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**Neurolinguistics of Trilingualism: Markers of Lexico-Semantic Processing in Cross-
Language Interaction**

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A dissertation submitted for
the degree of Doctor of Philosophy (PhD)

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DEFINITIONS

The following terms and terminological combinations are used in this dissertation.

Automatic vs. strategic processing – automatic processes are fast and stimulus-driven, whereas strategic processes are slower and shaped by task goals.

Backward translation recognition paradigm – participants process an English (L3) prime and evaluate candidate words in Kazakh/Russian as translation equivalents vs. distractors, allowing meaning-based cross-language activation to be tested.

Control (language control) – the broader system regulating competition dynamics (e.g., monitoring, response selection, inhibition), treated as a set of components rather than a vague label.

Cross-language activation – co-activation/competition among candidates from different languages, which becomes observable when reaction time/accuracy changes systematically as a function of language membership and congruency.

Inhibition – mechanisms that reduce the activation of competing representations in contexts with competition (e.g., multilingual lexical competition).

Interference – measurable performance costs arising when competing representations are co-activated.

Language non-selective lexical access – early lexical activation is not fully gated by language membership; cross-language candidates can activate, with effects modulated by proficiency/dominance/context.

Lexical access – time-dependent activation of lexical representations from memory in response to input, including (i) mapping from form to a lexical entry and (ii) activation of associated semantic information; described as graded/competitive with partial co-activation of candidates.

Lexical selection – selection of a target lexical item (especially in production), involving competition among semantic neighbours; distinguished from lexical access in your terminology framework.

Lateralization – hemispheric asymmetries in recruitment.

Mental lexicon – an individual's internal lexical system that stores and organizes knowledge about words, including their forms, meanings, and associative links. For multilingual speakers, it includes lexical representations from more than one language and supports lexical access and cross-language activation.

Mirror-image trilingual groups (design logic) – two groups share the same language set (Kazakh–Russian–English) but differ in L1 (L1 Kazakh vs. L1 Russian).

Natural bilingualism – the acquisition and use of two languages through regular communication in everyday life, typically in family, community, or immersion-like environments, rather than primarily through formal instruction.

N400 – an ERP component typically observed around 400 ms after stimulus onset and sensitive to semantic expectancy, relatedness, and contextual fit.

Network – interacting brain regions supporting computation.

Neurolinguistics – an interdisciplinary field that investigates the neural mechanisms underlying language representation, processing, and organisation in the brain.

Region of interest (ROI) – spatial clustering of electrode channels into predefined scalp regions (e.g., AL/CL/PR) to support topographic inference and stable ERP measurements.

Representations vs. processes – representations are structured knowledge in the cognitive system (distributed activation patterns encoding phonology/orthography/morphology/syntax/semantics). In contrast, processes are real-time

operations over representations (e.g., activation, selection, inhibition, integration, and prediction).

Semantic integration – incorporating a word’s meaning into an evolving sentence/discourse representation; sensitive to predictability/contextual constraint and associated with graded electrophysiological responses, such as the N400.

Semantic primes – stimuli (words, phrases, or pictures) presented before a target that pre-activate related semantic features and concepts in the mental lexicon, thereby shaping subsequent processing. In psycholinguistic tasks, a prime facilitates the processing of a semantically related target (e.g., faster responses and/or reduced N400 amplitude). It can also increase conflict when the following item is meaning-incongruent.

Semantic processing – includes lexical semantics (word meaning), compositional semantics (meaning from combining words), and discourse semantics (meaning across sentences/context).

Translation recognition (paradigm) – a task that forces participants to map between languages via meaning and can be engineered to contrast semantic compatibility vs. mismatch.

ABBREVIATIONS

Ag / AgCl	Silver / silver-chloride electrodes
AL	Anterior left (ROI)
AM	Anterior middle (ROI)
AR	Anterior right (ROI)
BIA+	Bilingual Interactive Activation Plus (extension of the BIA framework)
CEFR	Common European Framework of Reference for Languages
CL	Central left (ROI)
CM	Central middle (ROI)
CR	Central right (ROI)
df	Degrees of freedom
EEG	Electroencephalography
EOG	Electrooculography
ERP / ERPs	Event-related potential(s)
fMRI	functional magnetic resonance imaging
glmer	Generalized linear mixed-effects regression
HEOG	Horizontal electrooculography
Hz	Hertz
ICA	Independent Component Analysis
L1 / L2 / L3	First / Second / Third language
L1K / L1R	L1 Kazakh group / L1 Russian group
LEAP-Q	Language Experience and Proficiency Questionnaire
M1 / M2	Left / right mastoids (EEG reference sites)
ms	Milliseconds
μV	Microvolts
PET	Positron Emission Tomography
PL	Posterior left (ROI)
PM	Posterior middle (ROI)

pos	Candidate position within trial (model term)
PR	Posterior right (ROI)
RHM	Revised Hierarchical Model
ROI / ROIs	Region(s) of interest
RT	Reaction time
SD	Standard deviation
UDC	Universal Decimal Classification
VEOG	Vertical electrooculography

INTRODUCTION

Language processing in multilingual speakers is a complex neurocognitive phenomenon in which lexical representations from different languages may become simultaneously active. This co-activation can facilitate comprehension or create competition. The extent and nature of this co-activation depend on language experience, dominance, and learning sequence. These mechanisms are especially important in sequential trilingualism, where the third language is learned later and is usually less automatic than the second language. Kazakhstan provides a particularly informative context for studying multilingual processing. It is a multilingual country in which multiple languages interact across institutional domains and everyday communication. Within this linguistic landscape, Kazakh and Russian occupy the dominant positions. Kazakh, as the state language, constitutes a central component of the country's language policy and serves as a key marker of national identity and socio-political development. The Russian language, inherited from the Soviet period, continues to retain high institutional and communicative significance across all major domains, including politics, economics, science, education, mass media, and the service industry. Against this background, a relatively stable pattern of bilingualism has emerged in the country. Despite its internal heterogeneity, this pattern is generally described as a form of unbalanced, functionally distributed bilingualism, in which the two languages are used across partially differentiated social and communicative domains (Terlikbayeva & Menlibekova, 2021; Utegenova et al., 2024, p. 394). Many speakers use Kazakh and Russian in everyday life and learn English through formal education (Küçükler, 2020, p. 3; Sadulova et al., 2025). When considering the place and role of English in Kazakhstan, it is important to note that English has gained increasing prominence over time (Sartor, 2021). This development was closely associated with the establishment of the international scholarship program “*Bolashak*” in 1993, designed to support talented Kazakhstani students in pursuing higher education at

leading universities worldwide (President of the Republic of Kazakhstan, 1993). The presence of English in Kazakhstan was further strengthened by the implementation of the cultural and language policy initiative commonly referred to as the “*Trinity of Languages*” project, within which English was conceptualised as the language of integration into the global economy, alongside Kazakh as the state language and Russian as the language of interethnic communication (Tlemissov et al., 2020, p. 9007). The **State Program for the Development and Functioning of Languages in the Republic of Kazakhstan for 2011–2020**, approved in 2011, identified the creation of favourable conditions for the development of the country’s linguistic capital, including foreign languages, especially English, as a means of international and business communication (President of the Republic of Kazakhstan, 2011). The long-standing tradition of bilingualism in Kazakhstan has provided a productive foundation for the acquisition and use of a third language, in this case English (Sadulova et al., 2025). In this context, a comparative analysis of cross-linguistic interactions in trilingualism is of considerable theoretical and practical significance, particularly when the languages involved differ in their genetic affiliation and structural-typological properties. Because Kazakh and Russian differ substantially in typology and grammatical structure, they provide a valuable basis for examining how language distance interacts with learning history (Bakhtikireeva & Valentinova, 2022, p. 225; Dildabekova, 2017, p. 1228). Against this background, it is especially relevant to adopt an interdisciplinary approach to the investigation of trilingualism as a brain-based phenomenon. Despite extensive research on bilingual lexical access, trilingual neurocognitive evidence remains limited, especially for the Kazakh–Russian–English constellation (Pathak et al., 2025). The present dissertation addresses this gap by investigating trilingual word recognition using a controlled experimental paradigm and time-sensitive neurophysiological measures. Modern psycholinguistic and neurolinguistic research demonstrates that word recognition is not purely language selective. Lexical access may

involve parallel activation across languages, and this activation may show asymmetry depending on L1/L2 status and dominance. Behavioural measures (accuracy and reaction time) provide important evidence of processing difficulty, but they do not fully capture the time course of meaning-level evaluation. Event-related potentials (ERPs) offer millisecond resolution and allow researchers to observe when lexico-semantic processing diverges across conditions. In this dissertation, the N400 component is treated as a key marker of lexico-semantic integration and sensitivity to semantic congruency.

The study employed a backward translation recognition paradigm in which participants processed an English (L3) prime and evaluated Kazakh and Russian candidate words as either congruent translation equivalents or incongruent distractors. This design enables testing cross-language activation and comparing two mirror-image trilingual groups: L1 Kazakh / L2 Russian / L3 English and L1 Russian / L2 Kazakh / L3 English. Mirror-image logic provides a principled way to examine the role of language learning history in behavioural performance and N400 modulation.

The relevance of the topic is determined by the particular significance of multilingualism in Kazakhstan, where languages function within a complex system of cross-language interaction. In the current language situation, Kazakh functions as the state language and a state-building component, Russian plays an important role in interethnic communication, and English serves as one of the key means of international political, economic, academic, and professional integration. In this regard, the study of cross-language processing mechanisms is of not only linguistic but also strategic importance. The relevance of the study is also determined by the specific features of the current language situation and language policy in education, in which English is usually acquired against the background of already established Kazakh–Russian or Russian–Kazakh natural bilingualism. Although there are studies devoted to bilingualism and multilingualism, the neurolinguistic aspect involving

electroencephalography (EEG) and event-related potentials (ERP) data remains at an initial stage of development in Kazakhstani science. The relevance of the study is further strengthened by the growing interest in integrative linguistics and by the need to apply modern scientific and methodological approaches to the study of multilingualism in Kazakhstan.

The object of the research is the lexico-semantic processing of language units in cross-language interaction in the context of trilingualism.

The subject of the research comprises neurolinguistic markers of lexico-semantic word processing that reflect the specific involvement of the first, second, and third languages.

The purpose of the research is to conduct an integrative neurolinguistic analysis of the markers and neurocognitive mechanisms of lexico-semantic word processing in cross-language interaction in the context of trilingualism.

Research objectives:

- to construct the metalanguage of the study within an integrative approach and to substantiate the conceptual prerequisites for the development of neurolinguistic research in Kazakhstan, taking into account the language situation of the republic and the role of Kazakh, Russian, and English in multilingual education;
- to analyse theoretical approaches to the study of bilingualism and trilingualism, with reference to the mechanisms of language information processing in the mental lexicon of speakers of heterogeneous and typologically distinct languages;
- to justify the choice of English irregular verbs as stimulus material and to substantiate the use of the translation recognition paradigm as a method for assessing cross-language activation across Kazakh, Russian, and English;
- to analyse and integrate behavioural and EEG/ERP indicators of word recognition as a function of the participants' first and second languages;

- to propose an integrative design for the neurolinguistic analysis of lexico-semantic processing markers in cross-language interaction.

Research methods and techniques. This dissertation employs an experimental neurolinguistic approach that combines psycholinguistic behavioural methods with EEG/ERP methodology to investigate lexico-semantic access in trilingual translation recognition. This research was conducted in three stages. During the first preparatory and diagnostic stage, theoretical analysis and synthesis of the scientific literature were conducted, word stimuli were selected, and participant-selection criteria were established. At this stage, participants were surveyed, their language biographies were compiled, and the Language Experience and Proficiency Questionnaire (LEAP-Q) was used to assess their language background, patterns of language use, and self-reported proficiency (Marian et al., 2007). A pilot experiment ($n = 10$) was conducted to test the validity and technical feasibility of the procedure. In the second experimental stage, the translation recognition method, electroencephalography (EEG), and event-related potentials (ERPs) were employed. EEG data were recorded using a 64-channel ANT Neuro system; stimulus presentation and response registration were carried out in E-Prime 2.0; EEG preprocessing and ERP extraction were conducted in BrainVision Analyzer 2.0.1; and statistical analysis was performed in R using RStudio. Data were obtained from two complementary sources: behavioural responses (accuracy and reaction time) and electrophysiological recordings, particularly ERP components associated with semantic processing, especially the N400. During the third interpretive-analytical stage, the results were subjected to interpretive analysis and modelling to formulate conclusions regarding the role of the first, second, and third languages and to explain differences between types of language experience.

Research sources and materials. The experimental material for this dissertation consists of a controlled trilingual stimulus set designed for a translation-recognition task. The

stimulus set was compiled from lexical and corpus sources in English, Kazakh, and Russian, including lists of English irregular verbs, bilingual and trilingual translation dictionaries, and corpus resources. The English stimulus base was compiled from reference lists of irregular verbs and learner-oriented lexical resources, including the Cambridge Dictionary (table of irregular verbs) and the Oxford Learner's Dictionaries. Additional corpus-based verification was carried out using the British National Corpus (BNC) and the Corpus of Contemporary American English (COCA) to check lexical frequency and usage patterns in English. For the Kazakh material, lexical selection and verification were drawn from the National Corpus of the Kazakh Language (NCKL). For Russian, lexical verification was supported by the National Corpus of the Russian Language.

The final stimulus set comprised 105 English irregular verbs, selected because verbs are well-suited to elicit semantic congruency effects, including those reflected in N400 modulation. To reduce ambiguity, phrasal verbs and highly polysemous items were excluded, and verbs were treated as lexico-semantic units. English verbs were classified into three irregularity types to reflect differences in the underlying formal and mnemonic complexities. The translation materials included 210 Kazakh and 210 Russian words: half were congruent translation equivalents, and the other half were incongruent, non-translation controls. Incongruent items were matched to congruent items by mean word length (approximately six letters in Kazakh and seven letters in Russian). Orthographic differences within the shared Cyrillic script, including Kazakh-specific letters, were also considered during stimulus selection and matching. A full list of stimuli and their characteristics is provided in Appendix A.

Research participants. The study involved 38 right-handed university students recruited from the Faculty of Philology at Al-Farabi Kazakh National University (Almaty, Kazakhstan), forming two mirror-image groups of sequential trilinguals who shared the same

language repertoire (Kazakh, Russian and English) but differed in their first language: L1 Kazakh ($n = 22$) and L1 Russian ($n = 16$). All participants were functionally bilingual in Kazakh and Russian and had acquired English later as L3 through formal instruction, and they all met the inclusion criterion of approximately B1/B2 English proficiency, based on self-report and language-background assessment.

