

Effects of Cognitive Linguistics-Informed Instruction on L2 Learners' Behavioural and Neurocognitive Processing of English Prepositions

Man Ho Ivy WONG*

Hong Kong Shue Yan University, Hong Kong, China

Nicolson Yat-Fan SIU

The Hong Kong University of Science and Technology, Hong Kong, China

Cindy Wai-Man Tsui

The University of Hong Kong, Hong Kong, China

Abstract

The present study investigated the effects of cognitive linguistics (CL)-informed instruction on the L2 learning and processing of matched and mismatched prepositional phrases. An acceptability judgement test (AJT) containing 180 target items across 12 prepositional usages assessed behavioural and neural responses to semantic anomalies involving in, at, and over. Forty-six Chinese learners of English were recruited. Of these, 44 completed the pretest, a 60-minute computer-assisted training, and the posttest, thereby providing complete behavioural data; 41 also provided usable ERP data. Learners were randomly assigned to either CL-informed instruction, which provided schematic diagrams and cognitive-semantic explanations, or traditional definition-oriented instruction, which provided rule-of-thumb definitions and exemplars. Twelve L1 English speakers were recruited, of whom 11 contributed usable comparison data. Behaviourally, the CL-informed group showed greater improvements in accuracy than the traditional group for target and distractor prepositions. ERP analyses revealed instruction-by-time differences in N400 responses to distractor and unacceptable prepositions, indicating different changes in sensitivity to semantic anomalies. In post-training comparisons, the CL-informed group did not differ significantly from the L1 group in accuracy or reaction time, whereas the traditional group remained less accurate in the distractor and unacceptable conditions. For the ERP measures, the CL-informed group did not differ significantly from the L1 group on the analysed components, whereas the traditional group showed reduced P600 amplitudes in specific sentence conditions.

Keywords

Keywords cognitive linguistics; L2 grammar instruction; preposition learning; L1 processing

*Corresponding author mhwong@hksyu.edu

Cite this article

Wong, M. H. I., Siu, N. Y.-F., & Tsui, C. W.-M. (2026). Effects of cognitive linguistics-informed instruction on L2 learners' behavioural and neurocognitive processing of English prepositions. *Asian Journal of English Language Teaching*, 35(3), 122–155.
<https://doi.org/10.65961/AJELT-2026-3-007>

Introduction

A plethora of second language (L2) instructional studies have focused on finding effective ways to help learners develop their L2 competence. However, the language learning process of every individual is complex, as it involves a vast number of fixed and random factors contributing to the learner's success. Therefore, the commonly adopted behavioural measures can only bring indirect insights into the neurocognitive mechanisms involved in language processing (Paradis, 2009). To better understand variability in L2 acquisition, psycholinguists have adopted alternative approaches that go beyond behavioural measures, such as utilizing neurophysiological techniques. Electroencephalogram (EEG) is one of the widely used methods in cognitive studies since it provides researchers with a real-time neural activity measure and insight into the mechanisms involved in language processing. Event-related potentials (ERPs) are recorded by placing electrodes on the scalp to track changes in voltage between electrodes with millisecond precision. These ERPs reflect the electrical activity of neurons and provide valuable insights into time-locked events of interest. By measuring the average neural activation of target participants at individual electrodes, ERPs allow us to examine the specific patterns of brain activity associated with these events. (Kaan, 2007; Steinhauer, 2014). The resulting waveform can be interpreted in terms of frequency, timing, polarity, and scalp distribution.

With a growing interest in bilingualism and multilingualism, a large body of evidence from ERP studies has contributed to our understanding of language processing between native and L2 speakers (e.g., Hahne, 2001; Hahne & Friederici, 2001; Pakulak & Neville, 2011). Moreover, L2 studies along this line of research identify significant learning problems regarding various linguistic features, including subject-verb agreement (Tanner, Osterhout, Herschensohn, 2009), collocations (Peters, 2016; Pulido, 2023), articles (Batterink et al., 2014) among others. Although numerous cognitive linguistics-inspired studies have shown that English prepositions pose a serious challenge on L2 learners (e.g., Tyler, Mueller, & Ho, 2011; Tyler, 2012; Wong, Zhao, & MacWhinney, 2018; Wong, 2023), limited research effort has been made regarding the native (L1) and L2 processing of English prepositions (Sandra & Rice, 1995; Zane & Shafer, 2018).

Relatively little research has examined the neurocognitive effects of CL-informed instruction on English preposition learning. Zhao et al. (2020) provided initial evidence that CL-informed training may alter learners' neurocognitive processing: learners in the CL-informed group showed an increase in N400 amplitude after training, although the CL-informed and traditional instruction groups did not differ significantly in post-AJT accuracy or N400 amplitude. Moreover, because the study included only nine test items for each form–function mapping and provided more comprehensive feedback to the CL-informed group than to the traditional group, whether CL-informed instruction produced distinct neurocognitive benefits remained unresolved. These limitations highlight the need for further research using a larger set of assessment items and more balanced instructional conditions. Through examining both behavioural judgements of acceptability and neurophysiological measures (i.e., ERPs), the primary objective of the present research was to build on prior research efforts to examine the effectiveness of different instructional approaches (e.g. CL-informed instruction vs. traditional instruction) on the L2 learning and processing of matched and mismatched

prepositional phrases. The secondary objective was to contrast L2 performance and processing both before and after instruction with that of L1, unravelling any similarities and differences in behavioural and neural responses.

Background Literature

Understanding human cognition through cognitive linguistics (CL)

Image schemas, an important theoretical construct in cognitive linguistics, are characterised as preconceptual, embodied structures that arise from ‘human recurrent bodily movements through space, perceptual interactions, and ways of manipulating objects’ (Hampe, 2005, p.1). To illustrate, consider our recurring, physical interactions with all types of containers (e.g., boxes, rooms, and cars). These accumulated interactions with containers motivate our mental encoding of a CONTAINER schema. The CONTAINER schema, as shown in Figure 1, like other image schemas, is a highly schematic gestalt that captures only the structural contours of sensory-motor experience generated from multiple modalities.

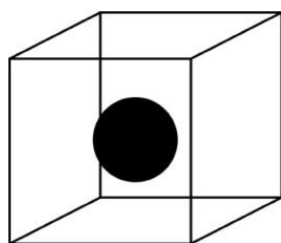


Figure 1. The CONTAINER schematization.

In Figure 1, the darkened circle represents a trajectory (TR), the primary, movable object of a scene whereas the container represents a landmark (LM), the secondary reference object of the same scene. Although these schematic representations contain only the most basic structural features of an experience, they are powerful tools that help build human cognition and facilitate our understanding and representation of the world. Further, to understand this cognitive operation of the human mind, Lakoff and Johnson (1980) proposed the Conceptual Metaphor Theory (CMT) to demonstrate how some unrelated, conventional linguistic expressions (e.g., in the staff room; in love) are, in fact, metaphoric extensions of concrete to abstract concepts. A conceptual metaphor is defined as a systematic set of mappings between two domains of experience. To illustrate how the mappings work, consider the sentence the couple are madly in love. The metaphorical expression of in love is a result of mapping an abstract domain, love, onto a concrete source domain, container. Moreover, this set of mapping is highly systematic in the sense that it captures a coherent view of the conceptual metaphor EMOTIONS ARE CONTAINERS (Kövecses, 2017).

Our frequent experiences with physical containers, e.g., entering a room, that have facilitated the conceptual mapping between emotion and container domains. We conceptualise emotions as containers to express the feeling of being enclosed or restricted by a particular kind of emotion, as if we had entered an enclosed space physically. In addition to tracing back to the origin of conceptual extensions of metaphorical expressions, CMT is also used to explain our conception of time (Lakoff & Johnson, 1999). For example, the prepositions before and

after were used to encode spatial meaning (e.g., the witness stood before the court) until it has been extended to indicate temporal meaning (e.g., all guests should arrive before 7pm). The extension became so successful that the temporal meaning for describing events on a timeline took prominence over its spatial sense of describing the positions of objects (Zane & Shafer, 2018). In conjunction with the CMT, image schemas not only serve as the anchors for understanding human conceptual system, but more importantly, they also demonstrate the semantic relatedness between the various functions of the same linguistic form. For example, the preposition form *over* has fifteen polysemous yet related functions attached to it, as illustrated through Tyler and Evans' (2003) Principled Polysemy Network (Figure 2). The systematic presentation of these form-function mappings, with the help of schematic diagrams, would promote a meaning-oriented approach to preposition learning, rejecting pure memorization of arbitrary rule-of-thumb definitions. Moreover, it regulates the knowledge space of learner in a more efficient fashion through a better conceptual organisation (Wong et al., 2018).

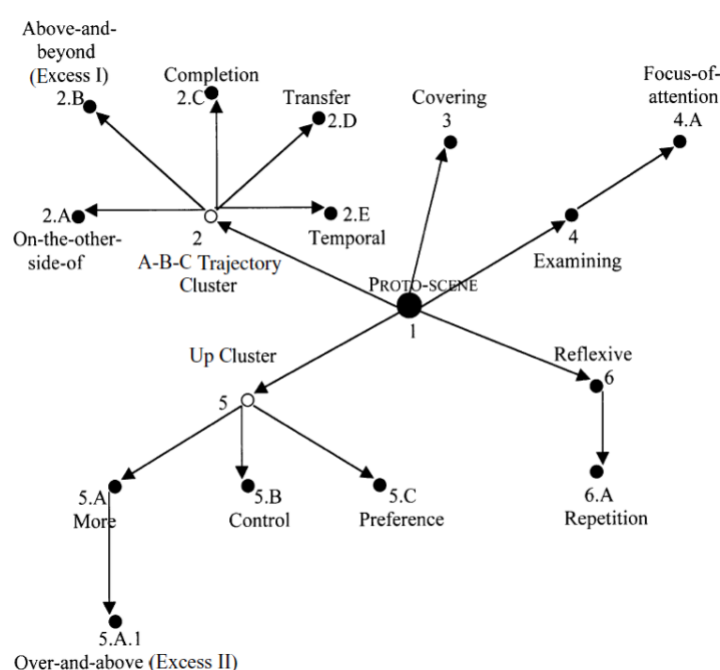


Figure 2. The semantic network of the preposition *over* (Tyler & Evans, 2003).

