average ERPs at three midline electrode sites for unambiguous words (black line) vs. ambiguous words (red line) when the context favors dominate meaning (left column) and subordinate meaning (right column) of the homographs in Experiment 1.

One possible reason is that the task used in this experiment was word recognition task, which did not require participants to integrate the syntactic context and the target word. In other words, participants could process these phrases as list of words. We will follow up on this in the second experiment reported in the next chapter.

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3.5 Interim summary and discussion

The result of Experiment 1 provides some implications to our research questions. We found a hint of the frontal negativity effect. However, the effect was much smaller compared to those reported in past research in English. Tanner et al. (2018) pointed out that grand mean ERP waveforms may not always reflect the central tendency of the population, despite the statistically reliable effects. According to their standpoint, it is possible that the grand mean waveforms are subjected to topographic or temporal distortion. Since previous experiments also revealed that the score on verbal fluency is linked with the effect pattern, we thus look into individual data on the basis of the neuropsychological performances. Intriguingly, such typical ambiguity effect was clearly seen on the majority of subjects with high score of reading experience. This result, on the one hand, provides a preliminary support for the view that the interpretation of ambiguous words can be influenced by experience (Rodd et al., 2016, 2013). On the other, it might explain the inference from the grand average data might be illusions of overlapping different ERP effects behind and thus gave rise to the unrecognizable ambiguity effect in grand-average waveforms across all participants.

After reexamining the data on the basis of high score group of neuropsychological tests, we found the prevalent negativity across the scalp when the context selected the subordinate meanings of the homographs. When the context favored the dominate meanings of the homographs, the ambiguity effect was relatively insignificant, which might denote the dominant meaning of the homographs are more likely to be processed as unambiguous words. Consequently, the meaning activation began earlier around 400-500 ms and needed not to sustain for long as compared with the subordinate meaning of homographs which involved in a meaning selection. Perhaps it provides some evidence

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for the view that meaning dominance indeed exert influences on lexical ambiguity resolution.

On the other hand, the comprehension task— word recognition task— used between blocks in present experiment might be the possible reason causing such a relatively slight effect. In fact, prior studies applied a semantic relatedness judgement task to facilitate participants to process the meaning of the whole phrases. In comparison, the word recognition task needed not to integrate the syntactic cues and the target word; instead, it could be done by recalling the target words. It seemed to increase participants' burden on memory load rather to help integrate the visual information. Since the accuracy rate of the task was also significantly lower, word recognition task might not be that ideal as we thought.

To make the above-mentioned potential factors clear, we began to do following follow-up studies like analyzing the individual data by grouping the items based on median split of behavior indexes, modifying the experiment by replacing another online comprehension task. we attempted to look for if these factors really make impacts on the result.

3.6 Follow up analysis: Inter-individual variability analyses

In view of inter-individual differences observed in past research (Lee & Federmeier, 2012), we also set out to explore the individual differences in the overall ambiguity effect across all participants. Figure 3.5 plots the mean amplitude differences during a typical time window for the frontal negativity effect (250-900 ms) post stimuli-onset at a representative channel (FZ) for each participant. This analysis revealed a great amount of individual variation within the interested window, with approximately half of the

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participants exhibiting an extended negativity and half a positivity, resulting in the cancellation of a significant overall main effect.

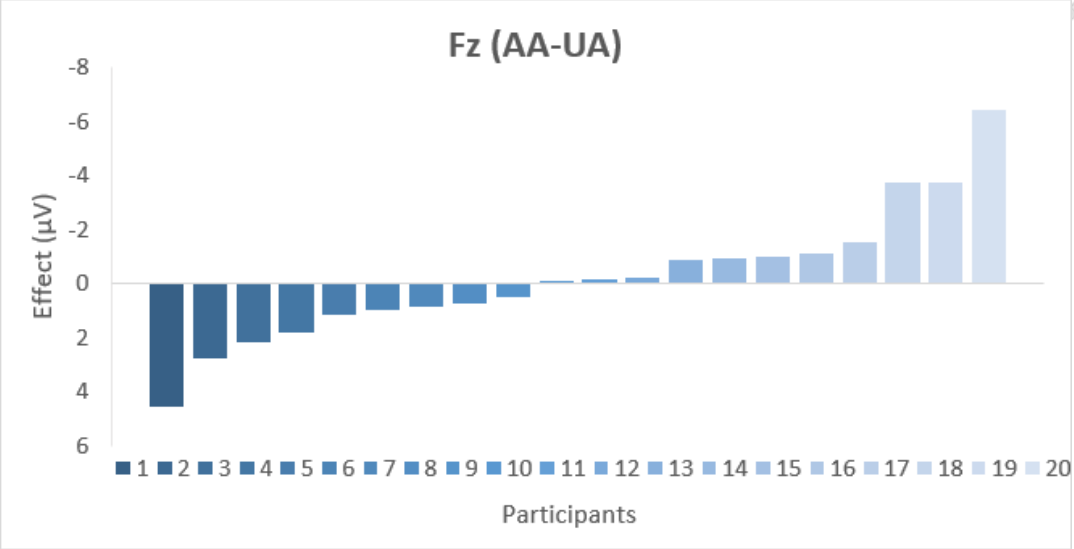

Figure 3.5. Effect sizes per participant for ambiguity manipulation at the representative frontal channel (Fz) within 250-900 ms.

To try to account for the source of individual variations, we analyzed the inter-individual variation depending on several neuropsychological indexes. According to past work, the effect patterns might differ due to participants' cognitive abilities. Verbal fluency test, for instance, has been widely assessed to measure verbal ability including lexical knowledge and lexical retrieval ability (Cohen et al., 1999; Weckerly et al., 2001; Federmeier et al., 2010) and executive control ability (Henry & Crawford, 2004; Fitzpatrick et al., 2013). Some related research has also indicated that better performance on verbal fluency is linked with greater amount of frontal negativity elicited by homographs (Lee & Federmeier, 2011). Motivated by previous findings, we attempted to look at group averages based on a median split of participants' neuropsychological performance to examine if the unapparent overall ambiguity effect was derived from the individual differences.

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Two neuropsychological tests were conducted in this study— reading experience assessed by an author and magazine recognition questionnaire and verbal fluency. As a first step to explore the possible influence of these two types of cognitive abilities, participants were divided into high and low score groups which was created by means of median-split method (see Figure 3.6). The means of low and high score groups in reading experience test were 28% and 51% respectively. For verbal fluency test, the mean of low score group was 105.2 and 140.7 for high. We grouped the ERPs according to the high/low group of two neuropsychological tests and observed relations between the brain responses and the cognitive abilities (see Figure 3.7 & Figure 3.8).

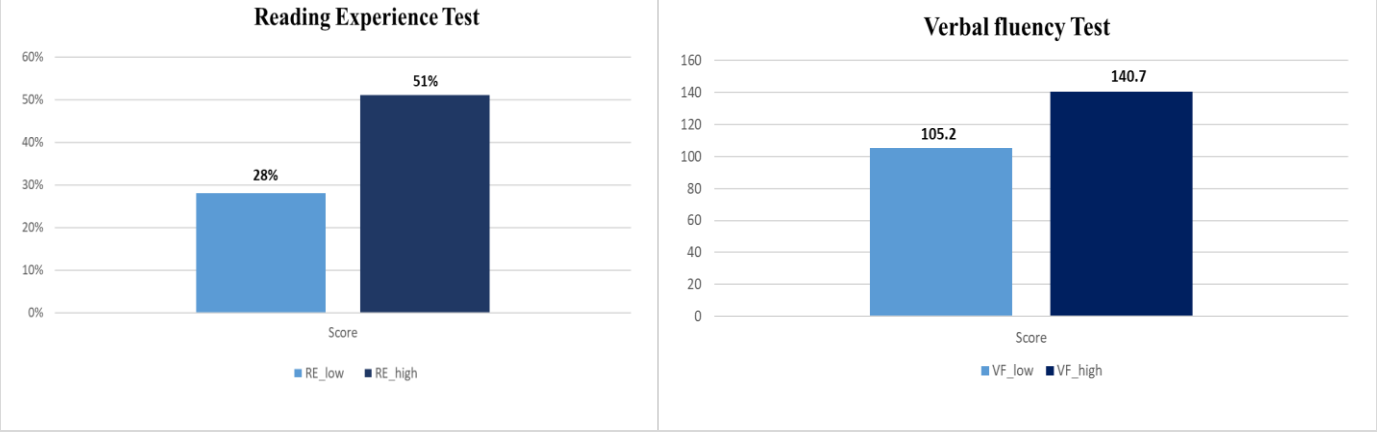

Figure 3.6. High/low score group based on a median split for two neuropsychological tests across twenty participants