The theoretical and methodological basis of the research integrates classical and contemporary research in psycholinguistics, bilingualism and multilingualism, and the cognitive neuroscience of language. At the theoretical level, the study draws on models of bilingual lexical access and cross-language activation, including the Revised Hierarchical Model (Kroll & Stewart, 1994), conceptual mediation accounts (de Groot, 1992), the Bilingual Interactive Activation Plus model (Dijkstra & Van Heuven, 2002), and control-based approaches to multilingual processing (Green, 1998; Abutalebi & Green, 2016). It also builds on frameworks of L3 influence and transfer, including the L2 Status Factor (Bardel & Falk, 2007), the Typological Primacy Model (Rothman, 2011), and more recent accounts emphasising structural proximity and property-specific transfer in multilingual development (Westergaard et al., 2017; Westergaard, 2019). The electrophysiological dimension of the dissertation is grounded in ERP approaches to lexico-semantic processing, with particular emphasis on the N400 tradition established by Kutas and Hillyard (1980), further developed by Kutas and Federmeier (2011), and methodologically supported by the ERP framework outlined by Luck (2014).

The international theoretical and methodological foundation is complemented by scholarship on the language situation in Kazakhstan, which provides the broader sociolinguistic context for neurolinguistic inquiry. The multilingual language ecology of Kazakhstan and the historical formation of Kazakh–Russian bilingualism have been examined in detail in the sociolinguistic works of Suleimenova (2009, 2011, 2020), Fierman (2005,

2006), Smagulova (2021), and Alisharieva et al. (2017), among others. These studies show that Kazakhstan represents a distinctive multilingual context characterised by widespread multilingualism, particularly among Kazakhs, with active use of both Kazakh and Russian across different communicative domains (Chernyavskaya & Zharkynbekova, 2024; Shelestyuk et al., 2022). This sociolinguistic background is complemented by Kazakhstani psycholinguistic and neurolinguistic scholarship that addresses bilingualism and multilingual development more directly, including research on child bilingualism and the relation between languages in bilingual development (Shayakhmetova, 2004), vocabulary comprehension strategies in monolingual and bilingual children of Northern Kazakhstan (Zhakupova et al., 2024), interference phenomena in bilingual speech, the relevance of neurolinguistic methods for bilingualism research, and the influence of L1 and L2 on third-language acquisition and processing (Ibrayeva et al., 2020; Ibrayeva & Zhaksylykkyzy, 2021; Ibrayeva, Zhaksylykkyzy, et al., 2023).

The institutional development of neurolinguistic research in Kazakhstan is also connected with the broader emergence of cognitive neuroscience at Al-Farabi Kazakh National University. Initial interdisciplinary projects led by A. M. Kustubayeva applied neurophysiological methods to the study of cognitive and emotional processes in the Kazakhstani population, and since 2019 this line of research has continued through the Cog-Neuro Centre and later within the Brain Institute (Kustubayeva et al., 2022; Ismagambetova et al., 2025; Zholdassova et al., 2021). Although these studies were not neurolinguistic in the strict sense, they contributed to the development of experimental and analytical approaches that are also relevant for language-and-brain research, since multilingual language processing depends on attention, cognitive control, response monitoring, and time-sensitive neural dynamics. The present dissertation extends this research trajectory into the neurolinguistic domain by applying EEG/ERP methodology to the study of trilingual lexico-semantic

processing in Kazakh–Russian–English speakers. In addition, the dissertation draws on foundational Kazakhstani psycholinguistic scholarship, including the textbook by Ibrayeva (2020), which systematises key concepts of language–speech interaction and the development of psycholinguistics in the national research tradition, as well as the trilingual learner’s dictionary *Psycholinguistics and Neurolinguistics: Russian-English-Kazakh Learner’s Dictionary* (Ibrayeva, Nabiyeva, et al., 2023), which contributes to the formation of a metalinguistic basis for neurolinguistic research in Kazakhstan. Taken together, these theoretical, methodological, sociolinguistic, and institutional strands motivate the dissertation’s focus on cross-language activation under controlled translation-recognition conditions and support the interpretation of group-dependent behavioural and N400 effects as manifestations of experience-weighted trilingual lexico-semantic processing.

The scientific novelty of the research. This work represents the first instance of neurolinguistic research in the Kazakhstani scientific context that examines trilingual lexico-semantic processing using EEG/ERP methodology at the Department of Turkology and Language Theory and the Brain Institute of Al-Farabi Kazakh National University.

1. For the first time in the Kazakhstani context, ERP analysis of lexico-semantic processing in trilinguals has been conducted, and an integrative design has been developed for the neurolinguistic analysis of lexico-semantic processing markers in cross-language interaction.

2. For the first time, the metalinguistic and terminological basis of neurolinguistics in the Kazakh language has been systematised. This contribution is reflected in the published *Psycholinguistics and Neurolinguistics Russian-English-Kazakh learner’s dictionary of terms* (Almaty: Qazaq Universiteti, 2023 (authors: Zh. K. Ibrayeva, G. S. Nabiyeva, K. Zhaksylykkyzy, A. M. Kustubayeva)), which represents one of the first attempts to create a specialised trilingual dictionary.

3. For the first time, a neurolinguistic analysis has been carried out to determine how functional experience, language dominance, and the sequence of acquisition of Kazakh and Russian modulate lexico-semantic access in cross-language processing.

4. This study developed and implemented a translation recognition paradigm with EEG recording, in which English irregular verbs served as semantic primes, while stimuli in Kazakh and Russian were presented as congruent translation equivalents or incongruent stimuli.

5. For the first time, behavioural and ERP data have been obtained, indicating the asymmetric nature of cross-language activation during the processing of English as a third language. This study established that the sequence of acquisition of the first and second languages plays a significant role in cross-language access initiated by the third language and contributes to the formation of two different functional routes of lexico-semantic processing.

Thus, the scientific novelty of the dissertation consists in the complex neurolinguistic, psycholinguistic, experimental, and metalinguistic analysis of Kazakh–Russian–English trilingual lexico-semantic processing as a dynamic neurocognitive system shaped by cross-language activation, typological distance, acquisition sequence, language dominance, and online semantic integration.

The theoretical significance of the research lies in its contribution to the development of models of multilingual lexical processing by demonstrating, through behavioural and ERP evidence, how three languages interact during lexico-semantic access. The study extends theories derived primarily from bilingual data by showing that cross-language activation in trilinguals is asymmetric and shaped by language dominance and learning history. It therefore supports the view of the multilingual lexicon as an adaptive system in which interlanguage connections vary in strength rather than functioning uniformly. By linking translation recognition performance to online neural markers of semantic

integration, the dissertation strengthens the interface between psycholinguistic theory, neurolinguistics, and cognitive neuroscience. It formulates testable predictions for future research on multilingual processing. The terminological framework developed in the dissertation, together with the trilingual learner's dictionary in psycholinguistics and neurolinguistics, also holds theoretical significance, as it may serve as a foundation for future terminological resources needed in Kazakhstani science.

The practical significance lies in its provision of a replicable experimental framework for assessing trilingual lexico-semantic access by integrating translation recognition with ERP methodology. The principles of stimulus construction used in the study, including controlled translation equivalents, non-translation distractors, non-cognate selection, and cross-language matching, may be employed in the development of experimental materials for other multilingual settings. The findings are also relevant for language education, particularly for curriculum development and assessment in Kazakh–Russian bilingual contexts where English is learned as a third language, since they demonstrate that cross-language links may be unequal and dependent on learning history. In addition, the study has practical value for applied psycholinguistics and future educational and clinical assessment contexts, since ERP-based indices, especially N400 sensitivity, enable evaluation of semantic processing not only through overt behavioural performance, such as accuracy and reaction time, but also through online neurophysiological responses. The full research cycle developed in the study, from stimulus construction and translation-recognition task design to EEG recording, ERP extraction, ROI-based analysis, and mixed-effects modelling, may serve as a basis for laboratory seminars, practical courses, and student research training in experimental linguistics. In this sense, the dissertation contributes not only empirical findings but also a transferable model for teaching multilingual language processing through hands-on experimental methodology. Finally, the dissertation has implications for computational

linguistics by supporting more realistic assumptions about unequal and experience-dependent multilingual lexical activation, which may inform the development of language technologies involving translation, cross-lingual retrieval, multilingual language assessment, and user modelling.

The main provisions submitted for defence are as follows:

1. Neurolinguistics in Kazakhstan is an emerging integrative field that requires its own methodological and metalinguistic substantiation. An analytical review of psycholinguistic and cognitive studies confirms that the study of language and the brain requires an interdisciplinary approach capable of linking linguistic phenomena with cognitive processes. At the same time, under the conditions of the dominance of English as the language of science, the metalinguistic basis of Kazakhstani neurolinguistics remains insufficiently systematised, and many established English-language terms still do not have stable Kazakh equivalents. This underscores the need to develop and standardise a specialised terminological base for neurolinguistic research in Kazakhstan.

2. The language situation and the language policy implemented in the field of education in the Republic of Kazakhstan have formed a specific group of sequential trilinguals for whom English functions as a third language on the basis of already established naturally acquired Kazakh–Russian or Russian–Kazakh bilingualism. Differences among Kazakh, Russian, and English in order of acquisition, degree of dominance, functional experience, typological structure, and sociolinguistic status make it possible to consider the mirror comparison of language configurations as a theoretically grounded model for investigating cross-language activation and lexico-semantic processing.

3. Trilingual word recognition in the translation recognition paradigm is based on semantic verification and reveals systematic effects of match-mismatch. Under conditions in which an English prime is presented and stimuli in Kazakh and Russian are subsequently

verified, the processing outcome is determined by whether the given language unit is a congruent translation equivalent or an incongruent stimulus. Incongruent stimuli elicit greater processing difficulty, expressed simultaneously in slower reaction times and lower response accuracy, thereby excluding an explanation of the results as a simple speed–accuracy trade-off.

4. Electrophysiological data indicate that semantic mismatch is detected at the stage of lexico-semantic processing. Incongruent stimuli in Kazakh and Russian elicit a more pronounced negativity in the 400–600 ms time window corresponding to the N400 component. Stimulus differentiation occurs at the level of semantic evaluation and is not limited to later decision-making processes. Thus, ERP data complement behavioural indicators by revealing the temporal dynamics of detecting semantic mismatch in the trilingual mental lexicon.

5. The N400 mismatch effect is modulated by candidate language and participant group, which demonstrates that cross-language semantic activation in trilinguals is integrated but functionally asymmetrical. The differences observed across Kazakh and Russian candidates and across L1 Kazakh and L1 Russian participants show that the two background languages are not equally engaged during L3 English-triggered translation recognition. These findings indicate that typological distance, acquisition sequence, dominance, and functional experience jointly constrain the efficiency of lexico-semantic access across languages. On this basis, the dissertation proposes two functional routes of L3-triggered lexico-semantic access: the *forked* route, reflecting relatively direct parallel access from L3 English to both background languages, and the *roundabout* route, reflecting weaker or less direct access to the less dominant background language, as shown by reduced N400 sensitivity to semantic mismatch. This supports the conclusion that the trilingual lexico-semantic system is not a

simple sum of three languages, but a dynamic neurocognitive system with unequal functional connections across languages.

Research approbation. The main provisions, theoretical conclusions, and practical results of the dissertation were discussed, verified, and approbated through publications in peer-reviewed scientific journals and through presentations at national and international scientific forums.

The dissertation was carried out within the framework of the Program-Targeted Funding project No. BR27198099, “Development of Integrative Scientific Research in Neuroscience,” supported by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan. The principal findings and conclusions of the study were approved at a research seminar of the Department of Turkology and Language Theory and at a research seminar of the Brain Institute of Al-Farabi Kazakh National University. The theoretical and practical parts of the dissertation were developed during a research visit to the Laboratory of Psycho- and Neurolinguistics at Paris Lodron University of Salzburg (Salzburg, Austria, 2022).

A total of 9 scientific works based on the dissertation materials were published, including 1 article in a Scopus-indexed journal (Q1), 5 articles in journals recommended by the Committee for Quality Assurance in Science and Higher Education (CQASHE) of the Republic of Kazakhstan, 3 papers in the proceedings of international and republican scientific conferences, and one trilingual learner’s dictionary.

Articles published in Scopus-indexed journals:

Zhaksylykkyzy, K., Ibrayeva, Z. K., Kustubayeva, A. M., Roehm, D., & Zholdassova, M.

(2026). Processing effects of L1/L2 from L3 in translation recognition paradigm: An exploratory ERP study. *Frontiers in Psychology*, 16, Article

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The structure and volume of the dissertation. The dissertation consists of a Definitions section, an Abbreviations list, an Introduction, three chapters, a Conclusion, References, and Appendices A, B, and C. The total volume of the dissertation is 203 pages, including 2 tables and 9 figures.

The first chapter outlines the conceptual basis of the research. It reviews psycholinguistic and neurolinguistic accounts of bilingual and multilingual lexical processing, clarifies the metalanguage of neurolinguistics, including key terms and core concepts, and describes the development of neurolinguistics in Kazakhstan as a foundation for studying trilingualism. The chapter further examines mechanisms and predictions of lexical access in bilingualism, summarises major third language processing frameworks, including L2 Status, typological, cumulative, and proximity-based accounts, and discusses semantic representation in multilingual lexical access. It also substantiates the relevance of Kazakh and Russian as

prior languages in trilingual processing, with particular attention to typological distance and structural asymmetry. The chapter ends with a summary of the theoretical foundations of the research.

The second chapter presents the methodological framework and experimental design. It provides an overview of psycholinguistic and neurolinguistic methods and experimental paradigms, specifies the general and study-specific methods, and describes participant profiling and grouping logic using a mirror-image design, namely L1 Kazakh versus L1 Russian, with defined inclusion criteria and language-background assessment. The chapter details the translation recognition paradigm, the principles of stimulus construction, including congruent and incongruent conditions and verb grouping, and the use of English irregular verbs as semantic primes. It also describes the experimental procedure and data collection protocol, including trial structure, timing, instructions, randomisation, practice procedures, EEG recording, and preprocessing. The chapter ends with a concise methodological summary.