Applying CL to L2 Instruction: Potentials and Challenges

Drawing from the field of cognitive psychology, numerous studies found that image schemas are psychologically real (Glover et al., 2004; Richardson et al., 2003; Zwaan, Maglianno, & Graesser, 1995). However, it begs the question whether these schematic gestalts are readily, if not equally, accessible for L2 learners. Since English prepositions remain one of the most challenging linguistic features in L2 acquisition (Celce-Murcia & Larsen-Freeman, 1999), the quick accessibility of these schematic gestalts could have great potentials for preposition learning. Therefore, researchers have investigated the effectiveness of schematic diagrams on learning prepositions over the past few decades (Boers & Demecheleer, 1998; Lam, 2009; Tyler,

Mueller, & Ho., 2010; Tyler, 2012; Wong et al., 2018; Wong, 2023), making notable contributions to the field of applied cognitive linguistics (Tyler, Huang, & Jan, 2018).

However, there are still many pressing questions that have not been resolved. For instance, Tyler and colleagues (Mahpeykar & Tyler, 2014; Tyler et al., 2010; Tyler, 2012) adopted the CL approach to teaching different linguistic features, including prepositions, phrasal verbs, modal verbs, however, their findings were rather mixed. Wong et al. (2018) identified several reasons that might have contributed to the divergent results in CL instructional studies: (i) heavy cognitive demand imposed on learners; (ii) inconsistent pedagogical materials and approaches; and (iii) a lack of practice for consolidation. Therefore, Wong et al. (2018) and Wong (2023) tried to overcome these issues via developing a computerised tutorial system called *The English Preposition Tutor*. To reduce the cognitive demand, the tutor presents training stimuli using a minimal-pair design so that learners can focus their limited cognitive resources on distinguishing between the two most competing form-function mappings, which is the target preposition and its distractor (e.g., *The girl waved at the flies* and *the girl waved to the flies*). In addition, not only did the tutor make the pedagogical materials adopted across treatment groups transparent and balanced, but it also managed to control the amount of practice. Both studies have found a superiority effect of CL instruction over traditional instruction, but only when productive knowledge is at work. In other words, learners who had received traditional instruction performed equally well on receptive tasks, such as multiple-choice cloze test. Thus, despite the positive learning outcomes, the neurological impact of CL-informed instruction remains largely unexplored. Behavioural methods, while valuable, can only offer indirect insights into the complex neurocognitive mechanisms underlying language processing.

Neurophysiological evidence for language processing: N400 and P600

ERP components are often elicited in L2 experiments and have been well-studied (Kaan, 2007; Morgan-Short & Tanner, 2014; Steinhauer & Connolly, 2008; van Hell & Tokowicz, 2010). Grey et al. (2018) identified three major benefits of studying language learning and processing through ERPs. First, the authors pointed out that ERP unravels group differences that may not be captured through behavioural measures of performance (e.g., Grey, Tanner & van Hell, 2017; Tokowicz & MacWhinney, 2005; Zhao et al., 2020). Second, ERPs are particularly useful for examining potential bilingual and/or monolingual differences in adult language learning of grammar. It is because the two classic ERP components, N400 and P600, are quite robust and replicable across ERP studies on both L1 and L2 processing. Third, qualitative differences can be elucidated through the revelation of different components during language processing.

For L1 processing, the lexical or semantic processing often elicits a N400 effect, a maximal negative deflection over centroposterior scalp regions around 300 – 500msec upon presentation of the stimulus, which was designed to capture meaning interpretation (Kutas & Federmeier, 2011). Similarly, L2 lexical or semantic processing consistently elicits N400s, even for L2 beginner learners (e.g., McLaughlin, Osterhout, & Kim, 2004). Specifically, N400 is found to be larger for words that are difficult to process due to anomalous meaning or other lexical characteristics, such as low frequency (Faretta-Stutenberg & Morgan-Short, 2017). Interestingly, the N400 is reduced in amplitude even for anomalous words if they are predictable from the preceding context or even simply sharing semantic features with the

strongly expected word (Federmeier & Kutas, 1999; Rommers et al., 2013; see Kutas & Federmeier, 2011 for a comprehensive overview). As for grammatical processing, a P600 effect is often elicited over posterior scalp regions around 600 – 900msec after stimulus presentation. This positive deflection has been posited to index processing of structure building (Swabb et al., 2012), such as cases of (morpho)syntactic violations.

On the other hand, in L2 processing, the elicitation and distribution of these effects have varied. For instance, earlier (e.g., around 400 msec), broader, and more anteriorly focused P600 effects have been detected in learners who received classroom and lab-based metalinguistic instruction (Bowden et al., 2013; Faretta-Stutenberg & Morgan-Short, 2018; Morgan-Short et al., 2012). Nonetheless, P600s in L2 appear to be more reliable at higher than at lower L2 proficiency (Grey et al., 2018). Recently, Morgan-Short et al. (2022) found that phrase-structure violations elicited a larger P600 effect when learners reported that their judgements were based on explicit knowledge, such as a remembered rule, rather than on implicit knowledge, such as intuition or guessing. A similar pattern was found for subject–verb agreement violations, which elicited a greater overall positivity following explicit source attributions. The authors pointed out that such evidence could reflect an L2 subjective awareness of grammatical violation through explicit knowledge. On the other hand, the functional significance of P600s has yet to reach consensus (Freunberger, Bylund, & Abrahamsson, 2022). In earlier research, its functional significance was associated to syntactic factors, such as sensitivity to ungrammatical and challenging structure (Kaan et al., 2000; Osterhout & Holcomb, 1992). However, late positivity was evidenced in the absence of syntactic violations and has been linked to several cognitive processes, including reanalysis of semantically incongruous words in context, integration or unification of different information streams, monitoring, retrieval, or structure building (Brouwer, Fitz, & Hoeks, 2012; Friederici, 2002; Gouvea et al., 2010; Hagoort, Brown, & Groothusen, 1993; Hagoort, 2003; Kaan et al., 2000; Kolk & Chwilla, 2007). The P600 has also been found to be a reliable marker of second language processing difficulties, with non-native speakers exhibiting larger P600 amplitudes than native speakers in response to syntactic violations (Kaan & Swaab, 2003; Schmidt-Kassow & Kotz, 2009). Additionally, studies have shown that training in a second language can lead to a reduction in P600 amplitude, suggesting that the P600 may be a useful tool for assessing language learning progress (Nichols & Joanisse, 2019; Street, 2017). In broad terms, the N400 reflects the difficulty involved in accessing or integrating the meaning of a word within its context: a larger N400 is generally observed when a word is semantically unexpected or difficult to integrate. The P600 reflects later-stage processing and has often been associated with the reanalysis, repair, or integration of information following a linguistic anomaly. Thus, changes in the N400 may indicate changes in learners' sensitivity to semantic appropriateness, whereas changes in the P600 may reflect changes in later, more controlled processing. However, these interpretations are not exclusive, and the precise functional significance of the P600 remains debated (Brouwer et al., 2012; Freunberger et al., 2022).

Zhao et al. (2020) adopted both behavioral and electrophysiological measures to compare the effectiveness of CL-informed and traditional instructions on English preposition processing. The authors adopted the English Preposition Tutor (Wong et al., 2018) to deliver instructions for the two treatment groups. The behavioral results from their study suggested that the superiority effect of CL-informed instruction was only present when the assessment task

required productive knowledge. In other words, no significant difference in accuracy was found between the two treatment groups on the post acceptability judgment test. As for the ERP results, the authors found a significant increase in the N400 amplitude among participants who received CL-informed instruction (e.g., providing schematic diagrams and CL explanations as feedback). However, the N400 amplitude of the CL-informed instruction group was not significantly different from that of the traditional instruction group (e.g., indicating only correctness as feedback). Their ERP results also suggested that the participants from the CL-informed instruction group, despite their proficiencies, became significantly better at detecting distractor prepositions after training. Although some new evidence emerged from the study to facilitate our understanding of preposition learning and processing, two key methodological issues were identified. First, there was only 9 test items in the acceptability judgement task for each form-function mapping, which was insufficient to reliably capture and analyse ERPs. Second, the CL-informed instruction group received comprehensive feedback while the traditional instruction received minimal feedback only, rendering the comparison between the two groups inequitable.

The Current Study

To address the two primary methodology concerns identified in Zhao et al.'s (2020) ERP study, our current investigation expanded the number of test items for each form-function mapping from 9 to 15. This adjustment aimed to offer a more comprehensive exploration of the neural processes underlying preposition processing. Also, the traditional instruction group in the current study received rule-of-thumb definitions and exemplars as feedback, rather than solely correctness feedback. This modification aimed to balance the pedagogical richness of training to ensure a fair comparison between the CL-informed and traditional instructions. Additionally, expanding upon Zhao et al.'s (2020) ERP study and prior behavioural investigations on L2 preposition learning (Wong et al., 2018; Wong, 2023), the main goal of the current study was to investigate L2 performance and changes in N400 congruity effects following CL-informed and traditional definition-oriented preposition instruction. Further, we aimed to evaluate the behavioral and neurocognitive changes among L2 English speakers before and after instruction, contrasting changes with L1 performance. Accordingly, the present study addressed the following research questions:

(1) Do cognitive linguistics-informed instruction (i.e., schematic-diagram feedback) and traditional instruction (i.e., rule-of-thumb definition and exemplars) produce varying effects on the learning and processing for matched and mismatched prepositional phrases?

(2) How do L2 performance and neurocognitive processing differ before and after instruction, compared to those of L1 speakers?

To address these two research questions, the related-anomaly paradigm (e.g., Federmeier & Kutas, 1999) was employed in an acceptability judgement test (AJT), where participants were presented with carefully constructed sentences with matched and mismatched prepositions, classified as either target (semantically acceptable), distractor (semantically anomalous), or unacceptable (semantically irrelevant) sentence conditions. While the L1 speakers would only need to complete the AJT once, the L2 learners would undergo the AJT again after receiving either the CL-informed instruction or the traditional instruction. Accuracy,

reaction time, and ERP data of L1 and L2 participants were collected for conducting comparative analysis.

Before any preposition training, it was anticipated that L1 speakers would exhibit significantly greater accuracy and shorter reaction times across all three sentence conditions compared to L2 learners. Also, L2 learners were expected to perform significantly worse in distractor sentence conditions, as these distractor prepositions typically provoke keen competition against the target prepositions. However, L2 learners were expected to demonstrate significant improvement in both accuracy and reaction times upon training. Specifically, it was predicted that the CL-informed group would demonstrate significantly better performance and faster reaction times compared to the traditional group in the post acceptability judgment test. As for the ERP data, we expected to find evidence for N400 component in both L1 and L2 speakers of English for unacceptable prepositions as they demonstrate a highly pronounced semantic anomalousness (e.g., *the girl was from a bad mood because she was tired*). As for distractor prepositions, we expected to find evidence for N400 component only in L1 speakers as we assumed that this sentence condition would be most challenging for L2 speakers. Nonetheless, we anticipated to find evidence for N400 component for L2 speakers after the preposition training. In addition, with compelling behavioural evidence to support the effectiveness of CL-informed preposition training (Wong et al., 2018, Wong, 2023; Zhao et al. 2020), we also expected to see a significantly greater amplitude in N400 component for learners receiving CL-informed instruction than those who underwent traditional training. Finally, we might also observe P600 component in L2 learners after training as late positivities may reflect controlled processing and increased awareness (Morgan-Short et al., 2022).