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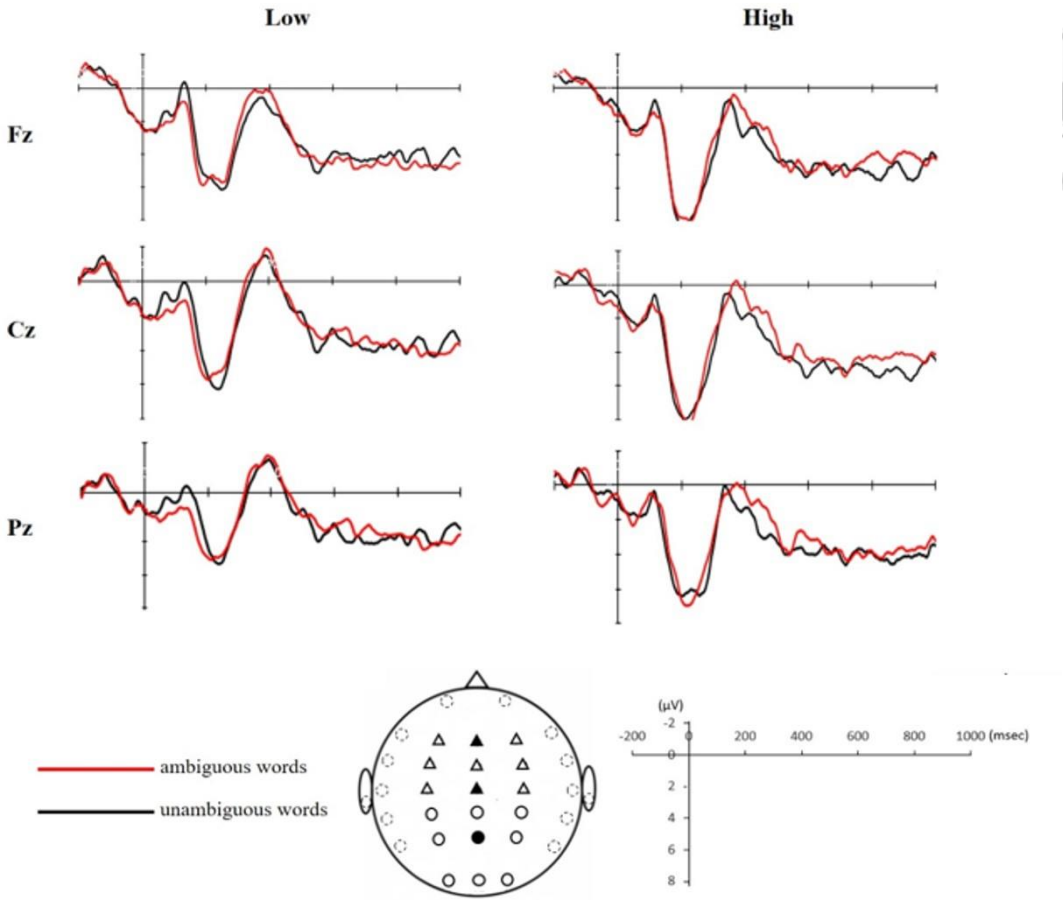

Figure 3.7. Grand average waveforms to ambiguous words (red line) and unambiguous words (black line) of the low and high score group for verbal fluency test are plotted at 3 representative midline electrode sites (Fz, Cz, and Pz) to observe the overall effect. There is no statistical significance between ambiguous words and unambiguous words in each group.

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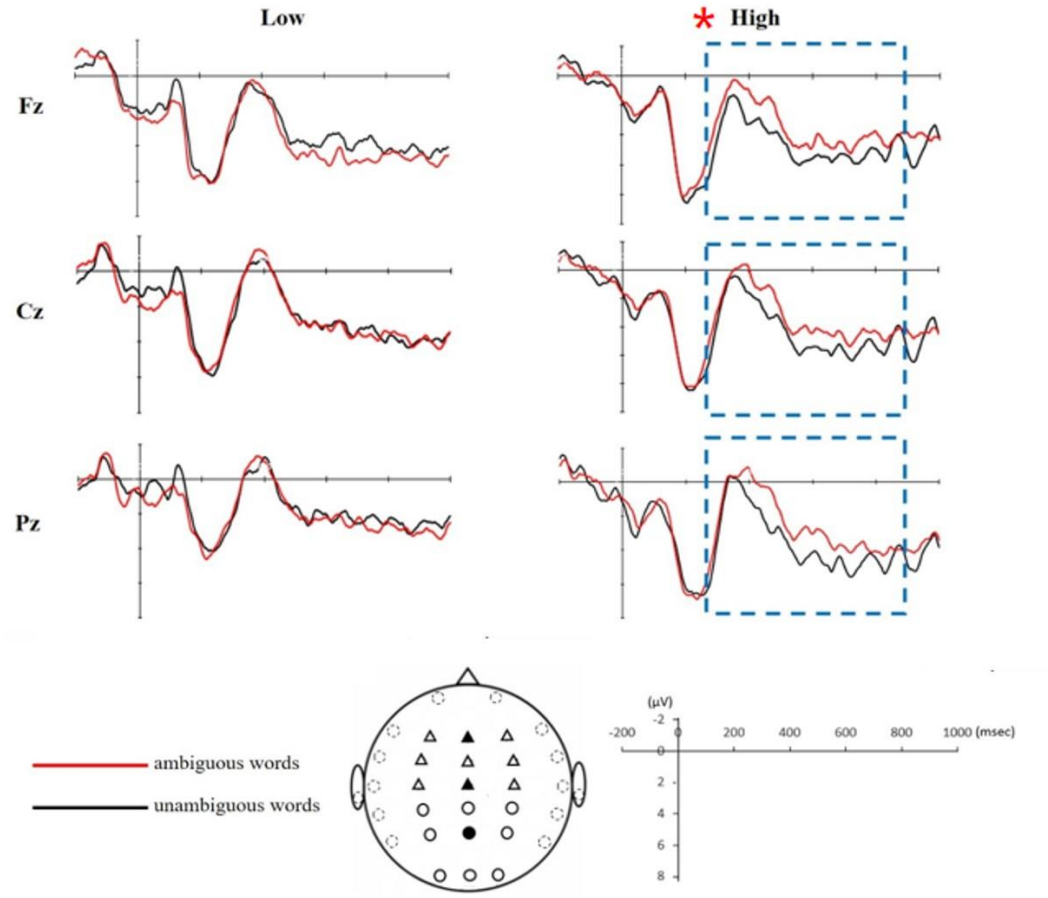

Figure 3.8. Grand average waveforms to ambiguous words and unambiguous words of the low and high score group for reading experience test are overlaid at 3 representative midline electrode sites (Fz, Cz, and Pz) to highlight the overall effect. There is a prominent statistical significance ($p<.05$) in high score group, while there is no difference between ambiguous words and unambiguous words in low score group.

The results showed that higher score groups for both verbal fluency and reading experience showed more frontal negativity effect than did the lower score groups. However, the between group difference was particularly robust for reading experience. To inspect if the inter-individual variability did result from the relation with reading experience, we plotted a boxplot to compare the brain response of the high and low score group for reading experience test at a representative channel (Fz) (see Figure 3.9). It showed obviously that most subjects with higher score in reading experience were likely to show a negativity to ambiguous compared to unambiguous words over frontal channels, whereas most subjects with lower score were prone to elicit a relative positivity effect.

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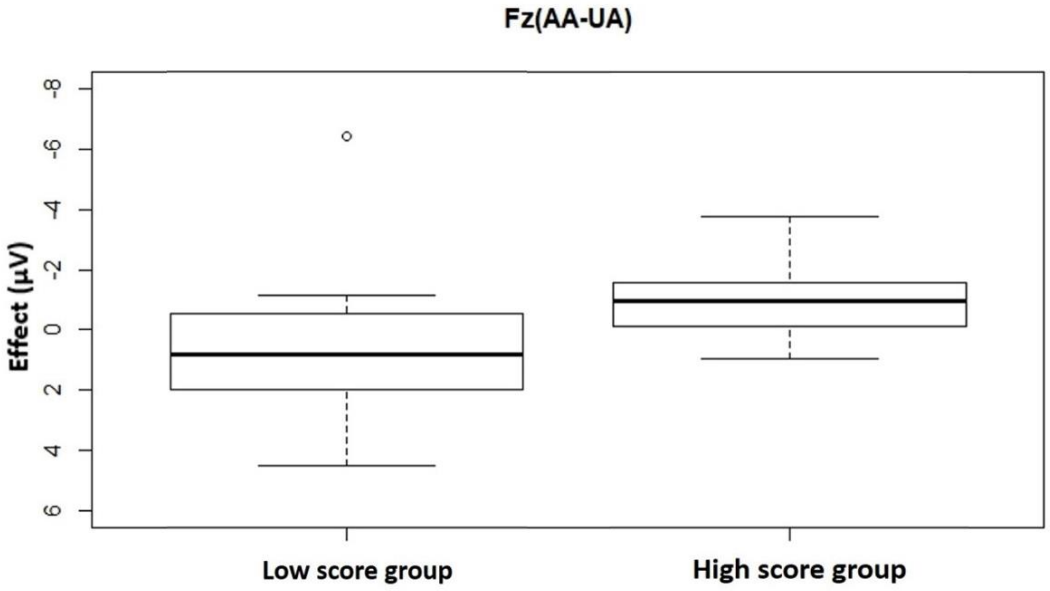

Figure 3.9. The boxplot plotted on the basis of the high and low score group for reading experience test at Fz to represent the brain response within two groups.