The third chapter reports the empirical findings of the study. It formulates behavioural predictions, presents accuracy and reaction-time results, and interprets the key effects and interactions in relation to hypotheses about cross-language activation. It also reports and interprets the electrophysiological findings. The chapter outlines ERP predictions and the rationale for the N400 analysis window, presents the ERP analysis strategy, including epochs, baseline correction, regions of interest, and time windows, and reports N400 congruency effects as well as group- and language-related interactions. Particular attention is given to L1/L2 asymmetries, the role of learning history, and the neurocognitive interpretation of trilingual lexico-semantic processing. The chapter concludes with an integrated discussion linking behavioural and electrophysiological findings to the broader theoretical framework, followed by a chapter summary.

The conclusion summarises the principal results, confirms the fulfilment of the research objectives, and outlines the theoretical and practical implications of the dissertation, as well as directions for further research. The References section presents the scholarly foundation of the dissertation. The appendices contain the experimental stimulus list, participant information and informed consent materials, and ethics-related documentation.

CHAPTER 1. THEORETICAL FOUNDATIONS OF MULTILINGUAL LEXICO- SEMANTIC PROCESSING

1.1 Psycholinguistic and Neurolinguistic Foundations of Multilingual Lexical Processing

Multilingual lexical processing is best conceptualised as a dynamic neurocognitive system in which several levels of language processing interact over time rather than as a simple retrieval of isolated lexical units from separate language-specific stores. Contemporary psycholinguistics and neurolinguistics no longer treat language comprehension as a strictly serial sequence in which orthographic or phonological form is identified first, lexical meaning is accessed next, and higher-order interpretation follows only afterwards (Pulvermüller et al., 2009). Instead, converging evidence indicates that language processing is incremental, probabilistic, and interactive, such that orthographic, phonological, morphological, lexical, semantic, syntactic, and discourse-level information can constrain one another in real time. In multilingual speakers, this architecture becomes more complex because processing unfolds under conditions of co-existing languages, partially overlapping lexical representations, unequal proficiency, and different histories of acquisition and use. Neurolinguistic evidence further shows that these processes are supported by distributed cortical networks rather than by a single localised language centre, with partially differentiated contributions of frontal and temporal regions to distinct language functions. In this sense, multilingual lexical processing must be viewed not as the simple coexistence of several monolingual systems but as an integrated and adaptive architecture shaped by language experience and task demands (Dijkstra & Van Heuven, 2002; Friederici, 2011; Hagoort, 2013). A foundational psycholinguistic principle relevant to multilingual lexical processing is incrementality. Comprehension does not wait until all information has been received before interpretation begins; rather, partial input is used immediately to generate and update hypotheses about form, structure, and meaning. On this view, processing is guided by expectations derived from

previous linguistic experience, and these expectations can operate at multiple representational levels. Current predictive accounts argue that language users do not necessarily anticipate one exact upcoming word, but they may pre-activate likely semantic features, structural possibilities, lexical candidates, and discourse-relevant information (Ito et al., 2016, p. 159). Such anticipatory processing is particularly important in multilingual speakers because contextual information may bias the system toward one language while other languages remain partially active in parallel. Thus, multilingual lexical processing reflects not only the bottom-up properties of the current stimulus, but also top-down influences from context, probability, language dominance, and prior experience. This means that the multilingual lexicon functions as a probabilistic system in which activation is continuously shaped by expectations and updated by incoming evidence.

At the *orthographic and phonological levels*, lexical processing begins with the extraction of formal cues from the input. In visual word recognition, the system analyses letter identity, letter position, orthographic regularities, and familiar sublexical patterns. In spoken language, it relies on acoustic-phonetic and phonological information unfolding over time. In monolingual processing, these formal cues activate lexical candidates within one language. In multilingual processing, however, a substantial body of evidence indicates that formal input may activate candidates from more than one language. One of the most influential conclusions of bilingual and multilingual word-recognition research is that lexical access is often *non-selective* with respect to language, especially during early stages of recognition. The BIA+ model proposed by Dijkstra and Van Heuven assumes that visual input activates orthographic, phonological, and semantic lexical representations across languages within a shared system, and that language membership does not serve as a strict early filter. Instead, language information acts as a source of bias within an interactive network. This view has major implications for multilingual lexical processing because it predicts that words from

non-target languages can become partially active even when only one language is required by the task. The behavioural consequences of such co-activation depend on the interaction between identification processes and later task or decision processes, but the fundamental point remains that early access is not fully restricted to one language alone (Dijkstra & Van Heuven, 2002).

At the *lexical level*, processing is no longer understood as a simple search through a mental dictionary. Instead, lexical access is commonly described as a graded process of competitive activation. Multiple candidates may become active simultaneously based on formal overlap, lexical frequency, contextual support, recent use, and semantic relatedness. Selection emerges through the interaction of these factors rather than through a discrete lookup operation. In multilingual speakers, lexical competition is intensified because more than one language can contribute to candidate representations. This means that multilingual lexical processing is not merely larger in scale than monolingual processing; it is qualitatively different because cross-language co-activation and competition are built-in properties of the system. Within such an architecture, lexical access must be understood as a distributed and experience-sensitive process, and multilingualism provides strong evidence against models that assume fully isolated language-specific lexicons during online recognition (Dijkstra & Van Heuven, 2002).

An additional processing level of major importance is *morphology*. Morphological structure links surface form to grammatical and semantic information and therefore plays a mediating role between lexical recognition and higher-order interpretation. Morphological processing can involve segmentation into stems and affixes, recognition of inflectional and derivational patterns, and extraction of grammatical features encoded in word form. In multilingual speakers, these operations are shaped not only by familiarity with the item itself, but also by typological differences among the languages involved. Languages vary in how

transparently they segment words, how grammatical information is distributed across morphemes, and how predictable the mapping is between form and function. Consequently, multilingual lexical processing cannot be assumed to rely on an identical morphological routine across all languages in the repertoire. Rather, speakers may develop different balances between decomposition and whole-form retrieval depending on language structure, proficiency, and exposure. From a psycholinguistic perspective, this means that morphology is not an isolated subsystem, but part of the broader architecture through which form is mapped onto lexical and semantic representations. From a neurolinguistic perspective, it also means that language processing must be explained in terms of distributed computations rather than uniform mechanisms that apply equally across all languages.

At the *semantic level*, multilingual lexical processing extends beyond the retrieval of the dictionary meaning attached to an individual word. Semantic processing includes lexico-semantic activation, conceptual mapping, semantic integration, and the updating of an evolving interpretation in context. In bilingual and multilingual memory models, words from different languages are not linked solely by lexical associations; they are also connected through shared or partly overlapping conceptual representations. A highly influential account in this area is the Revised Hierarchical Model (RHM), which proposes that lexical and conceptual links differ in strength depending on learning history and proficiency. Kroll and Stewart argued that in less proficient non-native language use, lexical mediation through the dominant language may be stronger, whereas with increasing experience, more direct conceptual links can develop for the later-acquired language. Although originally formulated for bilingual memory, this logic is directly relevant to multilingual lexical processing because L1, L2, and L3 may differ markedly in conceptual grounding and accessibility. A trilingual lexicon is therefore expected to be asymmetrical: languages do not necessarily contribute

equally to conceptual activation, and their relative involvement is likely shaped by age of acquisition, dominance, exposure, and functional range of use (Dufour & Kroll, 1995, p. 167).

From a neurolinguistic perspective, semantic processing is especially important because it exhibits one of the clearest and most robust electrophysiological signatures: the *N400*. Since its discovery, the *N400* has become a central marker of meaning-related processing in language comprehension. Kutas and Federmeier (2011) review extensive evidence showing that *N400* amplitude is sensitive to contextual expectancy, semantic relatedness, conceptual fit, and ease of integration. Importantly, the *N400* is not simply a detector of semantic anomaly; rather, it reflects graded aspects of meaning-related processing and can be modulated by both linguistic and non-linguistic factors. This makes it particularly valuable for multilingual research because it allows investigators to determine whether cross-language effects arise during online lexico-semantic evaluation rather than only during later strategic response stages. When multilingual differences emerge in the *N400* range, they strongly suggest that co-activation and mismatch detection are affecting the processing of meaning itself, not merely post-lexical verification (Alday & Kretzschmar, 2019, p. 2).

However, semantic processing does not occur independently of grammatical structure. At the *syntactic level*, lexical items are processed with respect to grammatical category, combinatorial possibilities, argument structure, and structural compatibility with the unfolding sentence or phrase. In natural language comprehension, lexical and syntactic processing are tightly interwoven. Friederici's synthesis of neurolinguistic evidence indicates that syntactic processing relies strongly on left-lateralized temporo-frontal networks, whereas semantic processing engages somewhat broader and less strictly lateralized networks. Hagoort's Memory, Unification, and Control model complements this perspective by proposing that language processing depends on stored linguistic knowledge, online unification of that knowledge into larger structures, and control processes that regulate the system under

contextual demands. This framework is particularly useful for multilingual lexical processing because it highlights that word recognition is not an isolated act of lexical retrieval. Rather, multilingual word processing is embedded in a broader architecture in which lexical items are interpreted as parts of structured, context-sensitive representations. In other words, the multilingual lexicon is functionally connected to the grammatical system from the earliest stages of interpretation (Friederici, 2011; Hagoort, 2013).

Beyond lexical and syntactic computation lies *discourse and contextual processing*, where individual words are interpreted in relation to a broader message-level representation. Contextual information constrains lexical processing very early and can reduce uncertainty by biasing the system toward some interpretations rather than others. In multilingual speakers, context plays an additional role because it may be biased toward one language and reduce interference from alternatives. However, context does not necessarily eliminate cross-language co-activation. Rather, it modulates its degree and functional consequences. Thus, multilingual lexical processing is context-sensitive but not fully context-determined: language membership, dominance, recency of use, and task relevance continue to influence the activation landscape even under relatively strong contextual support. This is fully compatible with probabilistic models of comprehension, which assume that prediction and updating occur at multiple levels and are constrained, but not absolutely dictated, by context (Kuperberg & Jaeger, 2016; Kutas & Federmeier, 2011).

A further key dimension is *cognitive control*. If several languages can be activated in parallel, the multilingual processing system requires mechanisms for monitoring conflict, maintaining task goals, selecting the relevant response, and reducing interference from competing alternatives. Green's inhibitory control account placed these mechanisms at the centre of bilingual language use, and Green and Abutalebi later refined this logic in the Adaptive Control Hypothesis. Their proposal is that language control processes themselves

adapt to the recurrent demands imposed by different interactional contexts. For example, single-language use, dual-language use, and dense code-switching place different demands on goal maintenance, interference suppression, and response selection. These ideas are highly relevant to multilingual lexical processing because they show that language competition is not merely a passive by-product of representational overlap. It is something the system actively regulates, and the efficiency of this regulation is shaped by experience. Accordingly, multilingual lexical processing must be understood as inseparable from the control processes that allow one set of lexico-semantic representations to be prioritized while others remain partially active in the background (Green & Abutalebi, 2013).

Neurolinguistic evidence also emphasises that language processing is implemented through *distributed neural pathways* rather than a single linear route. Hickok and Poeppel's dual-stream model distinguishes between a ventral stream involved primarily in mapping speech to meaning and a dorsal stream involved in mapping acoustic speech signals onto articulatory representations. Although this model was initially developed for speech processing, its broader significance lies in demonstrating that language functions depend on multiple interacting pathways with partially differentiated roles. For multilingual processing, this is especially important because different languages may rely to different degrees on such pathways depending on modality, automaticity, proficiency, and learning history. The broader implication is that multilingual lexical processing should not be reduced to one uniform mechanism or locus. Instead, it emerges from coordinated activity across neural systems responsible for form analysis, semantic activation, combinatorial processing, and control (Hickok & Poeppel, 2007; Friederici, 2011).

Taken together, psycholinguistic and neurolinguistic evidence support a view of multilingual lexical processing as a *multi-level, interactive, and adaptive architecture*. At early stages, orthographic or phonological cues activate lexical candidates. At subsequent

stages, these candidates compete, recruit morphological and semantic information, and become integrated into syntactic and discourse-level representations. Throughout this process, contextual expectations and cognitive control mechanisms constrain the system, while language experience determines the relative strength and accessibility of representations. Crucially, multilingual lexical processing is not simply monolingual lexical processing repeated in several languages. It is a qualitatively distinct mode of processing in which cross-language co-activation, asymmetrical representational strength, conceptual mediation, and adaptive regulation are fundamental properties of the system. This perspective provides the necessary theoretical foundation for investigating trilingual lexico-semantic processing as a phenomenon jointly shaped by linguistic structure, acquisition history, language dominance, and online neurocognitive dynamics (Dijkstra & Van Heuven, 2002; Friederici, 2011; Green & Abutalebi, 2013; Hagoort, 2013; Hickok & Poeppel, 2007; Kroll & Stewart, 1994; Kuperberg & Jaeger, 2016; Kutas & Federmeier, 2011).

In the context of Kazakhstan, the study of multilingual lexical processing has theoretical and practical importance. The existing language situation is shaped by long-standing Kazakh–Russian bilingualism, in which Kazakh and Russian function as socially embedded languages with different but overlapping domains of use (Sadulova et al., 2025). This bilingual foundation has been described in Kazakhstani sociolinguistic and bilingualism studies as a historically developed state of language contact, functional distribution, and language choice (Chernyavskaya & Zharkynbekova, 2024). However, recent changes in language policy and language planning in education have added a new dimension to this bilingual background: English is increasingly positioned as a third language associated with international science, technology, academic mobility, and global integration (Huertas-Abril & Shashken, 2021, p. 262). Unlike Kazakh and Russian, which many speakers acquire through everyday social exposure, English is typically acquired later and primarily in an instructional

environment. This creates a distinctive trilingual configuration in which naturalistic bilingual experience interacts with the classroom-based acquisition of a typologically and functionally different third language. This configuration makes the study of trilingual processing strategically important for Kazakhstan. The issue is connected not only with individual language learning but also with multilingual education, state language policy, international competitiveness, and the development of human capital. English functions as a major language of international science and technology; its acquisition is therefore one of the conditions for Kazakhstan's integration into the global academic and professional space. For this reason, Kazakh–Russian–English trilingualism should be examined not only from the perspectives of sociolinguistics and language policy, but also through psycholinguistic and neurolinguistic approaches that can explain how three languages are represented, activated, and regulated in the mind and brain. International research on multilingualism has shown that language environment, language contact, and language errors are important for understanding how several languages develop and interact within one speaker, including in studies of child bilingualism and multilingual education. In the Kazakhstani context, this line of inquiry is complemented by local studies of language situation, bilingualism, language contact, and multilingual education, which provide the sociolinguistic foundation for the present neurolinguistic investigation of online lexico-semantic processing.