Methods

Participants

Forty-six Chinese undergraduate learners of English, aged 19 to 30, were recruited from a university in Hong Kong. All L2 participants indicated that their first language was either Cantonese or Mandarin. They reported having learned English for more than 10 years, primarily in classroom environments. None had substantial L2 immersion experience or had lived in an English-speaking country for longer than a short vacation of less than two months. Regarding L2 proficiency, the mean of self-reported proficiency on the Hong Kong Diploma of Secondary Education (HKDSE) English examination was 3.45 out of 7, which is generally considered as intermediate level of English proficiency. We selected this participant sample because we expected that they would perform above chance overall on the acceptability judgement task but that they would still base their judgement on either knowledge of a preposition rule or pure intuition.

Twelve L1 English speakers were recruited to serve as a comparison group. All recruited participants were right-handed, had normal or corrected-to-normal vision, and reported no history of neurological or language-related disabilities. Testing took place in laboratories at two local universities. Sample sizes varied across the analyses because not all participants contributed complete or usable data at every stage. Of the 46 L2 learners, 44 completed all study components. Behavioural analyses were conducted using the available pretest and

posttest data. Following EEG preprocessing and artifact rejection, 41 L2 learners contributed usable data to the ERP analyses. Of the 12 recruited L1 speakers, 11 contributed usable data to the baseline behavioural comparisons. Sample sizes varied across the ERP analyses because of differences in data usability and are reported separately for each analysis.

Research Design

The study employed a mixed design. For the pretest–posttest L2 analyses, instructional group was a between-participants independent variable with two levels: CL-informed instruction and traditional definition-oriented instruction. Time was a within-participants variable with two levels: pretest and posttest, and sentence condition had three levels: target, distractor, and unacceptable. The dependent variables were response accuracy, reaction time, and the amplitude and latency of the ERP components examined. The L1 group completed the AJT once and served as a comparison group for evaluating L2 behavioural performance and neurocognitive processing before and after instruction.

Preposition Training

The computerised preposition tutor delivered instruction on three preposition forms: in, at, and over. Twelve prepositional functions were selected across the three target prepositions (see Appendix B). There were six training items for each form–function mapping, resulting in a total of 72 training stimuli (12 prepositional functions $\times$ 6 training items). All training stimuli were developed and revised based on (a) the Corpus of Contemporary American English and (b) major grammar reference books (Celce-Murcia & Larsen-Freeman, 1999; Huddleston & Pullum, 2002; Quirk et al., 1985). In addition, many stimuli were borrowed from or inspired by detailed cognitive-semantic analyses of prepositions (Lindstromberg, 2010; Tyler & Evans, 2003). The design of the computer-based training adopted a practice-based model (Anderson, 1995; DeKeyser, 1998). The pedagogical materials and instructional procedures were also informed by cognitive linguistics, sociocultural theory, and the competition model (see Appendix A).

The minimal-pair presentation format was held constant across the two instructional groups. Participants in both groups received the same target–distractor contrasts, training stimuli, number of practice trials, and training duration. The groups differed principally in the instructional feedback provided: the CL-informed group received schematic diagrams and cognitive-semantic explanations of the relationships between prepositional meanings, whereas the traditional instruction group received rule-of-thumb definitions and usage exemplars. Thus, the between-group comparison evaluated the relative effects of these two forms of instructional feedback within a common minimal-pair training format.

The AJT

Fifteen test items were created for each of the twelve form-function mappings, resulting in a total of 180 target items. Each target item consisted of three versions: (i) a sentence containing the target preposition, (ii) a semantically anomalous sentence containing a distractor preposition, and (iii) a semantically anomalous sentence containing an unacceptable preposition. The distractor preposition in the second version could be semantically congruent in a different context. For example, although *the boy waved to the mosquitoes in front of him*

was anomalous in the intended context, *waved to* would be acceptable when the recipient was a person. By contrast, the unacceptable preposition produced a more severe semantic anomaly, as in *the boy waved over the mosquitoes in front of him*. Because the semantic anomaly associated with distractor prepositions was more difficult to detect, L2 learners might frequently confuse them with the target prepositions. The sentence context preceding and following the critical preposition was kept identical across the three versions of each item. Thus, the versions differed only in the critical preposition, allowing responses to be attributed more directly to differences in prepositional meaning. The 180 target items, each with three versions, resulted in a pool of 540 target-item sentences. An additional 24 filler sentences containing other prepositions were included, producing a complete stimulus pool of 564 sentences.

The 540 target-item sentences were distributed across three counterbalanced test lists. Each list contained only one version of each target item: 60 target sentences, 60 distractor sentences, and 60 unacceptable sentences. The 24 filler sentences were also included, resulting in 204 trials in each AJT administration. The pretest and posttest assessed the same 180 underlying target items and form–function mappings, but different test lists were used across the two testing occasions. Participants were therefore not presented with the same item version at pretest and posttest. Trial order was also randomised within each administration. These procedures were intended to reduce direct item-repetition, practice, and ordering effects, although some familiarity with the underlying sentence contexts could not be ruled out. All sentences ranged from 9 to 12 words. Table 1 presents sample items in their three respective versions. Three L1 English speakers evaluated whether the items reflected their intended acceptability conditions, and revisions were made until consensus was reached.

Table 1. Sample sentences with target prepositions, distractor prepositions, and unacceptable prepositions in the acceptability judgment test

	Target prepositions	Distractor prepositions	Unacceptable prepositions
Spatial senses	The girl was <u>in</u> her room tidying her closet.	The girl was <u>at</u> a bad mood because she was tired.	The girl was <u>from</u> a bad mood because she was tired.
	The hunter shot <u>at</u> the birds on the oak tree.	The hunter shot <u>to</u> the birds on the oak tree.	The hunter shot <u>with</u> the birds on the oak tree.
	The boy slept <u>on</u> the bus because of the heavy traffic jam.	The boy slept <u>at</u> the bus because of the heavy traffic jam.	The boy slept <u>to</u> the bus because of the heavy traffic jam.
Non-spatial senses	The patient was <u>in</u> a coma after the car accident.	The patient was <u>on</u> a coma after the car accident.	The patient was <u>from</u> a coma after the car accident.
	The boss yelled <u>at</u> the worker for being late.	The boss yelled <u>to</u> his worker for being late.	The boss yelled <u>in</u> his worker for being late.
	The project was <u>on</u> hold due to a lack of money.	The project was <u>in</u> hold due to the lack of money.	The project was <u>to</u> hold due to the lack of money.

The testing was administered via a stimulus-delivery program written with the PsychoPy package. After the initial setup, the research assistant went through the instructional page

shown on the computer screen. After six practice trials, the participant pressed the space bar to begin the test. All participants were reminded to minimise eye and body movements during the EEG session. Each test trial in the AJT was presented in five to eight segments (Zhao et al., 2020), with each segment containing one to three words, for instance, *Her boss / jumped / at / the opportunity / without / much / thinking*. The head noun phrase was always positioned in the first segment of each sentence and the verb in the second. The preposition was always presented in the third segment, followed by the succeeding noun phrase in the fourth segment. Each trial started with a fixation cross [+] appearing at the centre of the screen for one second before the display of the first segment. The sentence was presented one segment at a time for 600 ms, with an interval of 600 ms between segments (see Figure 3). This relatively slow presentation rate was selected to allow the intermediate L2 learners sufficient time to process the multiword segments and to reduce overlap between neural responses to successive segments; however, it may have encouraged more deliberate processing than occurs during natural reading. The last segment of each sentence was followed by a 500-ms blank screen and then the prompt “???”. Participants were given up to two seconds to decide whether the sentence was acceptable by pressing the A key for acceptable or the K key for unacceptable. A blank screen appeared immediately after the participant responded and lasted between 500 and 2,500 ms, depending on the participant’s reaction time. The interval between trials was kept at 2,500 ms. A one-minute break was given every 30 trials.

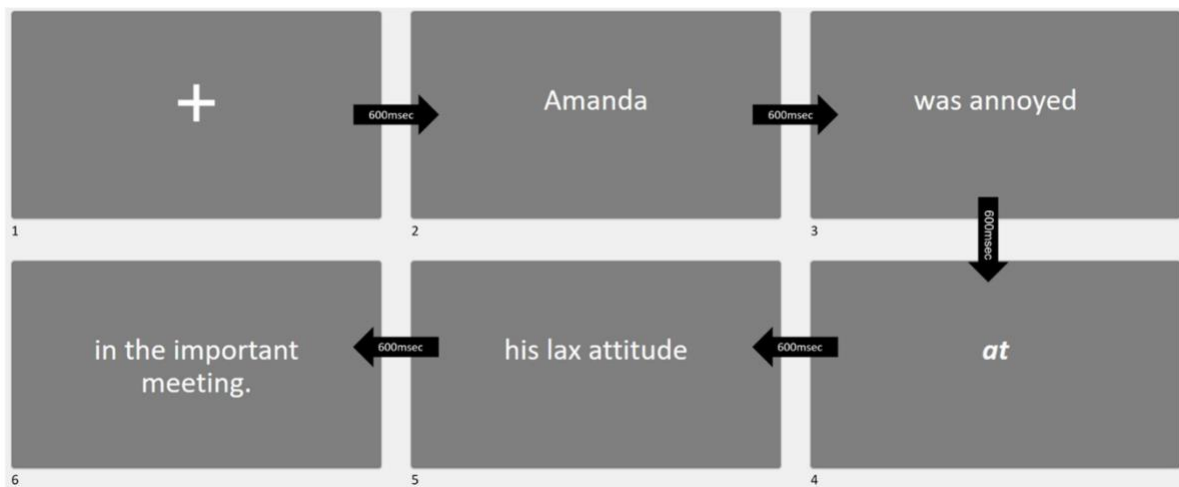


Figure 3. *The sample screen of a test trial.*

Procedure

The study consisted of two experimental sessions for the L2 participants, whereas the L1 participants completed only the first session. At the beginning of the first session, all participants provided informed consent and completed a 10-minute language background questionnaire. A research assistant then fitted each participant with an EEG cap, after which they completed the pretest AJT while EEG data were recorded. The L1 participants completed their involvement after this session. Following the pretest AJT, the EEG caps were removed from the L2 participants. They were then randomly assigned to either the CL-informed instruction group or the traditional instruction group and completed the 60-minute

computerised preposition training. EEG data were not recorded during the training because the study focused on changes in neurocognitive processing following instruction rather than processing during the instructional period. After completing the training, the L2 participants were fitted with the EEG caps again and completed the posttest AJT while EEG data were recorded. The posttest assessed the same underlying form–function mappings as the pretest but used a different counterbalanced test list, as described in the AJT section.