Motivated by this finding, we continue to investigate whether in the high score group of reading experience, these differences would be larger when the context biases the subordinate meaning of the homographs on the basis of the findings in Lee & Federmeier (2009). Figure 3.10 shows in the high group of reading experience, the waveforms to ambiguous vs. unambiguous words when the context favors dominate and subordinate meaning of the homographs, respectively.

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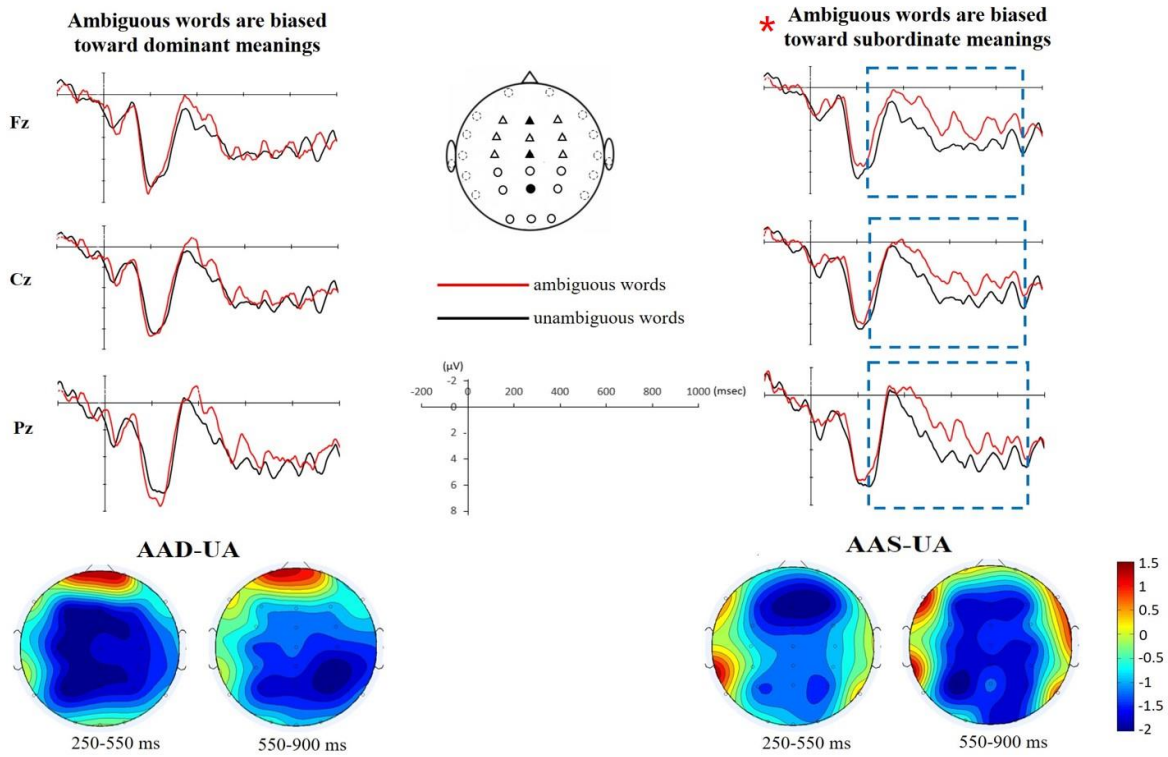

Figure 3.10. In the high group of reading experience, ERPs' responses at three representative electrodes of ambiguous (red line) vs. unambiguous words (black line) when the context favors dominate meaning (left column) and subordinate meaning (right column) of the homographs. The bottom four isopotential voltage maps show scalp distributions viewed from the top of the head for brain responses in both contexts in two time windows (250-550 ms and 550-900 ms). The statistical significance of the difference between unambiguous and ambiguous words is noted only in subordinate-biasing context. ($p<.05$) A clear contrast between groups shows that a notable frontal negative effect is elicited only in subordinate-biasing context.

In accordance with our prediction, in the high score group of reading experience, a robust sustained negativity was elicited when the context favors subordinate meaning of an ambiguous word. The effect was quite widespread, with the effect being only slightly larger in the frontal than in the central and posterior channels. In contrast, there is very little difference between unambiguous words and ambiguous words in the dominate-biasing context, except for the N400 effect.

3.7 Follow up experiment: Modification of experimental task

Two main questions were investigated in this modified experiment. To begin with,

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whether the weak frontal negative ambiguity effect to ambiguous words compared with unambiguous words in Experiment 1 was derived from the insensitive comprehension task was of pivotal importance. Therefore, we decided to substitute the online semantic relatedness judgement task used in Lee & Federmeier (2006) for the word recognition task used in Experiment 1 to enhance participants' attention so that they are more likely to process the cues along with the target words as phrases. For another consideration, participants in Experiment 2 were required to do both experimental lists to examine if there was a list difference which gave rise to such the disparate brain responses. We expect to observe a more robust effect as that in the previous studies with this modification.

3.7.1 Design and prediction

Design were identical with those used in Experiment 1 except that participants were asked to do a semantic relatedness judgment task instead of the word recognition task in Experiment 2. The semantic relatedness judgement task has been widely used to examine how target words are semantically represented in mind. Participant were asked to decide if the two phrases presented on the screen are related or unrelated in meaning. The purpose of this task was to require participants to integrate the syntactic cue and the target word to process the phrase as a phrase but not a pair of words. In so doing, we hope to encourage participants to interpret the meaning of the target based on the given context. In addition, this task can also help to ensure that the participants indeed attend to the stimuli. Also, as data analysis in Experiment suggest a possible role of list in explaining the individual difference, participants in Experiment 2 were tested with both experimental lists, with the order of lists counterbalance among participants.

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3.7.2 Method

Six right-handed young adults participated in this ERP experiment (5 females; mean age 22.4 years, age range 21-24) for cash. All were Chinese native speakers and have neither been exposed to other languages other than Taiwanese before the age of five nor had history of neurological or psychiatric disorders or brain damage. All participants were right-handed as measured by the Chinese translated version of Edinburgh inventory (Oldfield, 1970), with the mean laterality quotient being 0.81 (SD = 0.14 range = 0.6-1.0). No participants had known left-handed blood relatives, as assessed by a familial handedness questionnaire (Lee & Federmeier, 2015). Written consent was obtained from all participants. Participants were randomly assigned to one of the two experimental lists, and also, none had participated in any norming study.

Materials were identical with those used in Experiment 1. In addition, forty-two probes for semantic relatedness judgment were created. Half of the probe trials were semantically related to their target words, and the other half were semantically unrelated. The former was created on the basis of either the synonym or definition of a target word (e.g., sāndàoliàolǐ/三道料理/ three-CL dishes — sāndàocàiyáo/三道菜餚/three-CL meals), and words unrelated to any sense of the target words were obtained for the latter (e.g., fēichángbiànyí/非常便宜/very cheap — fēichángcōngmíng/非常聰明/very clever). In addition, probes always contained the same syntactic cue as that used in the immediately preceding trial in order not to draw extra attention to either word class or ambiguity of the words. All probes were well designed so that there were no trick questions.

Participants were seated 100 cm from the computer screen in a quiet testing room. The experiment began with a written instruction along with an 8-trial practice session for the purpose of familiarizing subjects with the task and the experimental environment. At

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the beginning of each trial, a plus sign appeared in the center of the computer screen for 500 ms to announce an upcoming word pairs. After a stimulus onset asynchrony (SOA) ranging randomly between 1000 and 1500 ms, each syntactic cue appeared in the center of the screen for 200 ms. The offset of the cue was followed by a 300 ms inter-stimulus interval (ISI) and then the target word was presented for 200ms. After a 1000 ms blank from the offset of the target word, a probe for a semantic-relatedness judgement followed one-third of the target words. Once the probe was displayed in phrase on the screen, participants needed to determine whether the phrase was semantically related or unrelated to the trial which had just preceded it and then to indicate their judgment with a button press, with "yes" for semantically related probe and "no" for semantically related probe. Respond hand for "yes" and "no" was counterbalanced across participants. The other two-thirds of the target words were followed by a message xiàyītí /下一題/NEXT TRIAL. Participants only needed to initiate the next trial by pressing either button while seeing the message xiàyītí /下一題/NEXT TRIAL on the screen. This screen lasted for 2500 ms, and the next trial started after a delay of 1500ms. The whole experiment was divided into 4 blocks, each lasting about 3.5 min. Figure 3.11 shows the trial procedure in Experiment 2. Participants were asked to do both experimental lists, and the order of lists was also counterbalance.

Two neuropsychological tests— reading experience and verbal fluency— were also conducted separately from the ERP recording session.