1.2 The Metalanguage of Neurolinguistics: Core Terminology and Conceptual Framework

The development of any scientific field is inseparable from the formation of its metalanguage. In linguistic scholarship, metalanguage is understood as a “second-order” language, that is, a language used to describe the object language itself (Akhmanova, 2004, p. 232). The emergence of new scientific paradigms in linguistics is therefore closely connected with the establishment of a stable conceptual and terminological system. As Azamatova

(2008) notes, linguistic terminology constitutes one of the central components of the metalanguage of linguistics, since it reflects the structural-semantic, pragmatic, and onomasiological characteristics of scientific concepts. In this sense, terminology is not merely an auxiliary element of scientific description, but one of the main instruments through which a field defines its object, methods, and explanatory boundaries.

The problem of metalanguage has become especially relevant in contemporary linguistics, which has moved beyond the limits of traditional language description and entered into active interaction with psychology, cognitive science, neuroscience, sociology, computer science, medicine, and other neighbouring fields. This expansion has led to the emergence of integrative linguistic directions, including psycholinguistics, cognitive linguistics, computational linguistics, and neurolinguistics. The formation of such interdisciplinary fields inevitably raises the problem of systematising and standardising terminology. Concepts borrowed from adjacent disciplines cannot be used mechanically; they must be adapted to the specific object of linguistic inquiry and interpreted in accordance with the aims of the field. The development of terminology is therefore linked not only to the growth of scientific knowledge, but also to shifts in scientific paradigms, the differentiation and integration of disciplines, cultural contacts, and the development of the language in which scientific knowledge is expressed (Kutina, 1966, p. 268). This issue is particularly important for neurolinguistics, which is still developing as an integrative research direction in Kazakhstan. Neurolinguistics draws on concepts from linguistics, psycholinguistics, cognitive science, neuroscience, psychology, medicine, speech pathology, and experimental methodology. As a result, its conceptual and terminological apparatus is heterogeneous. The same terms may be interpreted differently in different disciplines, and this creates difficulties in describing the mechanisms of interaction between language, speech, cognition, and the brain. In the process of developing the present dissertation, this problem became especially visible during the

selection, classification, and interpretation of terms related to multilingual lexico-semantic processing, mental representations, cross-language activation, EEG/ERP methodology, and neurophysiological markers of semantic processing.

The problem of terminology has particular relevance for Kazakhstani linguistics, where some modern scientific terms are still being clarified, translated, and standardised (Karagulova et al., 2016). This concerns not only traditional linguistic concepts, but also relatively new interdisciplinary directions such as cognitive linguistics, psycholinguistics, and neurolinguistics (Dmitryuk, 2020, p. 151; Issakova et al., 2025). At the same time, the foundations of a cognitive-oriented Kazakh linguistic metalanguage can be traced to earlier national scholarship (Zhubaeva, 2018, p. 215). In this regard, Zhubaeva's interpretation of Akhmet Baitursynov's works is especially important: Baitursynov's fundamental studies, including *Til quraly* and *Til tagylymy*, may be viewed as an early conceptual basis for describing language in relation to thought and consciousness (Zhubaeva, 2017). This shows that the development of neurolinguistic terminology in Kazakhstan should not be understood only as the borrowing of international terms, but also as a continuation of the national tradition of conceptualising language, thought, and speech activity.

Kazakhstani scholars have repeatedly addressed questions of linguistic norm, codification, terminology, scientific style, and the development of Kazakh as a language of science. These issues have been discussed in the works of R. Syzdyk, N. Uali, E. Suleimenova, N. Shaimerdenova, Sh. Kurmanbayuly, A. Salkynbay, O. Zhubaeva, A. Fazylzhan, and other researchers. Their studies show that the formation of scientific terminology is not only a technical problem of translation, but also a condition for the methodological development of national scholarship (Karagulova et al., 2016). This is especially relevant for fields whose terminology is based largely on Greek, Latin, and English scientific traditions. Neurolinguistics belongs precisely to this type of field, since many of its

basic concepts have entered Kazakhstani academic discourse through international neuroscience, psychology, medicine, and experimental linguistics. Therefore, the present dissertation treats the clarification of neurolinguistic metalanguage as a necessary theoretical and methodological step. Many concepts used to describe language-and-brain interaction do not yet have fully stable equivalents in Kazakh; some are translated inconsistently, while others are used differently in linguistics, psychology, cognitive neuroscience, psycholinguistics, and neurolinguistics. This creates a need for terminological unification and conceptual precision (Aldash et al., 2025; Issakova et al., 2025). This observation is directly applicable to neurolinguistics, where the conceptual apparatus is formed at the intersection of several disciplines.

Thus, the metalanguage of neurolinguistics in the present dissertation is not treated as a secondary issue. It is a necessary condition for describing multilingual lexico-semantic processing with theoretical precision. The clarification of key concepts makes it possible to connect linguistic phenomena with cognitive mechanisms and neurophysiological indicators, and also contributes to the development of neurolinguistics as an emerging interdisciplinary field in Kazakhstani linguistic science.

In the present dissertation, one of the central concepts is *multilingual processing*. This term refers not simply to the coexistence or mechanical addition of several languages in one speaker, but to the dynamic interaction of linguistic systems during comprehension, production, lexical access, semantic activation, and language control. A multilingual speaker does not process each language as an isolated monolingual system. Rather, several languages may become partially active, support or compete with one another, and be regulated according to task demands, proficiency, dominance, context, and learning history. This understanding follows the general psycholinguistic view that bilingual and multilingual speakers should not be treated as the sum of separate monolingual systems, but as speakers with an integrated and

experience-shaped linguistic architecture. In studies of lexical access, this view is further developed in models of non-selective bilingual word recognition and cross-language activation, according to which representations from more than one language may be activated during word processing (Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994; Kroll et al., 2010). The term *multilingual processing* is used in contemporary psycholinguistics and neurolinguistics to describe how several languages are represented, activated, and controlled in the mind and brain of a multilingual speaker. It is not associated with a single founder or first use; rather, it developed within the broader research tradition on bilingualism, multilingualism, cross-language activation, and third language acquisition. In the present dissertation, this term is used in line with studies of bilingual lexical access and multilingual language acquisition, especially the works of Dijkstra and Van Heuven (2002), Kroll and Stewart (1994), Cenoz (2003, 2013), De Angelis (2007), and Hammarberg (2014). This theoretical orientation is important because the present study examines how an English L3 prime activates and interacts with Kazakh and Russian candidate words during translation recognition.

The language configuration examined in this dissertation is Kazakh–Russian–English trilingualism. Two mirror-image groups are considered: L1 Kazakh / L2 Russian / L3 English and L1 Russian / L2 Kazakh / L3 English. Thus, Kazakh and Russian function as the two socially embedded background languages in the participants’ repertoires, while English is treated as the later-acquired third language. This configuration is theoretically important because Kazakh and Russian are acquired and used within the multilingual sociolinguistic environment of Kazakhstan, whereas English is typically acquired later and mainly through formal education (Huertas-Abril & Shashken, 2021, p. 262; Sadulova et al., 2025). Therefore, the dissertation distinguishes not only between three languages, but also between three different language statuses: first language, second language, and third language.

The terms first language, second language, and third language require careful clarification because they may be understood differently in linguistics, sociolinguistics, psycholinguistics, and language education. In general, lexicographic usage, a first or native language is usually associated with the language first acquired in childhood, whereas a second language is understood as a language learned in addition to the first language (Lexikos, 2012, p. 244). Lexicographic definitions of bilingualism also show that the phenomenon may refer both to an individual's ability to use two languages and to the social use of two languages within a community (Merriam-Webster, n.d.-a, n.d.-b). In psychological terminology, bilingualism is broadly understood as the regular use of two or more languages by an individual or within a speech community (American Psychological Association, 2018). In sociolinguistics, these terms are often considered in relation to language contact, language choice, language policy, and the functional distribution of languages in society. However, in psycholinguistics and neurolinguistics, L1, L2, and L3 are especially important because they may reflect the order of acquisition, dominance, proficiency, strength of lexical-conceptual links, and processing dynamics.

Since the labels L1, L2, and L3 may refer to different dimensions of language experience, including acquisition order, native status, dominance, proficiency, and functional use, it is necessary to clarify how these terms are used in the present dissertation. **Table 1** summarises several influential approaches to the definition of L1, L2, and L3 in multilingualism and third-language acquisition research and presents the operational definitions adopted in this study. The table does not present direct dictionary definitions in every case; rather, it summarises how influential authors conceptualise L1, L2, and L3 in multilingualism and third-language acquisition research.

Table 1

Conceptualisations of L1, L2, and L3 in multilingualism and third language acquisition research

Author	L1	L2	L3
Hammarberg (2010, 2018)	L1 is the native or primary language acquired from early infancy.	L2 is a non-native language added after the early L1 acquisition period.	L3 is the language currently being learned or used after the L1 and at least one previously acquired L2; it is “tertiary” in relation to the speaker’s previous languages.
Hammarberg (2014)	L1 may refer to the first-acquired language, but it may also overlap with native language, dominant language, or main functional language.	L2 may refer to the second language in chronological order, but also to any non-native language learned after L1.	L3 is not always simply “the third language” chronologically; the label must be clarified because chronology, dominance, proficiency, and function may not coincide.
Cenoz (2003, 2013)	L1 is one part of a wider multilingual repertoire.	L2 is a previously acquired language that may influence additional language learning.	L3 acquisition differs from L2 acquisition because third-language learners already have access to more than one linguistic system.

Author	L1	L2	L3
De Angelis (2007)	L1 is treated as one of the learner's previous languages.	L2 is also a previous language and may interact with later language acquisition.	L3 or additional language acquisition refers to the acquisition of languages beyond the L2 , including cross-linguistic influence, multilingual speech production, and the multilingual lexicon.
Bardel & Falk (2007)	L1 is the first language and may not always be the main source of transfer in L3 acquisition.	L2 may have a special status because it is a previously acquired non-native language.	L3 acquisition is qualitatively different from "true L2" acquisition because the learner has already acquired at least one L2.
Falk & Bardel (2010)	L1 is a background language in L3 acquisition.	L2 is another background language and may become an important transfer source.	L3 acquisition research examines how background languages, especially L1 and L2, influence the third language, particularly in vocabulary and syntax.
Rothman et al., (2013)	L1 is a possible source language in L3 acquisition.	L2 is also a possible source language.	L3 acquisition is a separate field because the third language may be influenced by different

Author	L1	L2	L3
			prior languages depending on typology, proficiency, and transfer conditions.
Operational definition in the present dissertation	L1 refers to the first-acquired and earliest established language: Kazakh in the L1 Kazakh group and Russian in the L1 Russian group.	L2 refers to the subsequently acquired societal language that is part of the stable bilingual repertoire: Russian for the L1 Kazakh group and Kazakh for the L1 Russian group.	L3 refers to English, the later-acquired language learned mainly through formal instruction and used as the primary language in the translation recognition paradigm.

Note. Compiled by the author based on theoretical and terminological discussions of multilingualism and third language acquisition.

Based on these definitions, the present dissertation adopts an operational interpretation of L1, L2, and L3 that combines acquisition sequence with experimental function. L1 refers to the first-acquired and earliest established language in the participant's developmental history: Kazakh in the L1 Kazakh group and Russian in the L1 Russian group. L2 refers to the subsequently acquired societal language that became part of the participant's stable bilingual repertoire: Russian for the L1 Kazakh group and Kazakh for the L1 Russian group. L3 refers to English as the later-acquired language learned mainly through formal instruction and used as the primary language in the translation recognition paradigm. Thus, in this dissertation, L1 and L2 designate the two prior background languages, whereas L3 designates the language that triggers semantic activation during the experimental task.

A dissertation in neurolinguistics requires not only empirical evidence and methodological rigour, but also conceptual precision. This is especially important in multilingualism research, where the same phenomenon may be described through the terminology of linguistics, psycholinguistics, bilingualism studies, cognitive neuroscience, and language education. In the present dissertation, the *metalanguage of neurolinguistics* is understood as the set of concepts through which language-related phenomena are defined, classified, and linked to cognitive and neural mechanisms. *Neurolinguistics* itself is understood here as an interdisciplinary field that investigates the neural mechanisms underlying language representation, processing, and organisation in the brain. It links linguistic phenomena to cognitive processes and neural systems, making it especially relevant for the study of multilingual lexical access, semantic processing, and electrophysiological markers such as the N400. Such a framework is necessary because neurolinguistics operates across several explanatory levels and therefore depends on terminological consistency to maintain theoretical coherence. (Friederici, 2011; Hagoort, 2013; Poeppel, 2012). One of the foundational terms in this framework is *bilingualism*. In a broad psychological sense, bilingualism refers to the regular use of two or more languages by an individual or within a speech community (American Psychological Association, 2018). In bilingualism research, specifically, the term has evolved from narrow definitions based on native-like command of two languages toward broader functional definitions that recognise variability in proficiency, age of acquisition, literacy, and domains of use (Hamers & Blanc, 2000). This broader view is particularly relevant in the context of Kazakhstan, where two languages may coexist within one individual's repertoire without necessarily being equally strong across all communicative situations.

Within bilingualism, it is useful to distinguish between *natural bilingualism* and *artificial bilingualism*. Natural bilingualism usually refers to the development of two

languages through sustained communicative exposure in everyday life, typically in family, community, or immersion-like environments. Artificial bilingualism, by contrast, refers to the acquisition of an additional language predominantly through formal instruction, often with more limited spontaneous use outside educational settings (Butler, 2012; Hammarberg, 2014). This distinction is important because learning context may affect lexical entrenchment, semantic accessibility, degree of automatization, and the balance between implicit and explicit routes of processing. In the present dissertation, this distinction is especially relevant because Kazakh and Russian are often developed under socially embedded bilingual conditions, whereas English is more typically acquired later in instructional settings.

A broader and more inclusive concept is *multilingualism*. Multilingualism is commonly used as the umbrella term for the use or knowledge of more than one language and may refer both to the individual and the societal level (Cenoz, 2013). This term is especially important for the present dissertation because the object of analysis is not only one bilingual pair, but a multilingual cognitive system in which several languages coexist and interact. The concept of multilingualism is preferable here because it captures the repertoire rather than reducing the system to separate dyadic relations.