Electroencephalogram Recording

To acquire the EEG data, the participants were presented with a stimulus-delivery program written with the PsychoPy package while wearing a 32-channel Emotiv EPOC Flex Saline system with a pre-set EASY cap. The electrodes were placed at specific locations on participants' scalps based on the 10-20 international system, including Cz, Fz, F7, F3, FC1, C3, FC5, FT9, T7, CP5, CP1, P3, P7, PO9, O1, Pz, Oz, O2, PO10, P8, P4, CP2, CP6, T8, FT10, FC6, C4, FC2, F4, F8, FP1 and FP2. We used mastoids as the reference. For detecting the eye-related artifacts, vertical electrooculogram was recorded with two electrodes placed above and below the right eye, while the horizontal electrooculogram was recorded with the electrodes placed on the left and right outer canthi. The sampling rate of the headset was 128 Hz, and the impedance was kept below 10 k Ω . The 128-Hz sampling rate was the fixed output rate of the recording system and provided lower temporal resolution than that of many contemporary EEG systems. Although the impedance criterion of below 10 k Ω was appropriate for the saline system, it was higher than the criteria commonly used with gel-based systems.

Analysis

Behavioural Analysis. To address the first research question, separate 2×2 mixed ANOVAs were conducted for each sentence condition—target, distractor, and unacceptable—with time (pretest and posttest) as the within-participants factor and instructional group (CL-informed and traditional definition-oriented instruction) as the between-participants factor. Response accuracy and reaction time were analysed as dependent variables. To address the second research question, baseline differences in accuracy and reaction time across the three sentence conditions were first examined separately for the L1 and L2 groups using repeated-measures ANOVAs. Independent-samples *t*-tests with Bonferroni correction were then used to compare the L1 and L2 groups within each sentence condition. Post-training performance was examined using independent-samples *t*-tests comparing the L1 group separately with the CL-informed and traditional instruction groups for accuracy and reaction time in each sentence condition.

EEG Preprocessing and ERP Analysis. EEG preprocessing was conducted using the MNE-Python package. A high-pass filter of 0.05 Hz and a low-pass filter of 60 Hz were applied to the signals. Epochs for the target, distractor, and unacceptable conditions were extracted from 200 ms before to 1,000 ms after the onset of the critical preposition. Epochs containing EEG signals exceeding 150 μ V or eye-blink artefacts were rejected, and trials containing other artefacts were also excluded. The remaining epochs were averaged separately for each participant, sentence condition, and electrode. To address the first research question, 2×2 mixed ANOVAs were conducted on mean amplitude in the N400 time window of 350–450 ms, with time as the within-participants factor and instructional group as the between-participants factor.

Analyses were conducted separately for the three sentence conditions across the anterior and posterior regions and at the midline electrodes. For the baseline L1–L2 comparisons, ERP responses to the three sentence conditions were examined at the midline electrodes Fz, Cz, Pz, and Oz within the N400 window of 350–450 ms and the P600 window of 550–650 ms. These electrodes were selected to capture differences across the anterior-to-posterior scalp distribution and to facilitate comparison with previous ERP studies. Differences among the sentence conditions were examined separately for the L1 and L2 groups. For the post-training comparisons, independent-samples *t*-tests were conducted to compare the L1 group separately with the CL-informed and traditional instruction groups. Amplitude and latency were examined at Fz, Cz, Pz, and Oz within the N200 window of 200–300 ms, the N400 window of 350–450 ms, and the P600 window of 550–650 ms. The time windows were determined through inspection of the grand-average waveforms with reference to previous research.

Effect-Size Measures. Hedges' *g* was reported for between-group comparisons. It is a bias-corrected version of Cohen's *d* and was selected because some comparison groups were relatively small. Positive and negative values indicate the direction of the group difference, whereas the absolute value reflects its magnitude. As general descriptive benchmarks, absolute values of approximately 0.20, 0.50, and 0.80 may be interpreted as small, medium, and large effects, respectively.

Partial eta squared (ηp^2) was reported for the ANOVA results. It represents the proportion of variance associated with a particular effect after accounting for the other effects included in the model. Values of approximately .01, .06, and .14 may be treated as small, medium, and large effects, respectively. These benchmarks were used only as general guidelines. Effect-size estimates were interpreted together with their 95% confidence intervals, and intervals with lower bounds at or near zero were taken to indicate substantial uncertainty in the magnitude of the corresponding effect.

Results

Do CL-informed and traditional instruction produce different effects on the learning and processing of matched and mismatched prepositional phrases?

The first research question examined whether CL-informed and traditional instruction differed in their effects on L2 learners' processing of matched and mismatched prepositional phrases. Significant time-by-instruction interactions were found for accuracy in sentences containing target prepositions, $F(1, 43) = 6.06$, $p = .018$, $\eta^2 = .124$, 95% CI [.003, .308], and distractor prepositions, $F(1, 43) = 4.62$, $p = .037$, $\eta^2 = .097$, 95% CI [.000, .277]. These interactions indicated that changes in accuracy from pretest to posttest differed between the two instructional groups, with greater gains among learners receiving CL-informed instruction than among those receiving traditional instruction (see Table 2).

Table 2. Two-Way Mixed ANOVA on Accuracy and Reaction time at different Trial types.

		Main effect of time				Main effect of Instructional Group				Interaction effect			
Trial type		df	F	p	Partial Eta Squared	df	F	p	Partial Eta Squared	df	F	p	Partial Eta Squared
Target	Accuracy	(1,43)	7.899	0.007**	0.155	(1,43)	1.010	0.320	0.023	(1,43)	6.062	0.018*	0.124
	Reaction time	(1,43)	10.561	0.002**	0.197	(1,43)	3.629	0.063	0.078	(1,43)	3.204	0.081	0.069
Unacceptable	Accuracy	(1,43)	112.177	0.000***	0.723	(1,43)	0.187	0.667	0.004	(1,43)	0.575	0.453	0.013
	Reaction time	(1,43)	13.493	0.001**	0.239	(1,43)	3.189	0.081	0.069	(1,43)	2.415	0.128	0.053
Distractor	Accuracy	(1,43)	110.772	0.000***	0.720	(1,43)	1.271	0.266	0.029	(1,43)	4.621	0.037*	0.097
	Reaction time	(1,43)	5.778	0.021*	0.118	(1,43)	3.666	0.062	0.079	(1,43)	0.585	0.449	0.013

Note. The analyses included L2 learners with available pretest and posttest behavioural data.

For the ERP results, a significant time-by-instruction interaction was found for the mean amplitude elicited by distractor sentences in the N400 time window over the posterior region, $F(1, 39) = 5.270, p = .027, \eta^2 = .119, 95\% \text{ CI } [.000, .311]$. Significant main effects of time were also observed over the anterior region for distractor sentences, $F(1, 39) = 5.070, p = .030, \eta^2 = .115, 95\% \text{ CI } [.000, .307]$, and unacceptable sentences, $F(1, 39) = 5.309, p = .027, \eta^2 = .120, 95\% \text{ CI } [.000, .312]$ (see Table 3). In addition, significant time-by-instruction interactions were observed for unacceptable sentences at Pz, $F(1, 39) = 5.177, p = .028, \eta^2 = .117, 95\% \text{ CI } [.000, .309]$, and Oz, $F(1, 39) = 5.097, p = .030, \eta^2 = .116, 95\% \text{ CI } [.000, .307]$ (see Table 4). Although these tests reached statistical significance, several effect-size confidence intervals had lower bounds at or near zero, indicating uncertainty in the magnitude of the observed effects.

Table 3. Two-way Mixed ANOVA on Anterior and Posterior for 350 – 450 ms time window

		Main effect of Time				Main effect of Instructional Group				Interaction effect			
	Sentence Type	df	F	p	Partial Eta Squared	df	F	p	Partial Eta Squared	df	F	p	Partial Eta Squared
Anterior	Target	(1,39)	.402	.530	.010	(1,39)	.434	.514	.011	(1,39)	.550	.463	.014
	Distractor	(1,39)	5.070	.030*	.115	(1,39)	.756	.390	.019	(1,39)	.538	.468	.014
	Unacceptable	(1,39)	5.309	.027*	.120	(1,39)	.791	.379	.020	(1,39)	1.225	.275	.030
Posterior	Target	(1,39)	1.590	.215	.039	(1,39)	.539	.467	.014	(1,39)	.838	.366	.021
	Distractor	(1,39)	2.479	.123	.060	(1,39)	2.746	.106	.066	(1,39)	5.270	.027*	.119
	Unacceptable	(1,39)	.167	.685	.004	(1,39)	.665	.420	.017	(1,39)	.672	.417	.017

Note. The analyses included L2 learners with available pretest and posttest behavioural data.

Table 4. Two-way Mixed ANOVA on midline electrodes (Cz, Fz, Pz, Oz) at 350 – 450 ms time window

Electrode	Sentence Type	Main effect of time				Main effect of Instructional Group				Interaction effect			
		df	F	p	Partial Eta Squared	df	F	p	Partial Eta Squared	df	F	p	Partial Eta Squared
Cz	Target	(1,39)	1.410	.242	.035	(1,39)	.772	.385	.019	(1,39)	.939	.339	.024
	Distractor	(1,39)	1.083	.304	.027	(1,39)	.000	1.000	.000	(1,39)	.000	1.000	.000
	Unacceptable	(1,39)	.403	.529	.010	(1,39)	.337	.565	.009	(1,39)	.581	.450	.015
Fz	Target	(1,39)	.307	.582	.008	(1,39)	.326	.571	.008	(1,39)	.472	.496	.012
	Distractor	(1,39)	1.612	.212	.040	(1,39)	1.846	.182	.045	(1,39)	.002	.963	.000
	Unacceptable	(1,39)	.252	.619	.006	(1,39)	.509	.480	.013	(1,39)	.920	.343	.023
Pz	Target	(1,39)	.024	.879	.001	(1,39)	.388	.537	.010	(1,39)	.447	.508	.011
	Distractor	(1,39)	.848	.363	.021	(1,39)	.000	1.000	.000	(1,39)	.000	1.000	.000
	Unacceptable	(1,39)	.020	.888	.001	(1,39)	.034	.855	.001	(1,39)	5.177	.028*	.117
Oz	Target	(1,39)	.172	.680	.004	(1,39)	.322	.574	.008	(1,39)	.481	.492	.012
	Distractor	(1,39)	.485	.490	.012	(1,39)	.000	1.000	.000	(1,39)	.000	1.000	.000
	Unacceptable	(1,39)	.000	1.000	.000	(1,39)	.005	.946	.000	(1,39)	5.097	.030*	.116

Note. The analyses included L2 learners with available pretest and posttest behavioural data.