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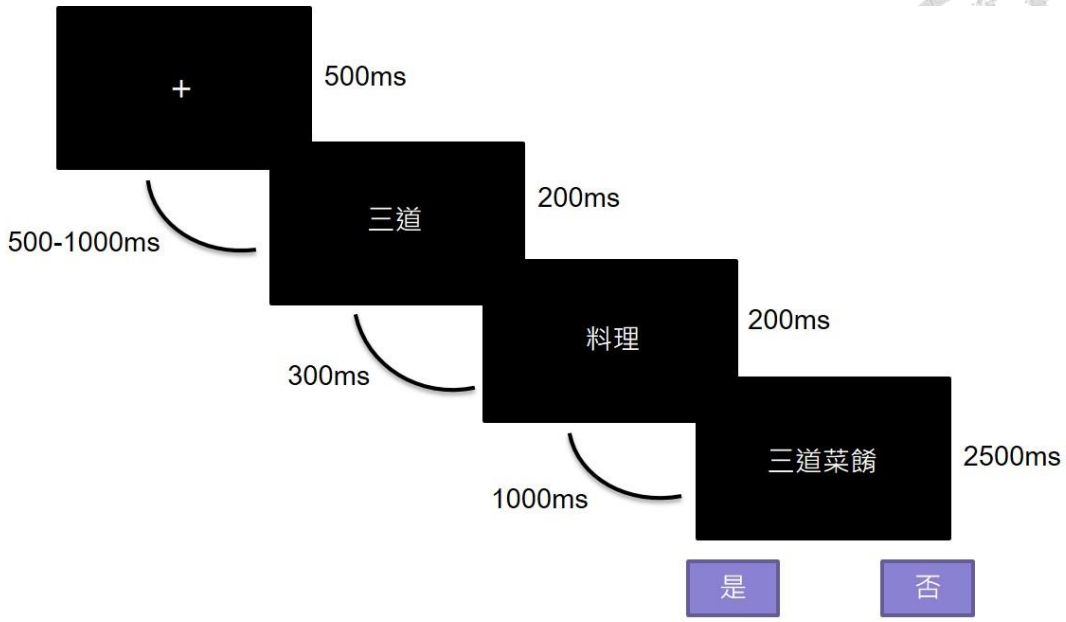

Figure 3.11. A diagram of trial procedure in Experiment 2

The EEG recording parameters and data analysis protocols were the same as in Experiment 1. Overall, trial loss due to artifacts and incorrect responses averaged 46%. Only datasets with more than 10 valid trials in each condition were included for further analysis. Four and six datasets were obtained from the first and second experimental lists. In total, 10 datasets from the participants were included in the following behavioral and ERP analyses.

3.7.3 Results of the first experimental list for each participant

Results reported below are from 4 participants who had enough trials for each condition for their first list.

3.7.3.1 Behavioral data

The mean and standard deviation of accuracy on the semantic-relatedness judgement task for each critical condition was: 96.66% (SD = 0.60) for the semantic related probe

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trials and 96.66% (SD = 0.90) for the semantic unrelated probe trials. In general, participants' correct response was much better than that in Experiment 1, suggesting that participants were more attentive in this study and were incorporating the syntactic cues to comprehend the meaning of the critical word.

The other two neuropsychological tasks, including verbal fluency and reading experience, were conducted off-line and both results were displayed in Table 3.4. For verbal fluency, the overall mean was 111.7 (SD = 23.69), and the overall mean for reading experience was 43.0% (SD = 0.07).

Comparing the neuropsychological performance across participants in Experiment 1 with that in Experiment 2, we found that the average scores of reading experience test was higher in Experiment 1 (Table 3.4). Moreover, even the lowest score in Experiment 2 fell on the high score group in Experiment 1. Based on the median division done in Experiment 1 (Table 3.4), these 4 participants are more comparable with the higher score groups in Experiment 1 for both verbal fluency and reading experience.

Table 3.4. Means and standard errors of two behavioral tasks in Experiment 1 and 2

Exp #	**Verbal fluency**		**Reading experience**	
	high group	**low group**	**high group**	**low group**
Exp. 1 (N=20)	140.7 (131-161)	105.2 (60-126)	51.0% (36.0%-66.0%)	28.0% (18.0%-35.0%)
Exp. 2 (N= 6)	111.7 (86-158)		43.0% (36.0%-52.0%)	

3.7.3.2 ERPs data

Grand average waveforms elicited by ambiguous words compared with unambiguous words were shown at Figure 3.12, in which middle and right columns show the waveforms in the dominant-biasing and the subordinate-biasing contexts.

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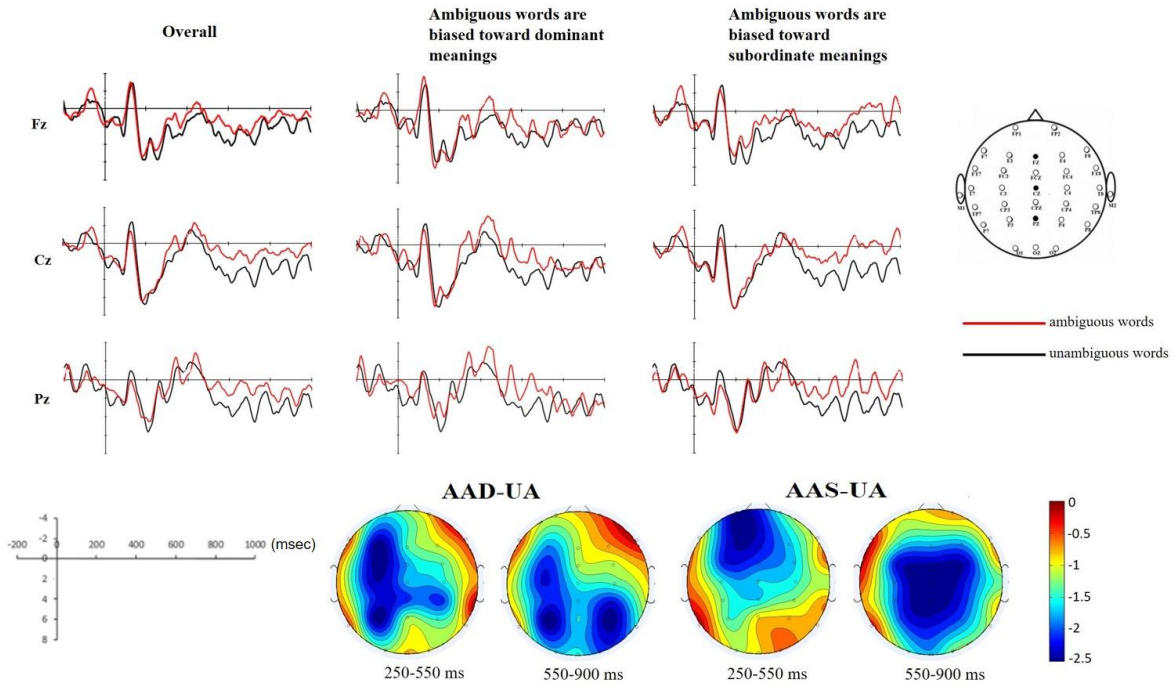

Figure 3.12 Grand average ERPs at three midline electrode sites for unambiguous words and ambiguous words in Experiment 2. The left-most column of the figure is the overall waveforms of ambiguous and unambiguous words, irrespective of meaning dominance. The middle column contrasts the brain responses to unambiguous vs. ambiguous words when the context biases to the dominant meaning of the homographs; the right-most column contrasts the brain responses to unambiguous vs. ambiguous words when the context biases the subordinate meaning of the homographs. Mean amplitude differences shown as isopotential voltage maps, whose distributions viewed from the top of the head for brain responses in two corresponding biasing contexts at middle and right-most columns in two time windows (250-550 ms and 550-900 ms).

Although the number of subjects is too small to yield a statistical analysis, a negativity ambiguity effect is still clearly visible in Experiment 2 (see Figure 3.12), and it is more robust than the overall ambiguity effect in Experiment 1 (see Figure 3.3). As these four participants all showed relatively high reading experience scores, the results here are consistent with findings in Experiment 1 that the ambiguity effect is likely to be shown in participants with high reading experience. The waveforms in Figure 3.12 show that when the context was biased toward the dominant meaning of the homograph, the effect emerged earlier and was less long-lasting only differed from around 300-800 ms,

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whereas when the context was biased toward the subordinate meaning of the homographs, a sustained negativity is observed in the frontal channel, but emerged later in posterior channels. is elicited till 1000 ms not only at frontal sites, but over central/posterior channels.

3.7.4 Within-subject comparison for potential list effects

We also took the opportunity to compare results of the two lists within each participants. Data from 4 participants with enough trials for both datasets are analyzed. The rationale is that if the individual variation we observed in Experiment 1 was due to participants' own processing difference, then we should expect to see similar trends across the two lists within each participant.

However, due to the limitation of the number of participants. The data were quite noisy and hard to interpret. Indeed, across the two lists, half of the participants shows the same tendency of brain response, while the other half shows the opposite tendency. The former matched up with our prediction that individual difference may manifest in both lists, but the latter, on the other hand, may be affected by the repetition effect, which results from seeing the same target words twice despite different phrasal usage, concluded in previous ERP literature. With relatively less participants, we could neither firmly assert nor deny the existence of individual difference.

3.8 Interim summary and discussion

Experiment 2 aims to demonstrate if the interpretation of ERPs can be complicated by individual differences which are not reflected in traditional analyses, and if such difference is derived from participants' reading experiences.