A more specific term within this broader frame is *trilingualism*. At the descriptive level, trilingualism refers to the use or knowledge of three languages by one speaker. However, from a psycholinguistic and neurolinguistic perspective, trilingualism is not simply bilingualism plus one more language. It creates a qualitatively different configuration because a later-acquired language may be processed under the influence of two previously established languages rather than one. As a result, lexical activation, competition, semantic mediation, and control may involve several asymmetrical relations within the same system (Hammarberg, 2014).

A central processing term is *lexical access*. In psycholinguistic usage, lexical access refers to the time-dependent activation of lexical representations from memory in response to incoming input. It includes both the mapping from form to lexical entry and the activation of associated meaning (Dahan & Tanenhaus, 2004, p. 498). Among bilingual and multilingual speakers, lexical access is generally treated as at least partially non-selective, meaning that lexical candidates from more than one language may become active during recognition (Dijkstra & Van Heuven, 2002). This term should be distinguished from *lexical selection*, which is more often associated with production and refers to choosing one lexical item among competing alternatives (Levelt et al., 1999). The distinction matters because lexical access concerns activation dynamics, whereas lexical selection concerns commitment under competition.

Closely related to lexical access is *cross-language activation*. This term refers to the co-activation of representations from more than one language during the processing of a stimulus in one language (Shook & Marian, 2017). Cross-language activation may involve orthographic, phonological, lexical, or semantic levels, and it is one of the central assumptions of non-selective access models of multilingual word recognition (Dijkstra & Van Heuven, 2002). In this dissertation, this term is especially important because the translation recognition paradigm is designed to test whether L3 English primes activate semantic representations linked to Kazakh and Russian candidates.

Another key term is *lexical competition*. Lexical competition refers to the state in which several candidate representations are simultaneously active and must be resolved through the interaction of formal similarity, contextual support, frequency, and task demands. In multilingual speakers, lexical competition is not limited to one language system. It can occur across languages whenever several representations are activated in parallel. In this

sense, lexical competition is not an occasional disturbance but a structural property of the multilingual lexicon.

A further indispensable term is *semantic processing*. In neurolinguistics and psycholinguistics, semantic processing refers to the activation, organisation, and interpretation of meaning during language comprehension or production. It may involve lexical meaning at the level of individual words, compositional meaning arising from combinations of words, and broader integration into contextual or conceptual structure. In the present dissertation, semantic processing is understood primarily in the lexico-semantic sense; that is, as the activation and evaluation of word meaning under cross-language conditions. This focus is appropriate because the experimental design does not test sentence-level interpretation, but rather the recognition of semantic correspondence between words across languages. In multilingual processing, semantic processing is especially important because co-activated lexical items from different languages may converge on overlapping conceptual representations or compete under conditions of semantic mismatch (Kutas & Federmeier, 2011; Lau et al., 2008).

Closely related to this is the term *semantic primes*. Semantic primes are stimuli that pre-activate a related concept or meaning representation before the appearance of a target item. In experimental psycholinguistics, a prime may facilitate or constrain the processing of a subsequent stimulus by activating semantic features associated with it. In the present dissertation, English verbs serve as semantic primes because they are used to activate a conceptual representation against which Kazakh and Russian candidate words are evaluated. The term is important because it clarifies that the English stimulus in the experiment is not simply the first item in a sequence, but a theoretically motivated source of conceptual pre-activation. Thus, semantic priming in the present study refers to the experimentally induced

activation of meaning that shapes the processing of subsequent translation candidates (Neely, 1991; Kutas & Federmeier, 2011).

Another central term is *word recognition*. In psycholinguistic usage, word recognition refers to the process by which an incoming orthographic or phonological stimulus is identified as a stored lexical item and linked to its linguistic representation. In models of visual word recognition, this process includes the activation of sublexical features, lexical candidates, and associated semantic information. In multilingual speakers, word recognition is especially important because it is one of the principal sites at which cross-language activation becomes observable. A written or spoken word in one language may activate not only target-language representations but also formally or semantically related items in another language (Van Hell & Dijkstra, 2002, p. 787). For this reason, word recognition in multilingualism is not simply recognition within one language, but recognition under conditions of representation overlap and potential competition.

A more specific term, especially relevant for this dissertation, is *translation recognition*. Translation recognition refers to a task or paradigm in which participants decide whether a stimulus in one language is the correct translation equivalent of a stimulus presented in another language. At the methodological level, the *translation recognition paradigm* is used to investigate how lexical and semantic information is accessed across languages and how multilingual speakers verify cross-language correspondence. This paradigm is theoretically important because it requires participants to go beyond form recognition and engage in meaning-based evaluation. In the present dissertation, translation recognition is not treated as a simple vocabulary task. It is used as a controlled psycholinguistic paradigm for examining whether L3 English primes activate conceptual information strongly enough to facilitate or interfere with the recognition of Kazakh and Russian candidates. For this reason, translation recognition occupies a central place in the

metalanguage of the dissertation, linking lexical access, semantic processing, cross-language activation, and decision-making within a single experimental framework (Kroll & Stewart, 1994; Dijkstra et al., 2019).

A further concept of major importance is *language dominance*. Language dominance refers to the relative strength, accessibility, or functional centrality of one language within a multilingual repertoire (Treffers-Daller, 2019, p. 377). It is not reducible to the order of acquisition alone, because a language acquired first may not remain dominant in all domains of use. In multilingual processing, dominance is relevant because it influences resting activation levels, speed of access, lexical stability, and the efficiency with which cross-language competition is regulated (Hammarberg, 2014). In the present dissertation, language dominance is conceptually important because mirror-image trilingual groups may differ not only in which language was acquired first, but also in how strongly Kazakh and Russian are represented in everyday and academic life.

The term *interference* refers to measurable processing costs that arise when competing representations affect performance. In multilingual contexts, interference may be expressed in slower responses, increased error rates, lexical intrusions, or greater neural cost under conflict (Festman et al., 2010, p. 7). Interference should be distinguished from cross-language activation itself: the latter refers to the broader phenomenon of parallel activation, whereas interference refers specifically to its disruptive consequence in each task.

One of the principal mechanisms proposed to regulate such conflict is *inhibition*. In broad cognitive terms, inhibition refers to the suppression or downregulation of interfering representations or responses (Tempel et al., 2019, p. 233). In bilingual and multilingual language processing, inhibition is most strongly associated with Green's (1998) Inhibitory Control account, which treats multilingual language use as requiring suppression of non-target lexical candidates depending on current goals. In this sense, inhibition is not simply a

descriptive metaphor for difficulty, but a proposed mechanism for competition management in a co-activated multilingual system.

The broader term *language control* includes inhibition but is not limited to it. Language control refers to the set of processes that regulate multilingual competition and support goal-directed language use (Branzi et al., 2016; Green & Abutalebi, 2013). These processes may include conflict monitoring, maintenance of the current language set, interference suppression, response selection, and flexible adaptation to contextual demands. In the Adaptive Control Hypothesis, Green and Abutalebi (2013) propose that such control processes are themselves shaped by recurrent patterns of language use. In the present dissertation, language control provides the conceptual link between multilingual co-activation and the regulation required to make accurate semantic decisions in the task.

A related term is *code-switching*. Code-switching refers to the alternation between languages within discourse, conversation, or even a single utterance. Although code-switching is not the direct empirical object of the present study, it remains conceptually relevant because it illustrates that multilingual speakers do not activate or deactivate whole languages in an all-or-nothing way. Instead, several languages may remain available to varying degrees while control mechanisms regulate their relative prominence.

At the neurophysiological level, several methodological terms are indispensable. *Electroencephalography (EEG)* refers to the recording of electrical brain activity from the scalp. EEG is especially valuable in language research because of its high temporal resolution. From the broader electrophysiological tradition of *evoked potentials*, cognitive neuroscience developed the more specific concept of the *event-related potential (ERP)*, that is, time-locked fluctuations in the EEG signal associated with sensory, cognitive, or motor events. ERPs are particularly useful in neurolinguistics because they make it possible to determine when processing differences emerge relative to stimulus onset (Kutas & Federmeier, 2011, p. 626).

Among ERP components, the *N400* occupies a central place in the metalanguage of neurolinguistics. The term refers to a negative-going component peaking around 400 ms after stimulus onset and is widely associated with lexico-semantic and meaning-related processing. However, it should not be treated as a synonym for semantic processing in general. More precisely, the N400 is an electrophysiological index that is reliably modulated by semantic expectancy, contextual fit, relatedness, and ease of integration. In the present dissertation, the N400 is used as a neural marker that constrains the interpretation of multilingual semantic processing.

Two additional terms are useful for the present study, namely *lateralization* and *region of interest (ROI)*. Lateralization refers to hemispheric asymmetry in neural recruitment. In language neuroscience, left-hemispheric dominance has long been a major principle, although different components of language processing may vary in the degree and form of their lateralization (Friederici, 2011). *ROI*, by contrast, belongs to the analytic vocabulary of electrophysiology and refers to predefined spatial groupings of electrodes or neural regions used for systematic comparison across conditions. In the present dissertation, ROI is part of the interpretive framework linking scalp distribution to the characterisation of ERP effects across anterior, central, and posterior regions.

The Kazakhstan context makes this terminological discussion especially important. Specialised terminological resources in psycholinguistics and neurolinguistics remain limited in Kazakhstan when compared with broader linguistic lexicography and general terminological work. This matters because the absence of stable equivalents across Kazakh, Russian, and English creates difficulties not only for translation but also for conceptual consistency in teaching, research, and interdisciplinary communication. In this context, terminological work becomes part of the development of the field itself. Consequently, *Psycholinguistics and Neurolinguistics: Russian-English-Kazakh learner's dictionary* is of

special significance. It is the *first trilingual dictionary* compiled in the fields of psycholinguistics and neurolinguistics (Ibrayeva, Nabiyeva, et al., 2023). This is methodologically important. Its main function is to align and stabilise terminology across three working academic languages rather than to provide an extended theoretical discussion of every concept. In the framework of the present dissertation, this is precisely what makes it valuable: it supports conceptual correspondence across Kazakh, Russian, and English in a field where exact equivalents are not always fully fixed.

In sum, the metalanguage of neurolinguistics in the present dissertation serves three interrelated functions. First, it provides *definitional clarity* by distinguishing core terms such as bilingualism, multilingualism, trilingualism, L1, L2, L3, lexical access, lexical selection, cross-language activation, lexical competition, language dominance, interference, inhibition, language control, code-switching, EEG, ERP, N400, lateralization, and ROI. Second, it provides *cross-level coherence*, allowing linguistic constructs to be linked systematically to cognitive mechanisms and neural indices. Third, in the Kazakhstan context, it contributes to *terminological stabilization*, which is especially important in a field where specialised multilingual resources have historically been limited. For these reasons, terminology is not treated here as an auxiliary matter. It is part of the theoretical architecture of the dissertation itself and a necessary condition for precise analysis of multilingual lexico-semantic processing.

1.3 The Development of Neurolinguistics in Kazakhstan

The development of neurolinguistics in Kazakhstan must be understood against the background of the country's multilingual language ecology, educational transformation, and state language policy. Kazakhstan is not merely a setting in which several languages coexist. It is a context in which language choice, language education, and language planning have long been connected to questions of national identity, interethnic communication, social

mobility, and international integration. For this reason, language in Kazakhstan cannot only be treated as a cultural or pedagogical phenomenon. It is also a cognitively and socially structured reality that provides meaningful conditions for the study of multilingual processing. The emergence of neurolinguistics in Kazakhstan should therefore be viewed not as an isolated academic development, but as part of a broader shift toward understanding language shaped by multilingual experience, institutional practice, and the changing communicative demands of society (Republic of Kazakhstan, 1995; Republic of Kazakhstan, 1997).

The legal and policy framework of the country reflects this structure clearly. The Constitution of the Republic of Kazakhstan defines Kazakh as the state language, while Russian is officially used on an equal footing in state organisations and local self-government. The Law “*On Languages in the Republic of Kazakhstan*” further states that both Kazakh and Russian are compulsory subjects in educational institutions. These legal provisions are important because they do not merely symbolise a multilingual reality; they actively structure it. They create a sociolinguistic and institutional environment in which Kazakh and Russian form the two principal languages of schooling, administration, and everyday communication. From a neurolinguistic perspective, this means that a large part of the population develops linguistic experience under relatively stable conditions of bilingual exposure, functionally differentiated language use, and continuous interaction between two socially significant languages. This is one of the central reasons why Kazakhstan is theoretically valuable for the study of multilingual lexical and semantic processing (Republic of Kazakhstan, 1995; Republic of Kazakhstan, 1997). This two-language foundation is also one of the main reasons why trilingualism in Kazakhstan takes a specific form. Kazakh and Russian are not simply “first” and “second” languages in an abstract psycholinguistic sense. They are socially embedded languages whose relative functions have been shaped by history, urbanisation, literacy practices, educational trajectories, and everyday bilingual use. In this environment,

speakers often grow up not with one dominant language and one marginal additional language, but with two languages that carry different symbolic and practical values across domains. Against this background, English became increasingly prominent as the language of internationalisation, academic mobility, technological modernisation, and integration into the global economy. Unlike Kazakh and Russian, English does not emerge from the same historical bilingual formation. Instead, it is introduced through educational policy, foreign language teaching, and the broader modernisation agenda of the independent state. This difference is crucial because it means that English typically enters the multilingual repertoire under distinct acquisition conditions and therefore occupies a different cognitive and functional status than the two societal languages.

A major symbolic and policy milestone in this process was the promotion of the cultural and educational project commonly known as the “*Trinity of Languages*”. This framework explicitly positioned Kazakhstan as a country in which Kazakh should develop as the state language, Russian should continue to function as the language of interethnic communication, and English should be learned as the language of successful integration into the global economy (Nazarbayev, 2007). This principle was incorporated into broader state language policy and educational planning, including language development programmes, and later reforms in secondary and higher education (Beisenova, 2013). The importance of this framework lies not only in its political visibility but also in the fact that it gave multilingualism a clear state-endorsed structure. It framed knowledge of three languages not as an optional individual advantage, but as an educational and social goal tied to modernisation, competitiveness, and the country’s future development.