How do L2 performance and neurocognitive processing differ before and after instruction compared with those of L1 speakers?

First, baseline performance was compared between the L1 and L2 speakers across the target, distractor, and unacceptable sentence conditions. For the L1 speakers, there were no significant condition effects on accuracy, $F(2, 20) = 1.26$, $p = .304$, $\eta^2 = .112$, 95% CI [.000, .331], or reaction time, $F(2, 20) = 1.68$, $p = .211$, $\eta^2 = .144$, 95% CI [.000, .368]. For the L2 speakers, however, there was a significant condition effect on accuracy, $F(2, 90) = 49.39$, $p < .001$, $\eta^2 = .523$, 95% CI [.372, .620], with the highest accuracy for target sentences and the lowest accuracy for distractor sentences. There was no significant condition effect on reaction time, $F(2, 90) = 1.68$, $p = .211$, $\eta^2 = .036$, 95% CI [.000, .123], although the L2 speakers responded descriptively more slowly to distractor and unacceptable sentences. The L1 speakers had significantly higher accuracy than the L2 speakers for target sentences, $t(55) = 4.002$, $p < .001$, $g = 1.327$, 95% CI [.637, 2.045]; unacceptable sentences, $t(55) = 5.764$, $p < .001$, $g = 1.910$, 95% CI [1.179, 2.680]; and distractor sentences, $t(55) = 6.944$, $p < .001$, $g = 2.299$, 95% CI [1.535, 3.112] (see Table 5). No significant differences in reaction time were found between the L1 and L2 speakers, although the L1 speakers responded descriptively faster across all three sentence conditions (see Table 6).

Table 5. Mean accuracy rate of L1 vs L2 speakers of English for different sentence conditions

Condition	L1 speakers of English			L2 speakers of English			t	p	Hedges'g	95% CI
	N	Mean	Std. Deviation	N	Mean	Std. Deviation				
Target	11	0.896	0.059	46	0.759	0.109	4.002	.000	1.328	[0.633, 2.023]
Distractor	11	0.843	0.091	46	0.514	0.150	6.944	.000	2.299	[1.521, 3.078]
Unacceptable	11	0.878	0.077	46	0.606	0.151	5.764	.000	1.910	[1.169, 2.650]

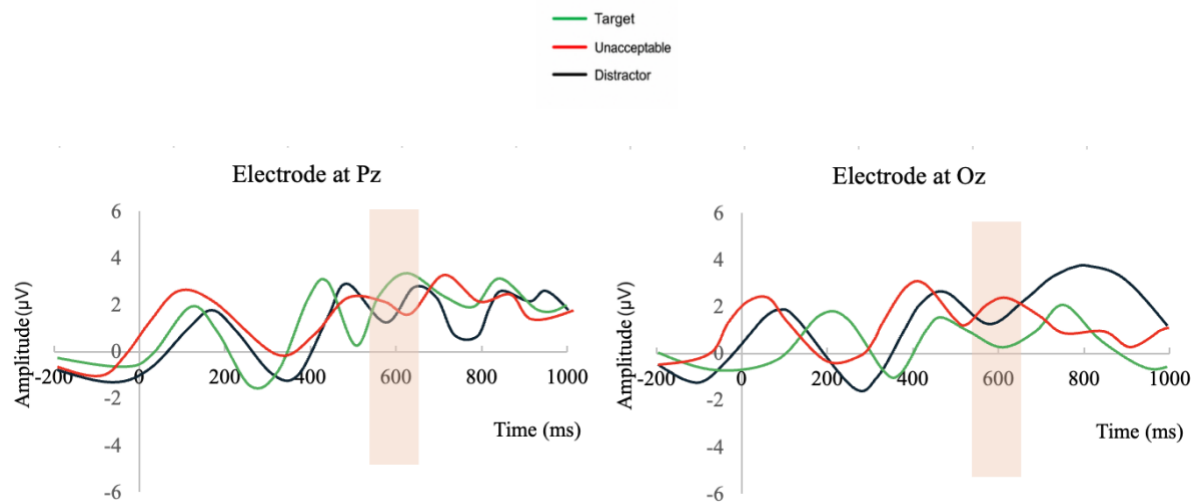
*** $p < 0.001$

Note. The baseline comparisons include 11 L1 speakers and 46 L2 learners.

Table 6. Mean reaction time of L1 vs L2 speakers of English for different sentence conditions

Condition	L1 speakers of English			L2 speakers of English			t	p	Hedges' g	95%CI
	N	Mean(s)	Std. Deviation(s)	N	Mean(s)	Std. Deviation(s)				
Target	11	0.584	0.176	46	0.632	0.193	-.759	.451	-0.249	[-0.900, 0.401]
Distractor	11	0.646	0.135	46	0.653	0.186	-.124	.902	-0.039	[-0.688, 0.610]
Unacceptable	11	0.616	0.151	46	0.653	0.177	-.632	.530	-0.211	[-0.862, 0.439]

For the ERP results, no statistically significant condition effects were observed for the L1 speakers in the N400 time window across the midline electrodes (all $ps \geq .09$). In the P600 time window, however, significant condition effects were found at Fz, $F(2, 82) = 4.36, p = .016, \eta^2 = .096$, 95% CI [.003, .215], and Cz, $F(2, 82) = 2.97, p = .047, \eta^2 = .068$, 95% CI [.000, .177]. P600 amplitudes were greater for unacceptable sentences than for target and distractor sentences. For the L2 speakers, no significant condition effects were observed in either the N400 or P600 time window (all $ps \geq .10$; see Figure 4).

**Figure 4. Representative grand-mean waveforms at Pz and Oz for L2 learners processing target, unacceptable, and distractor sentences at pretest.**

Second, the post-training performance of the two L2 instructional groups was compared with that of the L1 speakers. No statistically significant differences in accuracy or reaction time were found between the L1 speakers and the CL-informed group across the three sentence conditions (all $ps > .05$). By contrast, although no significant reaction-time differences were found between the L1 speakers and the traditional instruction group, the traditional group showed significantly lower accuracy for distractor sentences, $t(30) = 3.397, p = .001, g = 1.110$,

95% CI [.346, 1.914], and unacceptable sentences, $t(30) = 2.102$, $p = .044$, $g = .832$, 95% CI [.086, 1.607].

For the ERP measures, no statistically significant differences in the amplitude or latency of the analysed N200, N400, and P600 components were found between the L1 speakers and the CL-informed group across Fz, Cz, Pz, and Oz (all $ps > .05$). Compared with the L1 speakers, however, the traditional instruction group showed a significantly reduced P600 amplitude at Fz for distractor sentences, $t(33) = 2.972$, $p < .05$, $g = 1.035$, and at Cz for unacceptable sentences, $t(33) = 2.253$, $p < .05$, $g = .784$ (see Figure 5).

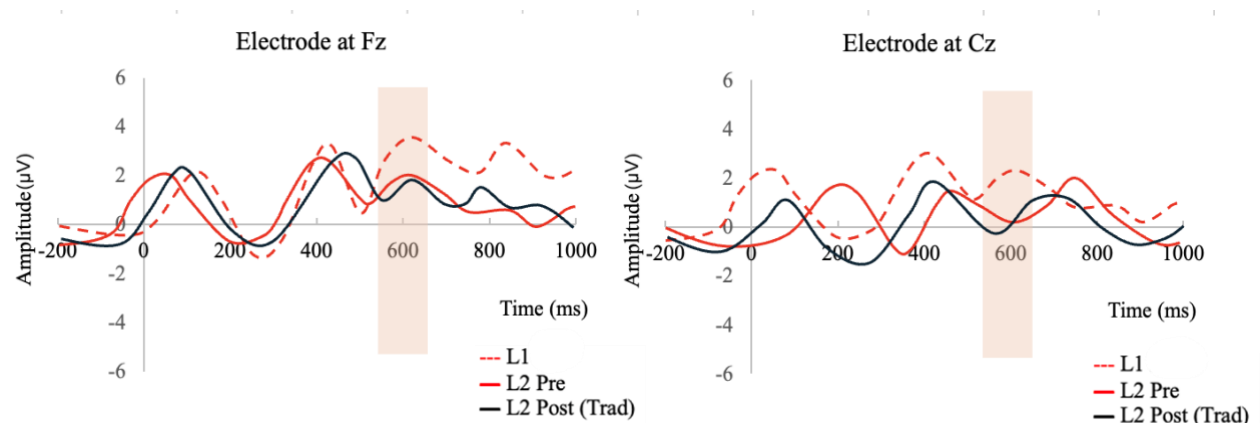


Figure 5. Grand mean waveforms at Fz for distractor sentences (left) and at Cz for unacceptable sentences (right), comparing the L1 speakers with the L2 learners in the traditional instruction group at pretest and posttest.

Discussion

Relatively little research has examined the neurocognitive changes associated with CL-informed instruction on English prepositions. The present study therefore compared the effects of CL-informed and traditional definition-oriented instruction on L2 learners' behavioural performance and ERP responses. The two instructional groups received the same training items, target–distractor contrasts, amount of practice, and training duration but differed in the instructional feedback provided. The study also compared L2 performance and neurocognitive processing before and after instruction with those of L1 English speakers. Overall, the findings indicated an advantage for CL-informed feedback in supporting accuracy and changes in semantic processing, particularly for target and distractor prepositions.

Changes in L2 Behavioural and Neurocognitive Processing Following Instruction

The behavioural results revealed significant time-by-instruction interactions for accuracy in the target and distractor sentence conditions. L2 learners in the CL-informed group showed greater improvements in accuracy than those in the traditional instruction group when processing target and distractor prepositions. This finding suggests that, within a shared minimal-pair training format, CL-informed feedback may support learners' ability to distinguish target prepositions from their most plausible competitors more effectively than traditional definition-oriented feedback.