Identical to Experiment 1, the results in Experiment 2 also agree with the

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assumptions that the performance of reading experience might be the main factor rendering the individual difference and thus give rise to the waveforms in discrepancy. By comparison, the ambiguity effect in Experiment 2 becomes relatively obvious due to the higher scores of reading experience across all participants. Most importantly, the brain responses to ambiguous vs. unambiguous words when the context biases to the dominant and subordinate meaning of the homographs are respectively similar to the tendencies seen in Experiment 1. To be specific, a larger sustained negativity is shown when the context favors the subordinate meaning of the homographs. The larger and longer negativity might reflect the suppression of dominant meaning or the process of revising meaning selection, which takes much more loads and thus causes the prominent effect indexed by negativity, whereas when the context selects the dominant meaning of an ambiguous word, the processing was more like an unambiguous word therefore there is no need to make meaning selection heavily, the effect then fades away swiftly. Last but not least, the improvement of online task, to some extent, might also provide some help to the more significant result because of the much higher accuracy rate compared with Experiment 1.

with respect to the individual difference demonstrated within subjects by reading two experimental lists, the result is discussed as follows. A half of data were found individual difference due to the consistent tendency of brain responses across two lists, which indeed supports our assumptions. For the other half data shown a positive-going waveform while doing second experimental lists, which might result from word repetition effect of the target words. Past research conducted in the visual modality indicated that in comparison with unrepeated words, the ERP to repeated words is more positive beginning 250-300 ms, extending as late as 800 ms post stimulus (Bentin & Peled, 1990; Karayanidis el at., 1991; Rugg & Nagy, 1987). Since the participants were required to do

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two experimental lists, in which the target words were represented twice in spite of different usage. Repetition of target words led to a positive-going waveform so that the opposite-direction brain response elicited in the second experimental list therefore seems not to be that unreasonable. Yet, more data should be counted in in the future in order to examine the proposition since it is simply a preliminary investigation with a few participants.

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Chapter 4 General discussion

The aim of this preliminary study is to investigate whether the syntactic context information alone is able to determine the lexical ambiguity resolution in Chinese biased homographs and whether meaning dominance exert an influence during the processing. In Experiment 1, using a semantically-impoverished but syntactically-biased preceding context— syntactic cues, we found that there was no robust negativity within the interested time window (250-900 ms) on the grand average waveform as prior research. Instead, a sustain negativity was observed in the high score group of reading experience after analyzing by groups. In Experiment 2, we used the same constraint and a substituted online task to improve participants' focus. The grand average waveforms displayed a significant negativity initially, but the same pattern within two experimental lists was only shown on half of participants. The result across this pair of experiments, however, only partially supported the finding in Lee & Federmeier (2009) since we found some potential factors such as individual characteristics of participants which may play a role in the elicitation of the frontal negativity.

4.1 Individual difference analyses

Our results showed that inter-individual variation plays a large role in the elicitation of the negativity. There is growing evidence from the ERP literature that brain responses associated with language processing can vary qualitatively across individuals, and even the typical brainwave components like N400 and P600 have been substantially manifested to have qualitative individual differences. In fact, it is possible for ERP effects presented in grand mean waveforms to be interfered by systematic distortion of the signal during averaging process (Tanner et al., 2018).

For example, Nakano at el. (2010) demonstrated that qualitatively different brain

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responses were shown between listeners with high or low working memory span when comprehending simple active sentences. They found in the contexts of animacy violations of grammatical sentences (e.g., *The box is biting the mailman*), N400 was elicited at verb in low working memory span subjects, yet a P600 was elicited in high working memory span ones. Similar report also indicated that unexpected words during sentence comprehension trigger a tradeoff between the two qualitatively distinct brain responses reflected in the N400 and P600 components of the ERP, and this tradeoff was constrained by individual differences in verbal working memory capacity (Kim et al., 2018). Such findings conclude that individual differences may be crucial to language comprehension.

Individual variation in patterns of language-related ERPs has not only been inspected from several aspects but also been unveiled qualitative individual differences from some sorts of behavioral measures. In particular, the variation in syntactic processing is associated with one's proficiency in grammar and vocabulary, whereas the processing of conflicting sentence was related to individual differences in cognitive control. Still more studies asserted that individuals' cognitive styles could delineate ones' social information processing. With respect to the disambiguation, Nieuwland and Van Berkum (2008) conducted event-related brain potential (ERP) study to examine the interplay between semantic and referential aspects of anaphoric noun phrase resolution in Dutch stories, indicating that some participants elicited an unexpected LPC to three types of problematic anaphors (ambiguity, incoherence, and ambiguity/incoherence) while others did not. Their result suggested that large individual differences exist and people differ in comprehension processes. Lee and Federmeier (2012) examined how aging affect the processing of ambiguity resolution by comparing ERP responses to homographs and unambiguous words in context which had only syntactic but semantic- neutrally information (e.g. plausible sentence: "*Ben tried the duck in the dish prepared by a famous*

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chef." vs. implausible sentence: "*Ben tried to duck in the dish prepared by a famous chef*.") The result revealed that a frontal negativity showed not only in the young adults but also those older adults who had high verbal fluency, indicating the older adults who have better cognitive abilities can display more young-like ERP patterns within the same task. Depending on the studies, it is therefore reasonable to infer the absence of frontal negativity observed in our data might be modulated by individual differences in participants' scores on neuropsychological tests since the individual waveforms indeed showed a half negative-going and other half positive-going ERPs at frontal sites. In order to examine the effects of individual differences within the target epoch, we looked into the ERPs based on the following individual difference measures.

Beginning with the inspection of verbal fluency, which is assessed in letter and category fluency tasks, the performance on these tasks is related to indicators of vocabulary size, lexical access speed, updating, and inhibition ability. It is well-accepted that individuals vary in their verbal fluency performance, and that this variability can have implications for language processing (Just & Carpenter, 1992; Cohen et al., 1999; Weckerly et al., 2001; Federmeier et al., 2010; Henry & Crawford, 2004; Fitzpatrick et al., 2013). Past work asserted that the ambiguity effect patterns were more likely to correlate with the performance in the fluency tasks (Lee & Federmeier, 2011). Evidence from clinical studies has also demonstrated that damage to frontal brain areas is associated with poor performance in the fluency tasks (Schwartz & Baldo, 2001). Surprisingly, our study yielded different ERP results which conflicted with the behavioral findings. To illustrate, the frontal negativity was nearly no significance in the high score group of verbal fluency, whereas the negativity was far clear to observe in the high score group of another index— reading experience. According to cognitive neuroscience literature on reading experience, individuals' overall meaning preferences can reflect their reading

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experience across a wide range of timescales even from minutes to years (Rodd et al., 2016). Some research also suggest that lexical-semantic representations are not fixed as previously thought, but very malleable and dynamic. More specifically, those who are equipped with highly reading skills not only being good at learning new meanings for previously unambiguous words, but being adept at updating their representations of word meanings based on their current linguistic experience (Rodd et al., 2013). Such ability, likewise, manifests on the ambiguous words. Using a word-meaning priming paradigm, Rodd et al. (2016) conducted four experiments to demonstrate how previous and recent reading experience influence word meaning accessibility and found that the interpretation of ambiguous words was influenced by experience that recently encountered meanings become more readily available. These works, to certain extent, may provide an explanation that the effect only prominent in the high score group of reading experience. By comparison, skilled language comprehension depends on the ability to disambiguate the precise meaning of individual words to build an accurate representation of the intended message. Once one has more chances to disambiguate information, it therefore qualifies themselves for better reading ability. Those who are good at reading might also show a greater sensitivity to the limited information context when processing ambiguous words, and might be more likely to possess advantage in the mechanism of meaning selection. The view proposed by Gernsbacher (1993) that less skilled readers are less effective in meaning suppression and tend to maintain activation of contextually-irrelevant meanings for a long may support the result as well. However, this result does not mean that verbal fluency task is not a good indicator. Prior study has pointed out that better verbal fluency performance is associated with greater amount of frontal negativity elicited by the older adults (Lee & Federmeier, 2011). Since our participants were all young adults, perhaps, the overall high verbal fluency scores across all participants was

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relatively unable to show a notable difference under this indicator. We can merely speculate that the present group differences are not reflected on the indicators as previously. Perhaps, only if the score of verbal fluency is below a certain threshold, it will then exert an impact and interference on the ambiguity resolution.

4.2 Effects of meaning dominance

According to our individual data, the ambiguity effect was finally observed in the high score group of reading experience. However, the effects on dominant-meaning and subordinate-meaning biased contexts seemed to show two sorts of electrophysiological patterns, which are elaborated as follows.