This policy direction has not remained static. The *Concept of Language Policy Development in the Republic of Kazakhstan for 2023–2029* shows that language policy continues to be updated in accordance with current national priorities. According to the

official government publication, the Concept is aimed at implementing the Constitution and further developing language policy under contemporary conditions. Its main directions include the modernisation of the Kazakh language based on the Latin script, the strengthening of the state language, and the development of the linguistic capital of Kazakhstan's citizens. Particularly important for the present dissertation is the fact that the document treats language development not simply as preservation, but as a strategic resource connected to education, social participation, and science. This confirms that multilingualism in Kazakhstan remains an active state project rather than only a historical legacy (Government of the Republic of Kazakhstan, 2023). For this reason, the trilingualism relevant to the present dissertation is not accidental or purely individual. It emerges from the structured interaction of language policy, educational design, and everyday multilingual practice. In Kazakhstan, the combination of Kazakh, Russian, and English has been institutionally reinforced through educational reform, especially through state initiatives on multilingual and trilingual education (Abasilov & Kapalbek, 2024). The state programmes on language development, later, education and science programmes, and the implementation of trilingual education in secondary and higher education all contributed to a model in which knowledge of three languages became framed simultaneously as an educational objective, a marker of cultural competence, and a sign of social modernisation. In this respect, Kazakhstan differs from contexts in which trilingualism arises only from family migration or local demographic diversity; here, trilingualism is not only socially present but also pedagogically cultivated and politically legitimised.

Research on trilingual education in Kazakhstan has shown that the policy logic consistently links Kazakh to statehood and national identity, Russian to broader communication across domestic and post-Soviet multilingual space, and English to global mobility, academic advancement, and economic competitiveness (Huertas-Abril & Shashken, 2021, p. 262). This functional distribution is highly relevant for neurolinguistic interpretation.

It suggests that the three languages are not simply acquired in sequence, but are associated with different domains, motivations, and communicative functions. Such asymmetry is likely to influence how lexical representations are formed, how frequently they are accessed, how strongly they are connected to conceptual knowledge, and how efficiently they are recruited under conditions of competition. Thus, the sociolinguistic structure of Kazakhstan is not just background information. It forms part of the explanatory basis for studying multilingual lexico-semantic processing. Within education, this policy was developed further through the concept of *polylingual education*. This concept in Kazakhstan treats multilingual education not as the simple accumulation of language classes, but as the formation of a polylingual personality through the coordinated acquisition of several languages and cultures. In this view, multilingual education is tied to broader goals of social adaptation, intercultural competence, intellectual flexibility, and educational modernisation. This is important because it shifts the educational meaning of multilingualism from a narrow linguistic issue to a broader developmental and social one. It also means that multilingual competence is understood as something integrated rather than fragmented. For neurolinguistics, this matters because it implies that multilingual experience is not merely quantitative. What matters is not only how many languages are known, but how they are learned, how they are distributed across functions, and how they become incorporated into one cognitive system.

The implementation of trilingual education in institutions such as Nazarbayev Intellectual Schools became especially influential because it provided a pilot model in which content learning, extracurricular activity, and language instruction were distributed across Kazakh, Russian, and English (Beisenbayeva, 2020, p. 606; Kalizhanova et al., 2020, p. 414). In such institutions, trilingualism was not treated as an abstract ideal, but operationalized through curriculum design and language allocation across disciplines. Even where implementation varied in quality and faced methodological, pedagogical, or social challenges,

the policy direction itself made multilingualism central to educational development in Kazakhstan. More importantly for the present dissertation, it created large groups of learners and speakers whose language experience cannot be adequately described by simple monolingual or even classic bilingual models. Their linguistic repertoires are shaped by differential but coordinated exposure to three languages, which makes them particularly important for neurolinguistic research.

This policy and educational context explain why neurolinguistics is especially important for Kazakhstan. If the country's educational and language policy aims not merely at bilingual maintenance but at stable trilingual development, then it becomes insufficient to study language only as a social, ideological, or pedagogical phenomenon. It is equally necessary to understand how multiple languages are represented, activated, and regulated in the mind and brain. Neurolinguistics becomes relevant here because it provides methods and concepts for investigating how multilingual speakers process competing languages in real time, how lexical and semantic activation unfold, how interference is regulated, and how language experience shapes cognitive and neural organisation. In other words, where policy promotes multilingual education, neurolinguistics helps explain what such education means at the level of actual processing mechanisms. This is especially important in Kazakhstan because the country's language policy has created large populations of bilingual and trilingual speakers (Küçükler, 2020, p. 3; Sadulova et al., 2025; Suleimenova & Tursun, 2014), which presents a significant area for neurolinguistic investigation into its cognitive and neural consequences

A methodologically relevant foundation for the development of neurolinguistic research in Kazakhstan can be found in the broader cognitive-neuroscience and psychophysiological research conducted at Al-Farabi Kazakh National University and the Brain Institute under the scientific leadership of A. M. Kustubayeva. Although many of these

studies were not neurolinguistic in the strict sense, they contributed to the local development of experimental and analytical approaches that are also essential for language-and-brain research. In particular, studies using the Attention Network Test, EEG/ERP recordings, analysis of the temporal dynamics of brain activity, executive-control paradigms, and source reconstruction of electrical brain activity established an important methodological platform for investigating cognitive processes through objective neurophysiological indicators (Kustubayeva et al., 2022; Matthews et al., 2025; Zholdassova et al., 2021; Ismagambetova et al., 2025). This methodological background is relevant to neurolinguistics because multilingual language processing also involves attention, cognitive control, response monitoring, and time-sensitive neural dynamics.

Recent studies linking cognitive abilities, memory, and brain-data analysis further broaden this methodological context. The study on genetically predicted memory and self-reported foreign-language proficiency is particularly relevant because it connects individual differences in memory with language-learning outcomes in a multilingual setting (Yerdenova et al., 2025). In addition, work on focused modulation of brain activity and EEG-based machine-learning approaches to brain-age prediction reflects the growing use of quantitative and neurotechnological methods within the KazNU research environment (Zhantleuova et al., 2025; Zhulduzbayev et al., 2026). These studies should not be interpreted as direct neurolinguistic predecessors of the present dissertation; rather, they demonstrate the development of a broader methodological infrastructure that supports future EEG/ERP-based investigations of language processing.

The relevance of neurolinguistics in Kazakhstan is further strengthened by the changing role of scientific discourse and internationalisation. Scientific communication in Kazakhstan is developing under conditions of growing internationalization, and this process creates new discursive priorities and challenges (Ovezmyradov, 2022, p. 191; Moldashev &

Tleuov, 2022). The analysis in these works highlights the increasing importance of English-language academic standards and the adaptation of local scholarly communication to international norms, while also preserving the multilingual character of Kazakhstan's intellectual space. This point is highly relevant for the present dissertation because it adds another dimension to the role of English in Kazakhstan. English is not only a foreign language taught in schools, but it is also becoming a language of science, publication, and academic visibility. As a result, the Kazakh–Russian–English configuration is reinforced not only through education and policy, but also through the internationalisation of scholarly discourse. For neurolinguistics, this matters because academic multilingualism influences the domains in which languages are used, the lexical fields in which they become dominant, and the kinds of conceptual knowledge they organise.

In addition to language policy and educational perspectives, bilingualism in Kazakhstan has been examined in a substantial body of local scholarship. Earlier studies addressed the language situation in Kazakhstan, Kazakh–Russian language contact, language choice, language planning, and the functional distribution of Kazakh and Russian in society (Khasanov, 1976, 1989, 1992; Suleimenova & Smagulova, 2005; Suleimenova et al., 2007, 2010, 2016; Smagulova, 2008). Other works focused on language interaction, interference, and bilingual speech in Kazakh–Russian and other multilingual contexts (Karlinsky, 1990; Kopylenko, 1988; Pak, 2012; Shaibakova et al., 2020; Zharkynbekova & Chernyavskaya, 2022). A further line of research examined second-language acquisition, educational bilingualism, and child bilingualism, including studies on the acquisition of grammatical forms, bilingual children's language development, and strategies of vocabulary comprehension in monolingual and bilingual children of Northern Kazakhstan (Agmanova, 2010; Aldabergenova, 1999; Altynbekova, 1989; Ayapova, 2021; Shayakhmetova, 2004; Vinnitskaya, 1999; Zhakupova et al., 2024). Taken together, these studies provide an

important national foundation for understanding bilingual experience in Kazakhstan. However, they mainly address sociolinguistic, developmental, educational, and psycholinguistic aspects of bilingualism, while the real-time neurocognitive mechanisms of multilingual lexical access remain insufficiently explored. This gap creates the need for neurolinguistic research that applies time-sensitive methods such as EEG/ERP to the study of Kazakh–Russian–English trilingual processing.

The emergence of neurolinguistics in Kazakhstan should therefore be viewed as part of a broader movement toward explaining language as a brain-based and cognitively grounded phenomenon. One significant step in this development has been the appearance of local scholarship that explicitly links bilingualism, multilingualism, and language acquisition to psycholinguistic and neurolinguistic approaches. In this regard, the publications associated with the present dissertation form part of that trajectory. It has been argued that bilingualism should be examined not only through sociolinguistic description, but also through methods capable of revealing the cognitive and neural mechanisms underlying language processing (Ibrayeva & Zhaksylykkyzy, 2021). This is important because it helps reposition bilingualism within the Kazakhstani academic context as a phenomenon requiring explanation at the level of processing, not just language policy or social distribution.

Further work on contemporary psycholinguistic and neurolinguistic methods in second-language acquisition has also emphasised the relevance of experimental and cognitively oriented approaches to the study of language learning and processing (Zhaksylykkyzy & Nabiyeva, 2021). Together, these works reflect a shift from descriptive language studies toward experimentally and cognitively informed language science in Kazakhstan. Their importance lies not only in their specific content, but also in their contribution to the local legitimization of psycholinguistic and neurolinguistic thinking within philological and language-science scholarship. Earlier work on language and brain

organisation in the Kazakhstani context also contributed to the local conceptual foundation of neurolinguistics by framing language as a function that should be understood in relation to brain mechanisms, rather than only through traditional structural linguistics (Zhaksylykkyzy & Zholdassova, 2020). Although this publication belongs to an earlier stage of the field's development, it is important because research fields often emerge through conceptual repositioning before they become methodologically consolidated. In this case, such work helped establish a local research narrative in which neurolinguistics could be recognised as a legitimate direction of inquiry within Kazakhstani philology and language science.

A particularly important milestone for the present dissertation's topic is the gradual transition from general bilingualism toward an explicit focus on third-language acquisition and trilingual processing. This shift is reflected in Kazakhstani psycholinguistic work examining how L1 and L2 influence L3 acquisition and processing (Ibrayeva, Zhaksylykkyzy, et al., 2023). This work is significant because it moves from general advocacy of psycholinguistic and neurolinguistic methods to a more focused engagement with trilingual processing, thereby preparing the conceptual ground for the dissertation's central concern with cross-language activation in Kazakh–Russian–English speakers. Further work connecting neurolinguistics with third-language acquisition placed Kazakhstan-related concerns within wider debates on multilingualism, cognition, and language learning (Zhaksylykkyzy et al., 2021). In this sense, the study of trilingualism in Kazakhstan did not emerge suddenly or in isolation, but developed gradually from earlier work on bilingualism, second-language acquisition, psycholinguistic methods, and multilingual educational practice. The present dissertation extends this trajectory into the neurolinguistic investigation of real-time lexical-semantic processing. Broader transformations in language education and digitalisation also form part of the context in which neurolinguistic and psycholinguistic approaches are becoming increasingly relevant in Kazakhstan. Recent work on the

digitalisation of foreign-language education has emphasised the need for flexible, research-based approaches to multilingual teaching in a rapidly changing technological environment (Nogaibayeva & Yersultanova, 2025). Although this direction is not narrowly neurolinguistic, it reflects a wider tendency toward the integration of language science, educational reform, and cognitively informed approaches to multilingual competence.

In this perspective, the development of neurolinguistics in Kazakhstan can be described through several milestones. The first is the consolidation of the country's multilingual language policy, which established the structural importance of Kazakh, Russian, and later English (Huertas-Abril & Shashken, 2021, p. 262; Kubieva et al., 2021, p. 42). The second is the expansion of multilingual and trilingual education as a strategic direction of educational modernisation (Nurlanova et al., 2022). The third is the emergence of local scholarship linking bilingualism, multilingualism, and language acquisition to psycholinguistic and neurolinguistic approaches (Sternin et al., 2021). The fourth is the creation of specialised terminological resources that support teaching and research in this domain. The fifth is the gradual institutionalisation of language-and-brain research through interdisciplinary academic platforms, including the structures associated with Al-Farabi Kazakh National University and the Brain Institute. Together, these developments form the basis for a neurolinguistic approach to trilingualism that is grounded not only in international theory, but also in Kazakhstan's own linguistic, educational, and scientific reality.

Thus, Kazakhstan provides not merely a demographic setting for the study of trilingualism, but a theoretically and socially meaningful environment in which neurolinguistic research becomes especially relevant. The coexistence of Kazakh and Russian, the policy-driven inclusion of English, the institutionalisation of multilingual education, the internationalisation of scientific discourse, and the growth of local conceptual and terminological resources together create a context in which the study of multilingual lexico-

semantic processing is both academically justified and practically significant. Against this background, the present dissertation examines trilingual processing not as an isolated psycholinguistic curiosity but as a phenomenon rooted in the linguistic reality, educational trajectory, scientific internationalisation, and policy framework of contemporary Kazakhstan.

1.4 Theoretical Models of Multilingual Lexical Access

Theoretical models of multilingual lexical access seek to explain how words are recognised, activated, and semantically interpreted when more than one language is available within the same cognitive system. The central question is not only whether several languages coexist in memory, but how they are organised, how they interact during online processing, and how semantic representation is accessed when lexical input in one language may activate competing or supporting representations in another. In multilingual speakers, lexical access is therefore a problem of representational architecture, activation dynamics, and control. It concerns the relationship between word forms and concepts, the degree to which activation is language-selective or language-nonselective, and the mechanisms through which the system resolves competition or exploits convergence across languages. Because the study of trilingualism emerged later than the study of bilingualism, most current accounts of multilingual lexical access build first on bilingual mechanisms and then extend them to the case of three or more languages (Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994; Kroll et al., 2010).