Because minimal-pair presentation was used in both instructional conditions, the between-group difference cannot be attributed to the minimal-pair format alone. Rather, within this shared contrastive training format, CL-informed feedback produced greater gains than traditional definition-oriented feedback. Presenting target and distractor prepositions in minimal pairs may have helped learners in both groups attend to subtle semantic contrasts. The additional advantage observed for the CL-informed group may therefore reflect the contribution of schematic representations and cognitive-semantic explanations beyond that shared contrastive practice. Nevertheless, because instructional feedback and presentation format were not independently manipulated, the present study cannot determine whether CL-informed feedback would have produced the same advantage without minimal-pair contrasts or whether its effectiveness was enhanced by this presentation format.

The behavioural results can also be compared with those reported by Wong et al. (2018) and Wong (2023). Instead of using an untimed receptive assessment, such as a sentence-level cloze task, the present study adopted a timed receptive assessment and detected an advantage for CL-informed instruction. These findings suggest that CL-informed instruction may have facilitated relatively rapid access to prepositional knowledge under time pressure. Timed measurements have sometimes been used to elicit more implicit or automatised knowledge (Morgan-Short et al., 2012, 2022). However, performance on a timed AJT alone cannot establish that the knowledge acquired was implicit. This interpretation should therefore be regarded as suggestive rather than conclusive.

The ERP results also revealed differences in changes across the two instructional groups. A significant time-by-instruction interaction was found for the mean N400 amplitude elicited by distractor sentences over the posterior region. Significant time-by-instruction interactions were also observed for unacceptable sentences at Pz and Oz. In addition, significant main effects of time were found for distractor and unacceptable sentences over the anterior region.

Given that the N400 is commonly associated with semantic access and integration, these findings suggest that instruction was accompanied by changes in learners' sensitivity to the semantic appropriateness of prepositions.

The findings extend those of Zhao et al. (2020), who reported an increase in N400 amplitude following CL-informed training but found no significant post-training difference between the CL-informed and traditional instruction groups. One possible explanation is that the larger number of test items and the more balanced instructional conditions in the present study provided greater sensitivity to changes in semantic processing. The N400 findings may therefore reflect increased learner sensitivity to semantic anomalies involving distractor and unacceptable prepositions. However, several effect-size confidence intervals had lower bounds at or near zero, indicating uncertainty in the magnitude of the observed effects. The results should therefore not be interpreted as definitive evidence that the two groups adopted categorically different or more efficient processing mechanisms.

Unlike the N400 findings, no statistically reliable post-training P600 condition effect was detected among the L2 learners. The 60-minute intervention may have been sufficient to support behavioural improvement and changes in semantic sensitivity but insufficient to establish the more stable controlled or reanalytic processing sometimes associated with the P600. This interpretation is consistent with evidence that P600 effects tend to be more reliably observed among learners at higher levels of L2 proficiency (Grey et al., 2018).

A further possibility concerns the nature of the stimuli. The critical contrasts primarily involved the semantic appropriateness of prepositions in context rather than clear morphosyntactic violations. Although participants were required to make explicit acceptability judgements, the sentences may not have consistently triggered the structural reanalysis or repair processes frequently associated with the P600. Moreover, the functional significance of the P600 remains debated and has been linked to several processes, including reanalysis, integration, monitoring, and retrieval (Brouwer et al., 2012; Freunberger et al., 2022). The absence of a reliable P600 condition effect should therefore not be interpreted as evidence that the instruction produced no neurocognitive change. Rather, the most readily detectable short-term changes appeared to concern semantic sensitivity, as reflected primarily in the N400 findings.

L2 Performance and Processing in Relation to L1 Speakers

With respect to baseline performance, the L1 speakers showed no significant condition differences in accuracy or reaction time. The descriptive statistics nevertheless showed that their accuracy was highest for target prepositional phrases, followed by unacceptable and distractor prepositional phrases. The same ordering was observed in the L2 learners' baseline accuracy, confirming that distractor prepositions caused the greatest difficulty.

Among the L2 learners, accuracy differed significantly across sentence conditions, with better performance on target than on distractor sentences. Distractor prepositions can be particularly confusing because they may combine plausibly with the verb but remain inappropriate in the surrounding context. For example, *she waved to the mosquitoes* is semantically anomalous in the intended context. By contrast, *she waved to her friend* is semantically plausible. The subtle difference lies in the semantic representations of the competing prepositions: *at* may indicate directing an action towards a target, whereas *to*

identifies the recipient of a communicative gesture. Because both *wave at* and *wave to* occur frequently, learners require a refined understanding of their meanings to distinguish matched from mismatched prepositions (MacWhinney, 2018; Wong, 2023).

Zane and Shafer (2018) similarly pointed out that prepositions are highly versatile and combine with a wide range of nouns, which can make the acceptability of particular semantic representations difficult to judge. The finding that distractor prepositions were the most challenging condition therefore has implications for classroom pedagogy. Teachers may need to draw learners' attention explicitly to the semantic differences between competing prepositions rather than teaching each preposition through isolated definitions.

For the baseline ERP results, reliable late positive effects were found among the L1 speakers when they processed sentences containing unacceptable prepositions. These effects emerged within the 550–650-ms window, which is consistent with the timing of the P600. The P600 has often been elicited in response to morphosyntactic violations and has also been associated with the reanalysis of semantically incongruous or unexpected words in context (Troyer & Kutas, 2020).

No statistically reliable N400 or P600 condition effects were found in the L2 learners' baseline processing of mismatched prepositional phrases. Representative L2 pretest waveforms at Pz and Oz are presented in Figure 4. This finding may indicate that the L2 learners' knowledge of the relevant prepositional meanings was not sufficiently robust for the semantic differences among the conditions to produce reliable ERP effects. It is also consistent with evidence that P600 effects are more reliably observed at higher levels of L2 proficiency (Grey et al., 2018). However, the absence of a statistically significant ERP effect should not be interpreted as evidence that learners were entirely insensitive to the sentence anomalies.

Following CL-informed instruction, no statistically significant differences in accuracy or reaction time were found between the L2 learners and the L1 speakers across the three sentence conditions. In contrast, learners who received traditional instruction continued to show significantly lower accuracy than the L1 speakers in the distractor and unacceptable conditions. These findings suggest that CL-informed instruction supported substantial behavioural improvement, particularly in learners' ability to identify mismatched prepositional phrases. However, the absence of statistically significant differences between the CL-informed and L1 groups should not be interpreted as evidence of statistical equivalence or fully L1-like performance, particularly given the small L1 comparison sample.

The post-training ERP comparisons also require cautious interpretation. No statistically significant differences in the amplitude or latency of the analysed N200, N400, and P600 components were found between the L1 speakers and learners in the CL-informed group. This means that the analyses did not detect reliable group differences, but it does not demonstrate that the groups engaged identical neurocognitive mechanisms.

By contrast, learners in the traditional instruction group showed a significantly reduced P600 amplitude at Fz for distractor sentences and at Cz for unacceptable sentences relative to the L1 speakers, as illustrated in Figure 5. These differences may reflect less robust recruitment of later-stage reanalysis or integration processes when learners encountered semantically inappropriate prepositions. This interpretation must remain tentative, however, given the debated functional significance of the P600, the small L1 sample, and the absence of a reliable post-training P600 condition effect within the L2 learners themselves.

Overall, the findings suggest that CL-informed feedback supported learners' behavioural performance and sensitivity to relationships among prepositional meanings more effectively than traditional definition-oriented feedback within the shared minimal-pair format. The clearest evidence concerned accuracy and N400 responses associated with semantic processing. Evidence concerning later P600 processing and convergence with L1 speakers was less conclusive.

Conclusion and Limitations

In sum, the present study provides further behavioural and neurocognitive evidence supporting the pedagogical potential of CL-informed instruction. To the best of our knowledge, it is among the first studies to examine changes in both L2 behavioural performance and neurocognitive processing before and after preposition training while also comparing L2 processing patterns with those of L1 English speakers. The behavioural findings demonstrated a distinct advantage for CL-informed instruction, with learners outperforming those in the traditional instruction group, particularly when processing target and distractor prepositions. The findings also provide behavioural and N400 evidence of increased sensitivity to prepositional meaning following CL-informed instruction. By contrast, in the post-training comparisons with L1 speakers, learners receiving traditional instruction remained less accurate in the distractor and unacceptable conditions, suggesting continued difficulty in detecting mismatched prepositional phrases. Moreover, several statistically significant effects were accompanied by wide effect-size confidence intervals with lower bounds at or near zero, indicating uncertainty in the magnitude and precision of the observed effects.

Several limitations should nevertheless be considered. First, no reliable post-training P600 condition effect was detected among the L2 learners. Evidence for convergence between L2 and L1 neurocognitive processing should therefore be interpreted cautiously. In addition, although 12 L1 speakers were recruited, usable data from only 11 were included in the reported comparisons. This small L1 analytical sample may have limited the stability and precision of the estimated ERP amplitudes and latencies. Accordingly, the absence of statistically significant differences between the CL-informed and L1 groups should not be interpreted as evidence of statistical equivalence or fully native-like processing. Future research with a larger L1 sample is needed to obtain more stable ERP estimates and assess the generalisability of the observed patterns.

Second, the present design did not independently manipulate instructional approach and presentation format. It therefore cannot determine whether CL-informed feedback would produce comparable effects without minimal-pair contrasts or whether its effectiveness was enhanced by minimal-pair presentation. A future 2×2 design crossing instructional feedback type—CL-informed versus traditional—with presentation format—minimal-pair versus non-minimal-pair—would be needed to identify their independent and interactive effects.

Several technical limitations should also be considered when interpreting the ERP findings. The 128-Hz sampling rate provided lower temporal resolution than that available from many contemporary EEG systems. Although broad amplitude changes within the N400 and P600 windows could be examined, peak-latency estimates should be interpreted cautiously. The relatively slow segment-presentation rate reduced overlap between responses to adjacent sentence segments but may have encouraged more deliberate processing and reduced the

ecological validity of the reading task. In addition, although the impedance criterion of below 10 k Ω was appropriate for the saline recording system, it was less stringent than the criteria commonly used with gel-based systems. Finally, the 150- μ V artifact-rejection threshold was relatively liberal and may have allowed some residual noise to remain in the retained epochs. Future studies should replicate the findings using a higher sampling rate, a faster or more naturalistic presentation paradigm, and more conservative or systematically evaluated artifact-rejection procedures.