To begin with, as pursuing the waveforms further by dividing ambiguous words into two conditions on the basis of whether the contextually appropriate interpretation of the NV-homograph was or was not its dominant meaning, we found the N400 effect was elicited on both conditions. N400 amplitude has been considered a component linked with semantic access, and has widely proven to be a reliable and consistent measure in the processing of meaning (Kutas & Hillyard, 1980; Kutas & Federmeier, 2011), such as semantic anomaly and concreteness effect. In addition to control the similar value of each linguistic feature across conditions like concreteness and familiarity, in present study, we served only the syntactic contextual information but not semantic. The N400 amplitudes, accordingly, were driven by the meaning dominance of target word itself, and seemed differ from that in previous study. A large body of literature has addressed N400 effects do not seem to be sensitive to the presence of semantic competition (Federmeier, Wlotko, De Ochoa-Dewald, & Kutas, 2007). Lee & Federmeier (2012) embedded noun/verb homographs and matched unambiguous words in the middle of sentences that is syntactically well-specified but semantically neutral to further investigate the underlying

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neural correlates and the functional role of the frontal negativity, claiming an enhanced N400 amplitude was reflected on the implausible words. Nevertheless, with only syntactic constraints, all phrases are quite plausible via grammaticality judgement task in present experiment. We supposed that the N400 on the dominant meaning of homographs vs. unambiguous words came from the initial meaning access. With a dominant-biased preceding context, it is possible that the N400 effect on the dominant meaning of homographs is simply a reflection of meaning activation of dominant meaning only with nearly no meaning competition and thus select the appropriate meaning under the support of advanced meaning dominance.

Comparing the difference pattern between the dominant meaning and subordinate meaning of the homographs, we found when processing is relatively easy, as when accessing the meaning of unambiguous words or the dominant meaning of the homographs, only the N400 displayed in a very short period of time. transient frontal effect which reveals a relatively slight meaning competition. By way of contrast, apart from the N400 effect, when the context favored the subordinate meaning of the homographs, the negativity was more significant and sustained till around 1000 ms post-stimulus onset. To be more specific, in the cases in which the context is biased toward the dominant meaning of a homograph, lexical processing seems to be much similar to that of unambiguous words. Such meaning access was simple straightforward and rendered the absence of sustained negativity followed by N400, revealing it is unnecessary to create the kind of selection demand here. On the other hand, when the context is biased toward the subordinate meaning of homographs, not only did the N400 show up, but also a more distinguishable negativity sustained longer. Although the N400 was supposed to be larger than the dominate meanings of the homographs, the amplitude might be attenuated by the succeeding sustained negativity effect, which is also the convincing evidence that a fierce

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selection mechanism between dominant meaning and subordinate meaning is undergoing. Such process is related to the suppression and inhibition of dominant meaning so that it would be more enduring and strenuous and need to involve in much more resources to help disambiguation. And, the attenuated N400 on the subordinate meaning of homographs may be the result of offsetting by the succeeding wider and longer-lasting negativity.

Furthermore, the result might provide a novel view for the absent subordinate bias effect (i.e., SBE) for NV-homographs in the finding of Folk and Morris (2003). Using eye-movement recording, Folk and Morris (2003) compared the eye-fixation times on syntactic category ambiguous (SCA) words in sentence reading. They asserted that such classical effect was only observed on NN-homographs, but not on NV-homographs, and thus concluded syntactic-category information could mediate the ambiguity resolution. However, the argument still remained unclear since SBE was indeed observed in second-pass times and in the post-target region for SCA words, suggesting a delay of meaning competition. Depending on our result, it may explain, firstly, syntactic information alone is unable to resolve ambiguity, the absent SBE on NV-homographs is only delayed. Second, the sustained negativity seen in the context biased toward the subordinate meaning of homographs might be the evidence of the delayed meaning competition in eye-tracking study. As concluded by Pickering and Frisson (2001), in comparison with the meaning of noun, the meaning of a verb takes more time to access and reach a high level of activation. Therefore, it is also possible that the processing difficulty of a verb meaning gives rise to a delay of meaning competition between the alternative meanings, but is manifested on the sustain negativity in our result.

4.3 Limitations and future research

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Given that the variability was inconsistent with the most possible behavioral factors suggested in the previous literature, most of which compared the cognitive abilities between young adults and older adults, there may be more individual factors accounting for the inter-individual variation in young subjects on ambiguity effect. Future ERP studies investigating lexical ambiguity resolution processing could take this variation into account when attempting to elucidate the nature of the individual differences by obtaining participants' additional individual behavioral measures such as measures of cognitive style or vocabulary size. Meanwhile, to augment the sampling size is also beneficial to certify the existence of individual variation.

In addition, as we attempted to demonstrate if individual difference on reading experience did work in Experiment 1, in the second experiment, all participants with better performance on reading experience were required to do two experimental lists to attest the supposition that the brain responses to two homogeneous experimental lists remained the same within individuals. The result showed that half participants indeed performed the same brain responses, except for two participants who represented inconsistent brain responses— negative-going waveform for the first list but positive-going for the second list. Though the result is out of tune with our prediction, it is not strong enough to overturn our supposition, either. More specifically, a number of studies have examined the effects on the ERPs elicited by words in lists, showing several distinct components are sensitive to repetition (Petten et al., 1991; Rugg, 1985). Such as N400, relative to new words, its amplitude will be reduced in all of the repetition conditions like texts or lists. LPC repetition effect, another related component, has been considered persisting across much longer repetition lags than the N400 in word list experiments (Rugg & Nagy, 1989). More relevant studies have also concluded that the ERP to repeated words is more positive beginning 250-300 ms, extending as late as 800 ms post-stimulus

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(Bentin & Peled, 1990; Karayanidis el at., 1991; Rugg & Nagy, 1987). Obviously, all time windows above-mentioned almost overlaps with the window of the ambiguity effect. Given that literature suggested that the repetition-sensitive ERP components are positive-going, it is hardly surprising that later presentation of the same word will perform the sort of positivity. Yet, here we do not tend to discuss the effect in detail. With less participants, we could merely provide a tentative supposition with respect to the inconsistency within individuals.

Another potential factor which drives the difference in lexical ambiguity resolution results of this study might be the linguistic properties. In comparison with English or Dutch, Chinese has a relatively impoverished agreement system, relying much more on semantic context information to assign interpretations, rather than structural information which may either be missing or unreliable. To be more specific, the word class and syntactic dependency is largely defined by lexical knowledge of the word itself as well as its surrounding words instead of those overt morphological markings as in Indo-European languages. Besides, of particular linguistic feature in Chinese is that most adverbs come from the extended usage of adjectives. For example, "*jízhe/急著/imminently*" was used as a syntactic cue for the verb usage of the ambiguous word "*guàhào/掛號/register*". Yet the adverbs "*jízhe/急著/imminently*" might bring some semantic information since it is transferred form the core meaning of the adjective "*jí/急/rapid*". In a word, what should be concerned is— whether the syntactic cues completely rule out the semantic information and whether the participants indeed processed the materials in 'syntactic way' without any influence of the semantic information. To reconsider the characteristics of Chinese words might help us to validate the effects observed in the present study.

Last but not least, there is still room for discussion on the effect of dominant- and subordinate-biasing context. While the sustained frontal negativity was prominent in

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subordinate-biasing context, the effect of dominant-biasing context was quite indistinct. To start, in Experiment 1, it was hard to affirm if the effect was like a N400 or a short-lived frontal negativity on account of the unclear scalp distribution. After modifying the experiment, however, the effect seemed to be posteriorly distributed. Although the effect of meaning dominance was interpreted as a N400 in this study, we don't rule out any other possible explanation due to the fact that the effect was resulted from fewer participants. If the effect on dominant-biasing context was a N400, we inferred that the syntactic context indeed helps to activate the dominant meaning so that there is unnecessary to bring in additional resources and the meaning selection could be easily done. However, if the effect on the dominant meaning of homographs is not a N400 but more likely to be a short-lived early frontal negativity, it is revealed that the process of meaning selection is not determined by preceding context but needs more top-down resources to be involved in. Hence, the conclusion will be more close to that in Lee & Federmeier (2009) which suggested syntactic information alone cannot intervene meaning selection of ambiguous words but can only lead to disambiguation at a late stage after meaning access. With the lack of large sampling, future studies need to further investigate into the issue to clarify the two sorts of frontal negativities represented on dominant- and subordinate biasing context respectively.

4.4 Concluding remarks

To sum up, since the frontal negativity effect did not show on all participants initially but exhibited in the split-group analysis, the present study could only make a preliminary inference that substantial inter-individual variation within lexical ambiguity resolution across the subjects in Chinese homographs. Such an individual difference might reflect on those who with higher reading abilities, who are more capable of recruiting additional neural resources to aid difficult semantic selection and thus more likely to perform online

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meaning selection. Based on the preliminary findings that a sustained frontal negativity was still involved in when the syntactic cues were biased toward subordinate meaning of homographs in split-group analysis, it is supposed that syntactic context information alone is insufficient to resolve ambiguity effect in Chinese. In particular, the frontal negativity reveals that a top-down executive mechanism will mediate automatically to aid selecting a contextually appropriate meaning of the ambiguous word and inhibit the inappropriate but dominant meaning. Moreover, the meaning dominance probably plays a large role to enhance the meaning activation, especially on dominant meaning of the homographs, which can be easily picked up without extra loads of meaning selection relative to subordinate meaning of homographs.

Taken together, the present study provides a cross-linguistic evidence and a different perspective to probe into lexical ambiguity resolution in Chinese words. Although Chinese is a language in which context plays a crucial role in meaning interpretation, different types of contexts may function distinctively. It is still less clear that syntactic context information alone is enough to resolve the lexical ambiguity in Chinese due to the different result from overall and spilt-group data. The results are only partly consistent with the view that in isolated visual word recognition, the semantic information is crucial, but the syntactic-category information is not, at least in Chinese. Beside, we found that variation between individuals may explain the inconsistency in results with respect to the ambiguity effect across experiments. Such findings highlight the need to take individual cognitive profiles into account when investigating language ambiguity resolution. Most importantly, the study offers an approach to explore the issue as well as provides a comparison for the future analysis.