A useful starting point is the distinction between *lexical form* and *semantic representation*. Lexical access does not consist only of matching an incoming orthographic or phonological string to a stored form. It also involves activation of meaning, and in bilingual or multilingual speakers, this meaning may be shared, overlapping, or differentially connected across languages. From this perspective, multilingual lexical access is not simply a matter of retrieving a word from the correct language. It is the process of mapping a stimulus onto a

network of form-based and concept-based relations in which several languages may become active at once. For this reason, models of multilingual lexical access must account for both the architecture of cross-language activation and the structure of semantic representation (Bailey et al., 2023, p. 496; Woumans et al., 2021).

Bilingual mechanisms as the foundation of multilingual lexical access. Research on bilingual word recognition provides the most influential theoretical basis for current models of multilingual lexical access. One of the strongest conclusions of this tradition is that lexical access is often language nonselective. This means that when bilinguals process a word in one language, lexical candidates from the other language may also become active, especially when there is formal or semantic overlap. Consequently, evidence for this conclusion comes from cognate facilitation, interlingual homograph interference, translation priming, and other cross-language effects that show that language membership does not operate as a strict early filter during visual word recognition. Theoretical models built on these findings treat the bilingual lexicon not as two fully separate systems, but as an integrated representational space in which languages interact dynamically during recognition (Desmet & Duyck, 2007, p. 174; Van Hell & Dijkstra, 2002).

The most influential account in this tradition is the *Bilingual Interactive Activation Plus (BIA+) model* (Dijkstra & Van Heuven, 2002). In BIA+, orthographic input activates sublexical and lexical representations across languages, while phonological and semantic information are also integrated into the recognition system. Language nodes do not function as absolute gates that block the non-target language; rather, they act as sources of bias within an interactive architecture. Crucially, the model distinguishes between the *word identification system* and the *task/decision system* (Van Hell & Dijkstra, 2002). This distinction is important because it explains why non-selective activation, a stable property of lexical access, may occur even when overt task performance varies depending on instructions, task demands, or

response requirements. In theoretical terms, BIA+ is highly relevant for multilingual lexical access because it establishes the basic principle that several languages may be co-activated automatically, while the eventual behavioural output depends on later decision processes. It also implies that semantic representation is not accessed in isolation from cross-language lexical dynamics, but through an integrated activation system in which several candidate pathways remain available.

A complementary line of theorising is found in bilingual memory models, especially the *Revised Hierarchical Model (RHM)*. Kroll and Stewart (1994) proposed that bilingual lexical organisation includes both lexical links between translation equivalents and conceptual links between words and shared meaning representations. In the original formulation, L1 words are assumed to have stronger direct links to conceptual memory, whereas L2 words, especially at lower proficiency, are more likely to access meaning through mediation by L1 lexical representations. Later reassessments of the RHM clarified that the model should not be read as a rigid developmental sequence, but as a framework for understanding asymmetries in lexical-conceptual mapping, translation direction, and proficiency effects (Kroll & Stewart, 1994; Kroll et al., 2010). For the present dissertation, the model remains highly useful because it foregrounds the relationship between lexical form and semantic representation. It predicts that multilingual lexical access is shaped not only by surface activation, but also by the relative strength of conceptual links established through language experience.

From the perspective of *semantic representation*, the RHM is particularly important because it assumes that different languages can connect to a partially shared conceptual system, but that the strength and directness of these connections vary. This matters for multilingual lexical access because the semantic effects observed in tasks such as translation recognition are unlikely to arise solely from formal lexical associations. If a word in one language activates its translation equivalent in another, this may happen not only through

direct lexical association, but also through convergence on shared conceptual content. The theoretical problem is therefore not whether semantic representation exists independently of the lexicon, but how lexico-semantic links are weighted across languages with unequal histories of use.

Further development in bilingual lexical modelling is represented by *Multilink*, a computational model designed to account for bilingual word recognition and word translation within a unified framework (Dijkstra et al., 2019). Multilink integrates assumptions from both BIA+ and the RHM and includes representations of form, meaning, and translation relations. It is especially relevant because it moves beyond isolated recognition and tries to account for translation production as well, including effects of cognate status, frequency, lexical similarity, proficiency, and translation direction. The theoretical contribution of Multilink is important for multilingual lexical access because it explicitly links bilingual recognition to semantic representation and translation behaviour in one model. This makes it particularly informative for paradigms, such as translation recognition, in which the relationship between lexical form and conceptual equivalence is central.

Another foundational component of bilingual models concerns *language control*. If several languages are active in parallel, multilingual processing cannot be explained by representational structure alone. It also requires mechanisms of regulation. Green's *Inhibitory Control model* proposed that bilingual language use involves suppression of irrelevant lexical candidates and control over competing language schemas. Later, the *Adaptive Control Hypothesis* argued that control processes are not fixed, but shaped by recurrent interactional contexts, such as single-language use, dual-language use, or code-switching environments. These models are crucial for multilingual lexical access because they explain why the same integrated lexicon can produce different patterns of facilitation or interference depending on language history, task demands, and habitual context of use. They also help bridge

representational accounts of the lexicon with real-time performance data, since lexico-semantic activation must often be interpreted alongside control demands and competition management (Green, 1998; Green & Abutalebi, 2013).

Taken together, bilingual mechanisms provide three basic assumptions that remain foundational for multilingual lexical access. First, lexical activation is often nonselective. Second, lexical and conceptual links are asymmetrical and shaped by experience. Third, cross-language competition requires control; these principles do not yet explain how a third language enters the system, but they provide the conceptual architecture from which more specific L3 accounts develop.

Third language processing accounts and the problem of source language selection. When a third language is added, the theoretical problem changes. In bilingual models, the main question is how two languages interact within one system. In trilingualism, the question becomes more complex: if L3 processing recruits prior languages, which prior language is most likely to shape it, and why? This is the central issue addressed by major L3 processing accounts. While many of these models were first developed in relation to morphosyntax, their logic is directly relevant to lexico-semantic processing because they propose different principles for how previously acquired languages are weighted during later language use.

One influential proposal is the *L2 Status Factor*, associated with Bardel and Falk (2007). This account argues that the second language may enjoy a privileged role in L3 acquisition and processing because L2 and L3 share important experiential properties: both are non-native systems, both are often acquired later, and both are frequently learned through formal instruction. Under this view, L3 processing may recruit L2 more readily than L1 because the multilingual system treats the previously acquired non-native language as a more accessible source of structure or strategy. Although the model was developed mainly for

transfer in morphosyntax, its relevance to lexico-semantic processing is substantial. If L2 and L3 share patterns of explicit learning, classroom-based vocabulary building, or domain-specific academic use, then L2 may influence how semantic representations are accessed or mediated during L3 tasks. In this sense, the L2 Status Factor may be interpreted as a weighting account that privileges non-native system similarity rather than chronological priority alone (Bardel & Falk, 2007; Bardel & Falk, 2012).

A second influential proposal is the *Typological Primacy Model (TPM)*. Rothman (2011, 2015) argues that cross-linguistic influence in L3 acquisition is primarily determined by structural proximity between the L3 and one of the previously acquired languages. The core assumption is that the multilingual system selects as its primary source of transfer the language perceived to be typologically closest to the target. Although the TPM was designed for early L3 morphosyntactic transfer, its logic also bears directly on lexico-semantic processing. Typological proximity may influence semantic representation through lexical similarity, shared distributional patterns, or parallel mappings between words and concepts. From this perspective, semantic access in L3 may be disproportionately shaped by whichever prior language offers the strongest similarity-based bridge to the target. Thus, the TPM can be reinterpreted for lexico-semantic work as a model in which semantic representation is weighted by perceived language closeness rather than by acquisition order alone.

A third influential account is the *Cumulative Enhancement Model (CEM)*. Flynn, Foley, and Vinnitskaya (2004) proposed that previously acquired languages can contribute positively to the acquisition of additional languages when their influence is facilitative. Rather than one prior language dominating, the model emphasises the possibility that the multilingual system accumulates useful representational resources. Although originally formulated in relation to grammar, the logic of cumulative enhancement is highly relevant to lexico-semantic representation. If several languages strengthen conceptual networks, translation

relations, or associative pathways, then semantic access in L3 may draw on more than one prior language in a facilitative way. This is important because it prevents multilingual lexical access from being reduced to a single-source model. It allows for the possibility that several languages contribute differentially but cumulatively to the development and use of L3 semantic representation.

More recent L3 research has also introduced models that argue for *property-by-property transfer* rather than wholesale transfer from a single source language. The *Linguistic Proximity Model (LPM)* holds that cross-linguistic influence in L3 acquisition is incremental and selective, guided by local similarities rather than by full-language transfer (Westergaard et al., 2017). Although formulated primarily for grammatical development, the model is also informative for lexico-semantic interpretation because it suggests that multilingual lexical access may be selective and domain-sensitive. In semantic processing, some concepts, lexical fields, or lexicalization patterns may be more strongly associated with one prior language, whereas others may reflect influence from another. Accordingly, semantic representation in a trilingual system may be property-sensitive and differentially distributed rather than uniformly derived from either L1 or L2.

Semantic representation in multilingual lexical access. The subtitle of this section specifically highlights *semantic representation*, and this focus is essential. Multilingual lexical access cannot be fully explained by formal activation alone; even when orthographic or phonological overlap plays an important role, the processing of translation equivalents, semantic congruency, and meaning mismatch depends on how words in different languages are linked to concepts (Kharkhurin, 2017, p. 3; Shook & Marian, 2012, p. 310). This is why bilingual mechanisms and L3 accounts must ultimately be read together through the lens of semantic representation.

In bilingual models such as the RHM, semantic representation is usually treated as at least partially shared across languages, although the lexical routes to that shared representation may differ in strength. In computational approaches such as Multilink, semantic representation is not a passive storage system, but part of the activation architecture through which lexical forms converge on meaning. In L3 models, by contrast, the question is not only whether meaning is shared, but which previously acquired language provides the strongest access route to it under conditions (Angelovska et al., 2023). Thus, semantic representation becomes the site where bilingual architecture and L3 weighting principles intersect.

For the purposes of the present dissertation, this intersection is especially important because the experimental paradigm is not a formal lexical decision task, but a *translation recognition paradigm* designed to test semantic congruency. In such a task, the relevant theoretical issue is not merely whether the system recognises lexical form, but whether an L3 English prime activates a concept strongly enough to facilitate or disrupt evaluation of Kazakh or Russian candidates. This requires a model in which semantic representation is central, not peripheral. It also requires a view of multilingual lexical access in which the relation between form and meaning is shaped by acquisition history, language dominance, typological distance, and control demands. Accordingly, the most suitable theoretical position for this dissertation is not a single model taken in isolation, but an *integrated account*. From BIA+ are the assumptions of nonselective lexical activation; from the RHM, the distinction between lexical and conceptual links and the possibility of asymmetrical semantic mediation. From Multilink comes the attempt to model recognition and translation within one system. From control-based accounts comes the idea that competition must be regulated. Finally, L3 models contribute different hypotheses about which prior language is most likely to influence L3 processing and why. Together, these models support a view of multilingual lexical access

as an integrated, experience-sensitive system in which semantic representation is shared to some degree across languages but access to that representation is uneven, weighted, and shaped by language history.

In the Kazakh–Russian–English trilingual configuration examined in this dissertation, these theoretical issues are particularly important. Kazakh and Russian provide two previously acquired languages with different typological profiles and distinct sociolinguistic functions (Utegenova et al., 2024, p. 393; Zharkynbekova & Chernyavskaya, 2022, p. 783), and potentially different strengths of lexico-semantic representation. English, as L3, is processed against this background. The main question is therefore not whether multilingual lexical access occurs, but how semantic activation is distributed across the three-language system and how the relative weighting of L1 and L2 shapes access to meaning during L3-triggered processing. This is precisely the question that motivates the next subsections, where studies supporting L1-based and L2-based accounts of L3 influence can be examined in greater detail.

1.5 Kazakh and Russian as Prior Languages in Trilingual Processing: Typological Distance and Structural Asymmetry

The contrast between Kazakh and Russian as prior languages is theoretically informative because it captures how multilingual systems are shaped not only by order of acquisition, but also by *genealogical distance*, *structural organisation*, and *domain-specific language experience*. In a trilingual context, it is rarely sufficient to state that speakers know three languages. What matters for lexico-semantic processing is how those languages are represented, how strongly they are linked to conceptual knowledge, how routinely they are used across communicative domains, and how efficiently competition is regulated when several candidate systems become available. In the context of Kazakhstan, Kazakh and Russian are not peripheral languages but central languages of socialisation, education, and

communication (Bekmurzaev, 2020, p. 8). Many speakers acquire both relatively early yet still differ in which language becomes dominant in literacy, schooling, and formal use (Suleimenova & Tursun, 2014). Consequently, the L1 configuration is not merely a biographical variable. It indexes differences in early exposure, parsing routines, literacy development, and long-term distribution of use, all of which may shape the architecture of multilingual lexical access.

A major explanatory factor behind these differences is *typological distance*, understood as relative similarity or dissimilarity across phonology, morphology, syntax, and lexical organisation. Typological distance matters for multilingual processing because structural similarity may increase the likelihood and strength of cross-language co-activation, whereas greater distance may reduce direct facilitation, even though competition can still arise through shared conceptual domains or partial overlap in meaning. The Kazakh–Russian contrast is especially informative in this respect because the two languages differ both *genealogically* and *typologically*, making them a particularly strong case for examining how prior-language structure affects L3 processing.

From the perspective of genetic classification, Kazakh belongs to the Turkic language family, specifically to the Kipchak branch, whereas Russian belongs to the Indo-European family, within the East Slavic subgroup of the Slavic branch (Comrie & Corbett, 1993; Johanson & Csató, 1998; Timberlake, 2004). This means that Kazakh and Russian are not closely related languages, but historically distinct systems belonging to different major language families. Although Kazakh has sometimes been discussed in connection with the broader Altaic hypothesis, this classification remains disputed; therefore, in the present dissertation, Kazakh is treated more cautiously as a Turkic language rather than as a settled member of an Altaic family (Campbell & Poser, 2008; Georg et al., 1999). This clarification is important because the dissertation relies on the typological and genealogical contrast

between Kazakh and Russian as a theoretically relevant factor in explaining trilingual lexical-semantic processing.