Despite these limitations, the findings shed light on how instruction and assessment can be designed to develop and evaluate learners' knowledge of preposition use. For example, teachers could use class time to discuss the subtle yet crucial semantic differences between target and distractor prepositions while leaving drilling and reinforcement to computer-assisted training. For assessment purposes, material developers could use corpus data and machine-learning techniques to estimate which prepositions compete most strongly in particular contexts and use these as distractors in test items, thereby better reflecting the choices that learners may encounter in authentic language use.

Acknowledgement

This work has been fully supported by the University Research Grant of Hong Kong Shue Yan University (URG21/02) and partially supported by (Hong Kong Standing Committee on Language Education and Research (SCOLAR) grant (EDB(LE)/P&R/EL/203), both awarded to the first author.

References

- Anderson, J. R. (1995). Developing expertise. In J. R. Anderson (Ed.), *Cognitive psychology and its implications* (4th ed., pp. 272–304). New York: W. H. Freeman
- Batterink, L. J., Oudiette, D., Reber, P. J., & Paller, K. A. (2014). Sleep facilitates learning a new linguistic rule. *Neuropsychologia*, 65, 169–179. <https://doi.org/10.1016/j.neuropsychologia.2014.10.024>
- Batterink, L. J., Reber, P. J., Neville, H. J., & Paller, K. A. (2015). Implicit and explicit contributions to statistical learning. *Journal of Memory and Language*, 83, 62–78. <https://doi.org/10.1016/j.jml.2015.04.004>
- Boers, F., & Demecheleer, M. (1998). A cognitive semantic approach to teaching prepositions, *ELT Journal*, 52(3), 197–204. <https://doi.org/10.1093/elt/52.3.197>
- Bowden, H. W., Steinhauer, K., Sanz, C., & Ullman, M. T. (2013). Native-like brain processing of syntax can be attained by university foreign language learners. *Neuropsychologia*, 51(13), 2492–2511. <https://doi.org/10.1016/j.neuropsychologia.2013.09.004>
- Brouwer, H., Fitz, H. & Hoeks, J. (2012). Getting real about semantic illusions: Rethinking the functional role of the P600 in language comprehension. *Brain Research*, 1446, 127–143. <https://doi.org/10.1016/j.brainres.2012.01.055>
- Celce-Murcia, M., & Larsen-Freeman, D. (1999). *The Grammar Book: An ESL/EFL Teacher's Course* (2nd Edition). U.S.: Heinle & Heinle Publishers.
- DeKeyser, R. (1998). Beyond focus on form: Cognitive perspectives on learning and practicing second language grammar. In C. Doughty & J. Williams (Eds.), *Focus on Form in Classroom Second Language Acquisition* (pp. 42–63). Cambridge: Cambridge University.

- Faretta-Stutenberg, M., & Morgan-Short, K. (2018). The interplay of individual differences and context of learning in behavioral and neurocognitive second language development. *Second Language Research*, 34(1), 67–101. <https://doi.org/10.1177/0267658316684903>
- Federmeier, K. D., & Kutas, M. (1999). A rose by any other name: Long-term memory structure and sentence processing. *Journal of Memory and Language*, 41(4), 469–495. <https://doi.org/10.1006/jmla.1999.2660>
- Freunberger, D., Bylund, E., & Abrahamsson, N. (2022). Is it time to reconsider the ‘Gold Standard’ for nativelikeness in ERP studies on grammatical processing in a second language? A critical assessment based on qualitative individual differences. *Applied Linguistics*, 43(3), 433–452. <https://doi.org/10.1093/applin/amab058>
- Friederici, A. D. (2002). Towards a neural basis of auditory sentence processing. *Trends in Cognitive Sciences*, 6(2), 78–84. [https://doi.org/10.1016/S1364-6613\(00\)01839-8](https://doi.org/10.1016/S1364-6613(00)01839-8)
- Glover, S., Rosenbaum, D.A., Graham, J., & Dixon, P. (2004). Grasping the meaning of words. *Experimental Brain Research*, 154, 103–108. <https://doi.org/10.1007/s00221-003-1659-2>
- Gouvea, A. C., Phillips, C., Kazanina, N., & Poeppel, D. (2010). The linguistic processes underlying the P600. *Language and Cognitive Processes*, 25(2), 149–188, <http://doi.org/10.1080/01690960902965951>
- Grey, S., Sanz, C., Morgan-Short, K., & Ullman, M. T. (2018). Bilingual and monolingual adults learning an additional language: ERPs reveal differences in syntactic processing. *Bilingualism: Language and Cognition*, 21(5), 970–994. <https://doi.org/10.1017/S1366728917000426>
- Grey, S., Tanner, D., & van Hell, J.G. (2017). How right is left? Handedness modulates neural responses during morphosyntactic processing. *Brain Research*, 1669, 27–43. <https://doi.org/10.1016/j.brainres.2017.05.024>
- Hagoort, P. (2003). Interplay between Syntax and Semantics during Sentence Comprehension: ERP Effects of Combining Syntactic and Semantic Violations. *Journal of Cognitive Neuroscience*, 15(6), 883–899. <https://doi.org/10.1162/089892903322370807>
- Hagoort, P., Brown, C. M., & Groothusen, J. (1993). The syntactic positive shift (sps) as an erp measure of syntactic processing. *Language and Cognitive Processes*, 8(4), 439–483. <https://doi.org/10.1080/01690969308407585>
- Hahne, A. (2001). What’s different in second-language processing? Evidence from event-related brain potentials. *Journal of Psycholinguistic Research*, 30, 251–266. <https://doi.org/10.1023/A:1010490917575>
- Hahne, A., & Friederici, A. D. (2001). Processing a second language: Late learners’ comprehension mechanisms as revealed by event-related brain potentials. *Bilingualism: Language and Cognition*, 4(2), 123–141. <https://doi.org/10.1017/S1366728901000232>
- Hampe, B. (2005). Image schemas in Cognitive Linguistics: Introduction. In B. Hampe (Ed.), *From Perception to Meaning* (pp. 1–14). Berlin, New York: De Gruyter Mouton. <https://doi.org/10.1515/9783110197532.0.1>
- Huddleston, R., & Pullum, G. (2002). *The Cambridge grammar of the English language*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/9781316423530>
- Kaan, E. (2007). Event-related potentials and language processing: A brief overview. *Language and Linguistics Compass*, 1(6), 571–591. <https://doi.org/10.1111/j.1749-818X.2007.00037.x>
- Kaan, E., Harris, A., Gibson, E., & Holcomb, P. (2000). The P600 as an index of syntactic integration difficulty. *Language and Cognitive Processes*, 15, 159–201. <https://doi.org/10.1080/016909600386084>

- Kaan, E., & Swaab, T. Y. (2003). Repair, revision, and complexity in syntactic analysis: An electrophysiological differentiation. *Journal of Cognitive Neuroscience*, 15(1), 98–110. <https://doi.org/10.1162/089892903321107855>
- Kolk, H., & Chwilla, D. (2007). Late positivities in unusual situations. *Brain and Language*, 100(3), 257–261. <https://doi.org/10.1016/j.bandl.2006.07.006>
- Kövecses, Z. (2017). Levels of metaphor. *Cognitive Linguistics*, 28(2), 321–347. <https://doi.org/10.1515/cog-2016-0052>
- Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: Finding meaning in the N400 component of the Event-Related Brain Potential (ERP). *Annual Review of Psychology*, 62(1), 621–647. <https://doi.org/10.1146/annurev.psych.093008.131123>
- Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh*. New York: Basic Books
- Lam, Y. (2009). Applying cognitive linguistics to teaching the Spanish prepositions *por* and *para*. *Language Awareness*, 18(1), 2–18. <https://doi.org/10.1080/09658410802147345>
- Lindstromberg, S. (2010). *English prepositions explained*. Amsterdam: John Benjamins.
- MacWhinney, B. (1997a). Implicit and explicit processes: Commentary. *Studies in Second Language Acquisition*, 19(2), 277–282. <https://doi.org/10.1017/S0272263197002076>
- MacWhinney, B. (2018). Attrition and the competition model. In M. Schmid (Ed.), *The Oxford Handbook of Language Attrition*. New York: Oxford University Press. <https://psyling.talkbank.org/years/2018/attrition-chapter.pdf>
- Mahpeykar, N., & Tyler, A. (2014). A principled Cognitive Linguistics account of English phrasal verbs with *up* and *out**. *Language and Cognition*, 7(1), 1–35. <https://doi.org/10.1017/langcog.2014.15>
- McLaughlin, J., Osterhout, L., & Kim, A. (2004). Neural correlates of second-language word learning: Minimal instruction produces rapid change. *Nature Neuroscience*, 7, 703–704. <https://doi.org/10.1038/nn1264>
- Morgan-Short, K., Finestrat, I., Luque, A. & Abugaber, D. (2022). Exploring new insights into explicit and implicit second language processing: Event-related potentials analyzed by source attribution. *Language Learning*, 72(2), 365–411. <https://doi.org/10.1111/lang.12492>
- Morgan-Short, K., Steinhauer, K., Sanz, C., & Ullman, M. (2012). Explicit and implicit second language training differentially affect the achievement of native-like brain activation patterns. *Journal of Cognitive Neuroscience*, 24(4), 933–947. https://doi.org/10.1162/jocn_a_00119
- Morgan-Short, K., & Tanner, D. (2014). Event-related potentials (ERPs). In J. Jegerski & B. VanPatten (Eds.), *Research methods in second language psycholinguistics* (pp. 127–152). New York: Routledge.
- Nichols, E. S., & Joanisse, M. F. (2019). Individual differences predict ERP signatures of second language learning of novel grammatical rules. *Bilingualism: Language and Cognition*, 22(1), 78–92. <https://doi.org/10.1017/S1366728917000566>
- Osterhout, L., & Holcomb, P. J. (1992). Event-related brain potentials elicited by syntactic anomaly. *Journal of Memory and Language*, 31(6), 785–806. [https://doi.org/10.1016/0749-596X\(92\)90039-Z](https://doi.org/10.1016/0749-596X(92)90039-Z)
- Pakulak, E., & Neville, H. J. (2011). Maturational constraints on the recruitment of early processes for syntactic processing. *Journal of Cognitive Neuroscience*, 23(10), 2752–2765. <https://doi.org/10.1162/jocn.2010.21586>
- Paradis, M. (2009). *Declarative and procedural determinants of second languages*. Amsterdam: John Benjamins Publishing. <https://doi.org/10.1075/sibil.40>