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Appendixes

A. Ratings scores of each Experimental list

List 1

Biasing Context		**Unambiguous**		**Dominant-biasing**		**Subordinate-biasing**	
Rating type		UN	UV	NV-homograph	VN-homograph	VN-homograph	NV-homograph
Number		32	32	16	16	16	16
Phrase	**Grammaticality** (1: very ungrammatical; 7: very grammatical)	6.4 (0.3)	6.3 (0.3)	6.3 (0.4)	6.0 (0.8)	5.4 (0.9)	5.9 (0.6)
Target	**Familiarity** (1: very unfamiliar; 7: very familiar)	5.9 (0.4)	5.9 (0.4)	6.2 (0.3)	6.1 (0.5)	5.4 (0.7)	5.5 (0.7)
	Concreteness (1: very abstract; 7: very concrete)	4.9 (0.8)	4.0 (0.7)	5.1 (1.1)	4.1 (1.1)	4.5 (1.0)	4.4 (0.9)
	Meaning relatedness (1: very unrelated; 7: very related)	N/A	N/A	3.0 (1.2)	3.6 (0.9)	3.6 (0.9)	3.6 (1.1)
Cue	**Familiarity**	6.2 (0.4)	6.1 (0.5)	6.2 (0.5)	6.3 (0.5)	6.4 (0.2)	6.3 (0.6)
	Concreteness	4.0 (0.6)	2.8 (0.6)	4.8 (1.1)	3.3 (0.5)	4.6 (0.9)	3.2 (0.4)
Meaning frequency	**Contextual appropriate**	N/A	N/A	0.8 (0.1)	0.7 (0.1)	0.2 (0.1)	0.2 (0.1)
	Contextual inappropriate	N/A	N/A	0.2 (0.1)	0.2 (0.1)	0.7 (0.1)	0.8 (0.1)

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List 2

Biasing Context		**Unambiguous**		**Dominant-biasing**		**Subordinate-biasing**	
Rating type		UN	UV	NV-homograph	VN-homograph	VN-homograph	NV-homograph
Number		32	32	16	16	16	16
Phrase	**Grammaticality** (1: very ungrammatical; 7: very grammatical)	6.4 (0.3)	6.3 (0.3)	6.3 (0.5)	5.5 (0.9)	5.3 (1.0)	5.9 (0.6)
Target	**Familiarity** (1: very unfamiliar; 7: very familiar)	5.9 (0.4)	5.9 (0.4)	6.4 (0.3)	6.0 (0.4)	5.5 (0.6)	5.7 (0.6)
	Concreteness (1: very abstract; 7: very concrete)	4.9 (0.8)	4.0 (0.7)	4.6 (1.3)	4.3 (0.9)	5.0 (1.0)	4.1 (1.1)
	Meaning relatedness (1: very unrelated; 7: very related)	N/A	N/A	3.6 (1.1)	3.6 (0.9)	3.6 (0.9)	3.0 (1.2)
Cue	**Familiarity**	6.2 (0.4)	6.1 (0.5)	6.2 (0.5)	6.6 (0.3)	6.0 (1.0)	6.5 (0.2)
	Concreteness	4.0 (0.6)	2.8 (0.6)	4.4 (1.2)	3.4 (0.4)	4.2 (1.2)	3.3 (0.7)
Meaning frequency	**Contextual appropriate**	N/A	N/A	0.8 (0.1)	0.7 (0.1)	0.2 (0.1)	0.2 (0.1)
	Contextual inappropriate	N/A	N/A	0.2 (0.1)	0.2 (0.1)	0.7 (0.1)	0.8 (0.1)

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B. Examples of the questionnaire for Norming study 1: Meaning dominance

題號	目標詞	造句欄
1	同志	
2	啟動	
3	末端	
4	動人	
5	報酬	

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C. Examples of the questionnaire for Norming study 2: Meaning relatedness

題號	目標詞	詞義解釋	句子	評兩個語義關聯性高低 (1 最低；7 最高)
1	算帳	與人爭執較量或報復	小明對小華一直懷恨在心，誓言有一天一定要找他**算帳**。	
		計算帳目	銀行的會計每天都忙著**算帳**，龐大的帳目讓人頭疼。	
2	開刀	動手術	爸爸身上長了一顆脂肪瘤，醫生建議他趕快**開刀**拿掉。	
		責備、懲罰別人	我們老闆非常不講道理，常常拿無辜的職員**開刀**。	
3	走路	徒步行走	有了智慧型手機後許多人都當低頭族**走路**時都不看路。	
		開除、解聘	這間公司陷入財務危機聽說在過年前會有許多員工必須**走路**。	

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D. Instructions and sample items for Norming study 3: Familiarity

您好：

歡迎您參與本次的研究！本問卷之目的在於收集成人對以下中文字詞在熟悉程度以及通順程度上的評定，大約需25-30分鐘完成。

【第一部分】中文字詞熟悉程度判斷作業

在下方的表格中，您將會看到一些中文字詞，請根據您自己的生活經驗，對第二個欄位中文字詞的熟悉程度做判斷。由於有些字詞可能在不同語境下可以被解讀成不同意思，因此我們在第三個欄位中加註語意。請根據該字詞用作為該語意的情況來做熟悉度的判斷。

判斷時請在空格內填入 1 至 7。**(1 到 7 之間的整數都可使用，1 代表非常不熟悉；7 代表非常熟悉)**。

舉例來說：「書本」這個詞經常聽到且經常使用，因此有人可能會填 6 或 7；相反地，「天斛」這個詞不常聽到，甚至沒聽過，因此有人可能會填 2 或 1。**請依照您的直覺做判斷**，答案並無對錯之分。

請注意，填寫問卷時，**請以 1 與 7 表示最極端的兩種情況，並保持評分標準一致性**。若您發現自己經常填寫某些特定數字，而這確實是您認為最適合用來描述這些詞具體程度的選項，則無須更改答案。**若您對於指導語還有疑問的話，施測人員可以為您解答。**

我們要特別強調，此問卷評估作業並沒有正確答案，
請放輕鬆，根據您的主觀直覺評分作答。

題號	中文字詞	語意解釋	評分(1～7 分) 1 表示「非常不熟悉」 7 表示「非常熟悉」
1	入門	初學、多用在書名	
2	現實	存在於眼前的事實及狀況	
3	大意	大概	
4	油條	一種長條形中空的油炸麵食	
5	左右	方向	
6	鬥牛	簡易的籃球比賽	
7	機車	交通工具	
8	掛勾	用來懸掛物體的鉤狀器具	
9	滿月	陰曆每月十五日夜晚的月亮	
10	意識	人對外界的知覺	

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E. Instructions and sample items for Norming study 4: Concreteness

您好：

歡迎您參與本次的研究！本問卷之主要目的在於了解成人對以下中文字詞具體程度的評定，大約需25-30分鐘完成。

【第一部分】中文字詞具體程度評定

本研究之主要目的在於了解成人對中文字詞具體程度的判斷。在下方表格的第二個欄位您將會看到一些中文字詞，請根據您的生活經驗，對第二個欄位中字詞的具體程度做判斷。

根據該詞**能被五官所感覺（看得到、聽得到、聞得到、嚐得到、觸碰得到）**的程度，**在空格內填入1至7，1表示「非常難被五官所感覺到」；7 表示「非常容易被五官所感覺到」，數字越大代表此詞義越容易被五官所察覺**。

舉例來說：「水鳥」和「糖果」這兩個詞表示能被看到、觀察到或嚐到的具體事物，有人可能會填 6 或 7；相反地，「感情」及「希望」這兩個詞所表示的意義既看不到也觸碰不到，幾乎無法直接被五官所感受，有人可能會填 1 或 2。**請依照您的直覺做判斷**，答案並無對錯之分。

請注意，填寫問卷時，**請以 1 與 7 表示最極端的兩種情況，並保持評分標準一致性**。若您發現自己經常填寫某些特定數字，而這確實是您認為最適合用來描述這些詞具體程度的選項，則無須更改答案。

我們要特別強調，此問卷評估作業並沒有正確答案。
請放輕鬆，根據您的主觀直覺評分作答。

題號	中文字詞	語意解釋	評分(1～7 分) 1 表示「非常難被五官所感覺到」 7 表示「非常容易被五官所感覺到」
1	見識	指某人的經驗、知識	
2	雕塑	雕像	
3	包裹	指包紮成件的東西	
4	品味	對事物的品鑑能力	
5	開關	電源	
6	風光	風景、景色	
7	料理	菜餚	
8	看護	照顧病人的人	
9	成就	成功	
10	過去	已往、從前	

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F. Instructions and sample items for Norming study 5: Grammaticality judgement task

您好：

歡迎您參與本次的研究！本問卷之主要目的在於了解成人對以下中文字詞通順程度的評定，大約需25-30分鐘完成。

【第二部分】中文字詞通順程度評定

在以下表格中，您將會看到一些配對好的詞(例如:一顆糖果、事先克服、五棟反目..等等)。**請根據直覺作答，依照您對每一組字詞的通順程度，在空格內填入1至7。 1代表非常不通順；7代表非常通順**。1到7中間的任何整數都可使用。

舉例來說：「一顆糖果」這組字詞非常通順，有人可能會填6或7；相反地，「五棟反目」這組字詞不大通順，有人可能會填2或1。另外提醒您，**有些詞組並不是句子的開頭，請就該詞組本身的通順度來判定。**例如：「明年教室」雖然可以延伸為一個通順的句子（如：明年教室就會完工），但是在後面沒有添加任何詞語的情況下，「明年教室」這組字詞是不通順的，有人可能會填2或1。

請注意，填寫問卷時，**請以1與7表示最極端的兩種情況，並保持評分標準一致性**。若您發現自己經常填寫某些特定數字，而這確實是您認為最適合用來描述這些詞具體程度的選項，則無須更改答案。

我們要特別強調，此問卷評估作業並沒有正確答案。
請放輕鬆，根據您的主觀直覺評分作答。

題號	配對詞		評分(1～7分) 1 表示「非常不通順」 7 表示「非常通順」
1	努力	行李	
2	一堂	入門	
3	一種	現實	
4	本篇	大意	
5	好好	文件	
6	一根	油條	
7	不分	左右	
8	四場	鬥牛	
9	一輛	機車	
10	十個	掛勾	

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G. Questionnaire of reading experience test (Author Recognition Test)

分數：答對題數 _____ － 答錯題數 _____ ＝ _____

閱讀經驗測驗

作者姓名識別：在以下的名單當中，您將看見許多人名，其中有一些是書籍作者的姓名，有一些並非書籍作者的姓名，若您認為此人名為**真正的作者姓名**，請在左邊的欄位中打勾。請注意，勾選錯誤的人名將會減低您的分數，因此，請注意只勾選您認為且確定為作者的人名，謝謝！

_____	鐘瑜勻	_____	于盈曦	_____	趙凌庭	_____	席慕蓉
_____	吳淡如	_____	秋麗靜	_____	林文義	_____	卓駿霖
_____	木宗沂	_____	嚴安	_____	小野	_____	高狄
_____	端邦	_____	許展豪	_____	嚴長壽	_____	吳若權
_____	張愛玲	_____	鍾怡雯	_____	馬震超	_____	葉頤安
_____	余秋雨	_____	鯨向海	_____	簡冠賢	_____	劉墉
_____	江以波	_____	朱少麟	_____	胡釗	_____	藤井樹
_____	曹翊守	_____	九把刀	_____	何英杰	_____	鄭晴
_____	鍾文音	_____	張系國	_____	劉小倩	_____	向陽
_____	倪匡	_____	朱天文	_____	段照薇	_____	苗尹隱
_____	余華	_____	陳宜涵	_____	李逸夫	_____	鍾曉陽
_____	龐靖	_____	張曼娟	_____	沈文舟	_____	李智堯
_____	吳奕嘉	_____	王浩耘	_____	伊格言	_____	李家同
_____	吳念真	_____	綺陽	_____	周芬伶	_____	陳芳明
_____	朱天心	_____	顏芳	_____	白先勇	_____	王文興
_____	莊予茹	_____	王文華	_____	謝志彥	_____	周慧瑾
_____	張孟祥	_____	林夕	_____	林瓊君		
_____	林昱至	_____	駱以軍	_____	劉克襄		
_____	黃春明	_____	龍應台	_____	鄭惠玲		
_____	侯文詠	_____	楊宛萍	_____	余光中		
_____	馮家宣	_____	蘇霆建	_____	吳祥輝		
_____	金庸	_____	柳玄嵐	_____	陳映真		
_____	郝譽翔	_____	黃國華	_____	王羽雙		
_____	茵茵	_____	吳禹中	_____	劉星辰		
_____	林纓栩	_____	李大維	_____	蔡智恆		
_____	林蕙曼	_____	蔣勳	_____	張大春		
_____	曹維哲	_____	三毛	_____	簡媜		
_____	張曉風	_____	歐陽子	_____	蔡俞芸		

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H. Questionnaire of reading experience test (Magazine Recognition Test)

分數：答對題數 _____ － 答錯題數 _____ ＝ _____

閱讀經驗測驗

雜誌名稱識別：在以下的名單當中，您將看見許多名稱，其中有一些是真正的雜誌名，有一些並非真正的雜誌名。若您認為此名稱為**真正的雜誌名**，請在左邊的欄位中打勾。請注意，勾選錯誤的雜誌名稱將會減低您的分數，因此，請注意只勾選您認為且確定為真的雜誌名，謝謝！

___	Wii 特報	___	天下雜誌	___	筆電快訊	___	康健雜誌
___	品文	___	大腦奧秘	___	繪畫夢	___	PC 報你知
___	Cheers 快樂人	___	幸福生活	___	音樂論壇	___	皇冠
___	居家建設	___	一手車訊	___	財管達人	___	時報周刊
___	幼獅文藝	___	詩月	___	長春月刊	___	俏媽咪
___	La Vie	___	商業週刊	___	綠手指月刊	___	親子天下
___	Design 設計	___	PRIME 新視聽	___	新大小說	___	日日新訊
___	遠見	___	潮設計	___	當代設計	___	飲食風尚
___	富計畫	___	蔬生活	___	舞動世界	___	親親育兒
___	典藏今藝術	___	好孕誌	___	今周刊	___	文訊
___	探索生命	___	時事在握	___	文學手札	___	禪天下
___	看雜誌	___	Taipei Walker	___	科學人	___	寶貝守則
___	摩托車	___	PAR 藝術表演	___	讀者文摘	___	dpi 設計流行創意雜誌
___	創意科學	___	Ppaper	___	漂亮家居	___	室內 interior
___	電玩同盟	___	張老師	___	7-WATCH	___	食尚玩家
___	DECO 居家	___	網壇傳奇	___	行走天下	___	人體旅程
___	聯合文學	___	重機快訊	___	NBA 美國職籃 XXL		
___	講義	___	足球熱	___	影藏攝記		
___	PC home	___	窺探自然	___	新新聞		
___	錢進未來	___	背包客日誌	___	傳藝雙月刊		
___	PS3 情報誌	___	HiVi 家庭劇院	___	ARC 街頭藝術		
___	藝術家	___	優渥誌	___	裝潢世界		
___	單車上路	___	旅人誌	___	TVBS 周刊		
___	媽媽寶寶	___	電腦 DIY	___	世界走透透		
___	時尚設計風潮	___	車霸	___	鏡前鏡後		
___	新紀元	___	交響樂刊	___	暢遊 3C		
___	寶寶天地	___	健康人聲	___	設計到家		
___	高爾夫專刊	___	隨筆瘋	___	HOME JOURNAL 美好家居		

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I. Examples of stimulus materials in experimental list 1

UV	UN	AADNV	AADVN	AASNV	AASVN
即將 迎接	各類 消息	一種 現實	常被 左右	太過 大意	四場 鬥牛
尚未 聽說	這個 執照	一根 油條	間接 掛勾	超級 機車	各種 風光
難以 交差	各種 特色	一輪 滿月	細心 雕塑	馬上 回報	一場 角力
徹底 失去	各位 主管	一位 保全	相當 光彩	有點 意外	這種 效力
不能 動手	這支 球隊	一聲 招呼	完全 封口	待會 過去	一種 消遣
連日 比試	那群 子孫	一位 看護	常常 生氣	充分 料理	一些 便宜
只好 答應	她的 氣質	一份 保險	無法 形容	細細 品味	一群 同行
快速 切開	這對 夫妻	幾件 包裹	尚未 統一	趕快 成人	兩個 禮拜
如何 脫離	那位 作家	一場 感冒	更加 先進	一同 制服	兩個 打點
一起 返回	他的 條件	一絲 轉機	恰巧 經過	隨即 下場	一塊 如意

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J. Examples of stimulus materials in experimental list 2

UV	UN	AADNV	AADVN	AASNV	AASVN
全部 包辦	更多 原料	本篇 大意	全力 鬥牛	非常 現實	不分 左右
不斷 打量	他的 戀人	一輛 機車	繼續 風光	非常 油條	十個 掛勾
確實 遵守	這個 家族	一些 回報	繼續 角力	即將 滿月	一件 雕塑
努力 避開	這種 言論	一次 意外	一直 效力	努力 保全	一道 光彩
連日 比試	這個 執照	那些 過去	經常 消遣	盡情 招呼	各式 封口
如何 前來	各類 專欄	三道 料理	非常 便宜	細心 看護	一息 生氣
難以 交差	那群 子孫	兩種 品味	一起 同行	相當 保險	這種 形容
如何 脫離	這家 客運	一位 成人	趕去 禮拜	小心 包裹	那家 統一
只好 答應	一些 專家	一套 制服	仔細 打點	十分 感冒	各位 先進
居然 錯過	這支 球隊	這種 下場	未必 如意	匆忙 轉機	整起 經過

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