- Peters, E. (2016). The learning burden of collocations: The role of interlexical and intralexical factors. *Language Teaching Research*, 20(1), 113–138. <https://doi.org/10.1177/1362168814568131>
- Pulido, M.F. (2023). Generalizing knowledge of second language collocations: The roles of within- and cross-language similarity on acceptability and event-related potentials. *Language Learning*, 73(2), 578–612. <https://doi.org/10.1111/lang.12543>
- Quirk, R., Greenbaum, S., Leech, G., & Svartvik, J. (1985). *A comprehensive grammar of the English language*. London: Longman.
- Richardson, D. C., Spivey, M. J., Barsalou, L. W., & McRae, K. (2003). Spatial representations activated during real-time comprehension of verbs. *Cognitive Science*, 27(5), 767–780. https://doi.org/10.1207/s15516709cog2705_4
- Rommers, J., Dijkstra T., & Bastiaansen, M. (2013). Context-dependent semantic processing in the human brain: Evidence from idiom comprehension. *Journal of Cognitive Neuroscience*, 25(5), 762–776. https://doi.org/10.1162/jocn_a_00337
- Sandra, D., & Rice, S. (1995). Network analyses of prepositional meaning: Mirroring whose mind—The linguist's or the language user's?. *Cognitive Linguistics*, 6(1), 89–130. <https://doi.org/10.1515/cogl.1995.6.1.89>
- Schmidt-Kassow, M., & Kotz, S. A. (2009). Event-related brain potentials suggest a late interaction of meter and syntax in the P600. *Journal of Cognitive Neuroscience*, 21(9), 1693–1708. <https://doi.org/10.1162/jocn.2008.2115>
- Steinhauer, K. (2014). Event-related potentials (ERPs) in second language research: a brief introduction to the technique, a selected review, and an invitation to reconsider critical periods in L2. *Applied Linguistics*, 35(4), 393–417. <https://doi.org/10.1093/applin/amu028>
- Steinhauer, K., & Connolly, J. F. (2008). Event-related potentials in the study of language. In B. Stemmer & H. Whitaker (Eds.), *Handbook of the cognitive neuroscience of language* (pp. 91–104). San Diego: Elsevier. <https://doi.org/10.1016/B978-0-08-045352-1.00009-4>
- Street, J. A. (2017). This is the native speaker that the non-native speaker outperformed: Individual, education-related differences in the processing and interpretation of Object Relative Clauses by native and non-native speakers of English. *Language Sciences*, 59, 192–203. <https://doi.org/10.1016/j.langsci.2016.10.004>
- Swaab, T. Y., Ledoux, K., Camblin, C. C., & Boudewyn, M. A. (2012). Language related ERP components. In E. S. Kappenman & S. J. Luck (Eds.), *The Oxford Handbook of Event-Related Potential Components* (pp. 398–440). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780195374148.013.0197>
- Tanner, D., Osterhout, L., & Herschensohn, J. (2009). Snapshots of grammaticalization: Differential electrophysiological responses to grammatical anomalies with increasing L2 exposure. *Proceedings of the 33rd Boston University conference on language development* (pp. 528–539). Cascadilla Press.
- Tokowicz, N., & MacWhinney, B. (2005). Implicit and explicit measures of sensitivity to violations in second language grammar: An event-related potential investigation. *Studies in Second Language Acquisition*, 27(2), 173–204. <https://doi.org/10.1017/S0272263105050102>
- Troyer, M., & Kutas, M. (2020). To catch a snitch: Brain potentials reveal variability in the functional organization of (fictional) world knowledge during reading. *Journal of Memory and Language*, 113, Article 104111. <https://doi.org/10.1016/j.jml.2020.104111>
- Tyler, A. (2012). *Cognitive Linguistics and Second Language Learning: Theoretical Basics and Experimental Evidence*. New York: Routledge. <https://doi.org/10.4324/9780203876039>

- Tyler, A., & Evans, V. (2003). *The semantics of English prepositions: Spatial scenes, embodied meanings and cognition*. Cambridge: Cambridge University Press.
- Tyler, A., Huang, L., & Jan, H. (2018). *What is applied cognitive linguistics?: Answers from current SLA research*. Berlin, Boston: De Gruyter Mouton. <https://doi.org/10.1515/9783110572186>
- Tyler, A., Mueller, C., & Ho, V. (2010). Applying cognitive linguistics to instructed L2 learning: The English modals. *AILA Review*, 23(1), 30–49. <https://doi.org/10.1075/aila.23.03tyl>
- Tyler, A., Mueller, C., & Ho, V. (2011). Applying cognitive linguistics to learning the semantics of English preposition to, for, and at: An experimental investigation. *Vigo International Journal of Applied Linguistics*, 8, 181–205.
- van Hell, J. G., & Tokowicz, N. (2010). Event-related brain potentials and second language learning: syntactic processing in late L2 learners at different L2 proficiency levels. *Second Language Research*, 26(1), 43–74. <https://doi.org/10.1177/0267658309337637>
- Wong, M. H. I. (2023). Fostering conceptual understanding through computer-based animated schematic diagrams and cue contrast. *TESOL Quarterly*, 57(4), 1309–1338. <https://doi.org/10.1002/tesq.3195>
- Wong, M. H. I., Zhao, H., & MacWhinney, B. (2018). A cognitive linguistics application for second language pedagogy: The English preposition tutor. *Language Learning*, 68(2), 438–468. <https://doi.org/10.1111/lang.12278>
- Zane, E., & Shafer, V. (2018). Mixed metaphors: electrophysiological brain responses to (un)expected concrete and abstract prepositional phrases. *Brain Research*, 1680, 77–92. <https://doi.org/10.1016/j.brainres.2017.12.008>
- Zhao, H., Huang, S. T., Zhou, Y. C., & Wang, R. M. (2020). Schematic diagrams in second language learning of English prepositions: A behavioural and event-related potential study. *Studies in Second Language Acquisition*, 42(4), 721–748. <https://doi.org/10.1017/S0272226311900069X>
- Zwaan, R. A., Magliano, J., & Graesser, A. (1995). Dimensions of situated model construction in narrative comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 386–397. <https://doi.org/10.1037/0278-7393.21.2.386>

APPENDIX A. Sample screens for the CL-informed group and the traditional instruction group.

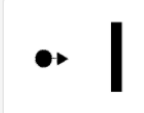
CL-informed instruction



Trajector: The empty beer bottle
Landmark: The wall



The preposition **AT** shows that the landmark (the wall) is being targeted/attacked by the trajector (the beer bottle) (用活动体对准界标).



The preposition **TO** shows that the trajector (the beer bottle) is moving towards and to be received (接收) by the landmark (the wall).

You must study the two schemas before making a choice.

- ☐ The man hurled the empty beer bottle **to** the wall.
- ☐ The man hurled the empty beer bottle **at** the wall.

(1 of 72)



Trajector: The empty beer bottle
Landmark: The wall

Correct! (+1 ★)

The preposition **AT** means the landmark is being targeted (or attacked) by the trajector (用活动体对准界标).

That is, the man was trying to target the wall with the empty beer bottle. The preposition **TO** is wrong, because it means that the landmark receives (接收) the trajector and does not indicate hostility (敌意).

You must study the two schemas before making a choice.

- ☐ The man hurled the empty beer bottle **to** the wall.
- ☒ The man hurled the empty beer bottle **at** the wall.

(1 of 72)

Next

Traditional instruction



1 ★

AT is used to show the direction of or towards somebody/something(向着/朝着):

1. What are you staring **at**?
2. He pointed a gun **at** her.
3. Somebody threw paint **at** the prime minister.

TO is used to indicate the direction of something; towards something(向/朝/对着某方向或某处):

1. I walked **to** the office.
2. It fell **to** the ground.
3. It was on the way **to** the station.

You must study the two explanations before making a choice.

☐ My naughty sister threw the fluffy cushions **to** me.

☐ My naughty sister threw the fluffy cushions **at** me.

(2 of 72)



1 ★

AT should be used in this sentence because it means "the direction of or towards sb/sth"(向着/朝着). (example: He pointed a gun at her.)

TO indicates the direction of or towards sth(向/朝/对着某方向或某处). (example: I walked to the office.)

You must study the two explanations before making a choice.

☒ My naughty sister threw the fluffy cushions **to** me.

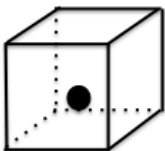
☐ My naughty sister threw the fluffy cushions **at** me.

(2 of 72)

Wrong

Next

APPENDIX B. Six pairs of selected form-function mappings for preposition training.

Form	Schematic Diagram	Function	Form
IN		To enclose something within a container	There were five police officers <u>in</u> the station. The couple was madly <u>in</u> love.
AT		To aim at a target	The council member threw an egg <u>at</u> the chairperson. Professor Chan is mad <u>at</u> a student.
		To locate a point along the route	Blair set out for Beijing but stopped <u>at</u> Shanghai airport. Johnson started out <u>at</u> a small company and rose to become the managing director.
OVER		Higher than, exerting influence	The mother leaned <u>over</u> her baby's cradle. The leader has power <u>over</u> his followers.
		To cross from one side to another	The horse jumped <u>over</u> the fence. James got <u>over</u> his divorce.
		Covering	He put a blanket <u>over</u> his books. Silence lay <u>over</u> the town at midnight.

Dr. Man Ho Ivy Wong is an Assistant Professor in the Department of English Language and Literature at Hong Kong Shue Yan University. Her research interests include cognitive linguistics, second language grammar instruction, digital language learning, and Bayesian statistics. She has received competitive research funding from SCOLAR for her work on cognitive linguistics-informed instruction on English prepositions. She was a Fulbright Visiting Researcher at Georgetown University and a Bowland Research Fellow at the University of York, where her project focused on grammar instruction and Bayesian statistical modelling.

ORCID: 0000-0002-4774-6147

Email: mhwong@hksyu.edu.

Dr. Nicolson Yat-Fan Siu is a Lecturer I in the Division of Social Science at The Hong Kong University of Science and Technology. He is a neuropsychologist whose research focuses on human cognitive functions, including attention, memory, and time perception, as well as neurodevelopmental and neurodegenerative disorders. His work uses neurophysiological methods such as EEG and TMS, and includes intervention studies supporting children with special educational needs and older adults with cognitive impairments.

Email: nicsiu@ust.hk

ORCID: 0000-0001-9465-8310

Cindy Wai-Man Tsui's research interests centre on the relationships between neurological signals, cognitive functioning, and mental health. She completed her BSc at the University of Hong Kong and co-founded Neurodyssey Association in Hong Kong. She collaborates with researchers on multidisciplinary EEG studies.

Email: cindy.wm.tsui@gmail.com

ORCID: 0000-0001-8244-7655