Beyond genealogy, the distinction becomes even more relevant at the level of *typological profile*. Kazakh is characteristically described as an *agglutinative* language. In agglutinative systems, grammatical meanings are commonly expressed by a sequence of suffixes attached to a stem, with morpheme boundaries tending to remain relatively transparent (Yerimbetova et al., 2021, p. 58). Reference descriptions of Kazakh emphasise extensive suffixation, clear stem–suffix organisation, and the accumulation of inflectional and derivational information through overt morphological chaining (Issakova et al., 2023, p. 123). Kazakh also exhibits *vowel harmony* and *consonant assimilation*, both of which affect suffixal realisation and contribute to systematic morphophonological regularity. In addition, descriptive accounts identify Kazakh’s canonical clause structure as predominantly *subject–object–verb (SOV)*, although alternative orders may occur under discourse-driven conditions (Johanson & Csató, 1998). These properties suggest a system in which grammatical relations and many semantic distinctions are distributed incrementally across suffixes and are therefore potentially available to processing in a relatively ordered and segmentable way.

Russian, by contrast, is a predominantly *fusional* language. In fusional systems, a single inflectional ending may encode several grammatical categories at once. Russian reference grammars emphasise its case morphology, grammatical gender, number marking, and the central role of verbal aspect, while general descriptions of Slavic structure note that endings in Slavic languages are largely fusional and often bundle more than one grammatical feature simultaneously (Timberlake, 2004; Wade, 2011). Russian nouns and adjectives inflect across a six-case system; verbs encode aspectual distinctions that play an especially prominent role in event interpretation. These properties mean that grammatical information in Russian is often packed into paradigmatic inflectional forms rather than distributed

transparently across a sequence of suffixes. In processing terms, this creates a system that may rely more heavily on inflectional pattern recognition, paradigm knowledge, and whole-form familiarity.

These differences motivate the notion of *structural asymmetry* as a processing-relevant concept. In the present dissertation, structural asymmetry refers to differences in the way linguistic information is organised and therefore made available during lexico-semantic access. In an agglutinative language such as Kazakh, concatenative suffixation and relatively transparent segmentation support the incremental extraction of grammatical cues as a word unfolds (Abudouwaili et al., 2024; Yerimbetova et al., 2021, p. 58). Over time, this may foster highly automatized parsing routines in which morphologically ordered cues guide interpretation in a relatively predictable manner. In a fusional language such as Russian, by contrast, the mapping from form to feature bundles may be less transparent because several grammatical values are encoded simultaneously and because surface forms are often conditioned by larger paradigmatic structure. This may shift the balance toward stronger reliance on lexical familiarity, stored inflectional patterns, and paradigm-based retrieval. The point is not that one system is simpler than the other. Rather, the two systems distribute information differently, and these differences are likely to matter for multilingual processing.

The contrast is also visible in *phonological and morphophonological organisation*. Kazakh displays robust vowel harmony, a core organising principle affecting the surface form of grammatical suffixes (Bowman & Lokshin, 2014, p. 1). Most native Kazakh words contain either front or back vowels, and suffixes vary; accordingly, consonant alternations in suffixes further contribute to morphophonological regularity. Russian can employ vowel harmony (synharmonia) for phonetic unity within words (Aleksakhin, 2014, p. 222). Instead, it relies on a phonological system with rich consonantal contrasts, including palatalisation, and on a morphology in which inflectional endings and stem alternations play a more paradigmatic

role. These differences are relevant because lexical access is not only semantic; it is also form-sensitive. If languages differ sharply in phonological regularity and suffixal behaviour, multilingual speakers may develop different expectations about how to form cues that map onto meaning.

Although the present dissertation focuses on lexico-semantic processing rather than on morphosyntax as such, lexical access does not develop outside grammar. Words are learned, stored, and interpreted within language-specific structural environments. In Kazakh, lexical items are frequently encountered in forms where grammatical and derivational information is layered overtly and cumulatively (Dzhusupov, 2023, p. 489; Yerimbetova et al., 2021, p. 58). In Russian, lexical items often appear within paradigmatic systems where several grammatical values are fused into single endings (Valentinova et al., 2023, p. 234). Over time, such structural environments may shape how lexical material is segmented, anticipated, and semantically integrated. This is one reason why typological distance is relevant even in a lexico-semantic paradigm: semantic processing is embedded in language-specific form–meaning architectures, and prior languages may therefore shape L3 processing not only through lexical similarity, but through more general habits of linguistic organisation.

To understand why these structural differences matter for trilingual processing, it is useful to relate them to models of *bilingual lexical access* and *language control* already discussed in the previous section. Bilingual research has shown that lexical access is often non-selective, meaning that input in one language can activate candidates in another language, especially when there is overlap in form or meaning (Dijkstra & Van Heuven, 2002). In such a framework, typological distance becomes relevant because it influences where co-activation is likely to occur and how strongly it may propagate. Languages that share cues at some representational levels may support stronger co-activation, whereas structurally distant languages may show weaker direct facilitation even if competition remains possible through

shared conceptual relations. At the same time, non-selective activation does not imply the absence of control. On the contrary, it implies that control is functionally necessary. Green's (1998) Inhibitory Control model and Green and Abutalebi's (2013) Adaptive Control Hypothesis are relevant here because they explain how multilingual speakers regulate competition among partially active systems. Within such a perspective, the contrast between L1 Kazakh and L1 Russian becomes theoretically valuable because it allows the present dissertation to examine how *structural asymmetry* and *experience-based control* interact in trilingual processing. Within Kazakhstan's multilingual ecology, this issue becomes especially salient. Although both Kazakh and Russian are the central languages of the country, the experiential distribution of these languages differs across speakers. L1 configuration often correlates with differences in early exposure, language of literacy, formal education, and long-term specialization of use. These experiential factors matter because lexical systems are shaped by use: frequency, reading practice, academic vocabulary, and communicative domain strengthen some pathways and weaken others. Consequently, two trilingual groups may share the same language set and still differ in which language provides the strongest default activation in formal contexts, which language supplies the densest lexical network for abstract vocabulary, and which language contributes most strongly to competition during online processing. When English is added as L3, the explanatory role of the Kazakh–Russian contrast becomes even more important. English is processed not in isolation, but through an already established Kazakh–Russian bilingual architecture that includes weighted activation profiles, domain-specific experience, and entrenched regulatory routines. Third-language processing accounts provide several ways of thinking about this. The *L2 Status Factor* proposes that L2 may exert privileged influence because L2 and L3 often share non-native status and similar learning conditions (Bardel & Falk, 2007; Falk & Bardel, 2011). The *Typological Primacy Model*, by contrast, proposes that structural similarity is the main

determinant of influence and predicts that the language typologically closest to the L3 will be selected as the primary source of transfer or activation (Rothman, 2011, 2015). Although these models were largely developed in relation to grammar, their logic also applies to lexico-semantic processing because lexical access is shaped by the strength of form–meaning mappings, structural similarity, and the routines through which meaning is reached. In this sense, the contrast between L1 Kazakh and L1 Russian should not be treated as a simple mirror-image manipulation. It is a way of testing how *structural type*, *typological distance*, and *experience-based weighting* interact in a trilingual system.

This integrated perspective also clarifies why the relation between *L1 status* and *dominance* should not be treated as automatically symmetrical. In the L1 Kazakh group, Kazakh may be the earliest and most deeply grounded language, but Russian may still be highly accessible or even dominant in some formal domains, depending on education and literacy history. In the L1 Russian group, Russian may show higher resting activation and stronger accessibility in academic or written contexts, while Kazakh may remain functionally important but less automatically engaged under certain task conditions. Because dominance, literacy, and domain of use are shaped by both societal distribution and individual trajectories, the relation between L1 and the strongest functional language is not necessarily one-to-one. This asymmetry is theoretically valuable because it provides a principled basis for explaining why the same trilingual task may yield group-specific patterns of facilitation, interference, and semantic congruency effects.

Taken together, typological distance and structural asymmetry between Kazakh and Russian provide an essential explanatory basis for studying trilingual processing in Kazakhstan. Kazakh, as a Turkic language of the Kipchak branch, is characterized by agglutinative morphology, vowel harmony, and relatively transparent suffixal organisation, whereas Russian, as an East Slavic language, is characterized by fusional inflection, case and

gender paradigms, and bundled grammatical marking (Britannica, n.d.; Dotton & Wagner, 2018; Johanson & Csató, 1998; Timberlake, 2004; Wade, 2011). These differences shape availability, segmentation routines, and the timing of constraint application during comprehension. When combined with L1–L2 configuration and domain-specific language experience, they yield principled variation in how the multilingual system weights activation across languages and regulates competition. For this reason, the contrast between L1 Kazakh and L1 Russian constitutes not only a sociolinguistically grounded grouping variable, but also a theoretically necessary dimension for a mechanistic account of trilingual lexico-semantic processing.

1.5.1 The First Language as the Main Source in Third-Language Lexico-Semantic Processing

One influential position in third language research holds that the *first language (L1)* may function as a major, and in some cases primary, source of influence in L3 lexico-semantic processing. In this line of work, the importance of L1 is explained not only by chronology but by representational depth. The first acquired language is usually the most entrenched system, the one with the strongest lexical-conceptual links, the highest degree of automaticity, and the broadest integration with autobiographical and everyday semantic knowledge. From this perspective, when an L3 word is encountered, semantic access may be disproportionately supported by L1-based representations, especially when the L3 is less proficient, less automatized, or still developing as a lexico-semantic system (Kroll & Stewart, 1994; Kroll et al., 2010).

A major theoretical basis for this position is the *Revised Hierarchical Model (RHM)*. Although originally formulated for bilingual memory, the model has clear implications for L3 lexico-semantic processing. Kroll and Stewart (1994) argued that L1 words generally have stronger and more direct links to conceptual memory, whereas later-acquired languages

initially rely more heavily on mediation through already established representational routes. When this logic is extended to a trilingual setting, it predicts that the semantic interpretation of L3 input may often be stabilized through L1-mediated conceptual pathways, particularly in tasks involving translation, semantic verification, or lexical judgment. In this sense, support for L1 influence is grounded in the assumption that the earliest established language provides the most reliable route to meaning (Kroll & Stewart, 1994; Kroll et al., 2010). Support for an L1-centred account has also come from research on *lexical transfer* in third language production. Ringbom (2001) argued that lexical influence in L3 cannot be reduced to superficial borrowing alone and that the first language often remains a substantial source of lexico-semantic influence, especially where representational strength and similarity conditions favour it. This position is important because it links L1 influence not only to overt transfer errors, but also to deeper lexico-semantic support, such as reliance on familiar meaning organisation, established lexicalisation patterns, and conceptually stable vocabulary routes. In lexico-semantic terms, the first language can therefore remain a major resource even when more than one previously acquired language is available.

This argument has also been strengthened by work on *cumulative lexical similarity*. Foryś-Nogala (2025) reports that cumulative L1–L2–L3 lexical similarity may be more conducive to L3 word knowledge and L3 word processing than similarity restricted to L2–L3 pairs. Particularly relevant is the finding that low-frequency triple cognates can show an advantage over words supported only by L2–L3 overlap (Foryś-Nogala et al., 2025). While such results do not imply that L1 is always the sole source of support, they do reinforce the claim that the first language may remain a powerful lexico-semantic resource in multilingual processing, especially where broader cross-language semantic convergence is present.

Further support for L1 influence comes from broader discussions of the *multilingual lexicon*. Cenoz (2003), in considering cross-linguistic influence in third language acquisition,

argues that the organisation of the multilingual mental lexicon cannot be understood without considering the interaction of previously acquired languages. Although this work does not claim that L1 always dominates, it supports the broader point that previously established systems, especially the earliest ones, remain highly relevant for L3 lexical organisation and meaning access. In lexico-semantic processing, this suggests that the first language may continue to function as a stable conceptual reference system against which later-acquired lexical material is interpreted.

Translation and semantic priming research also indirectly supports the plausibility of an L1-based route. Studies of bilingual translation have shown that noncognate translation pairs can activate one another through shared semantic pathways rather than solely through surface similarity (Dimitropoulou et al., 2011). Such findings are relevant for L3 work because they demonstrate that conceptual mediation across languages can be strong even when formal overlap is minimal. In a trilingual context, this strengthens the assumption that the most deeply entrenched semantic system, often the L1, may function as a particularly strong source of conceptual support during L3 word processing (Aparicio & Lavaur, 2018). Overall, studies supporting the L1 as a main source of L3 lexico-semantic processing converge on several points. Firstly, the L1 typically has the strongest and most stable links to conceptual memory. Secondly, lexical transfer research has often identified robust L1 involvement in vocabulary-related phenomena. Thirdly, cumulative similarity studies indicate that the L1 can remain a major lexico-semantic resource even in a multilingual system with more than two prior languages. For the present dissertation, this line of research is directly relevant because the translation recognition paradigm targets meaning-level evaluation. If L3 English primes activate concepts through the most stable and semantically grounded system, then an L1-based route remains a theoretically and empirically well-motivated possibility (Kroll & Stewart, 1994; Ringbom, 2001).

1.5.2 The Second Language as the Main Source in Third Language Lexico-Semantic Processing

Alongside the L1-based position, a substantial body of research argues that the *second language (L2)* may serve as the primary influence in third-language processing. This position is most often associated with the *L2 Status Factor*, according to which the second language may enjoy a privileged role because it shares important experiential properties with the L3: both are non-native systems, both are commonly acquired later than the L1, and both are often learned under explicit, school-based, or metalinguistically mediated conditions. Although the strongest early support for this position came from syntax, the logic of the account has clear implications for lexico-semantic processing as well. If the multilingual system treats the L2 as the most accessible prior non-native language, then L3 lexical access and semantic mediation may be disproportionately shaped by L2 representations, especially in tasks that recruit explicit knowledge and controlled processing (Bardel & Falk, 2007).

A foundational empirical source for this position is the classic work of Williams and Hammarberg (1998) on language switches in L3 production. Their longitudinal case study showed that the learner's L2 could serve as a prominent "supplier language" in L3 production. Importantly, the study did not deny the role of L1. Rather, it demonstrated that L1 and L2 may assume different functional roles, and that L2 may become especially active when lexical support is needed during L3 use. This distinction became highly influential because it suggested that L2 is not simply another background language but may occupy a special position as the previously acquired non-native system most readily recruited when another non-native language is being processed.

Hammarberg (2001) elaborated this argument by proposing that L1 and L2 often play different roles in L3 production and acquisition. One of the most important outcomes of this work is the claim that L2 may be especially prominent in lexical retrieval support and non-

adapted language switches. Although much of the evidence comes from production, the theoretical relevance for lexico-semantic processing is strong. If the L2 serves as a particularly available source of lexical support, then it may also exert a powerful influence on how L3 lexical items are activated, interpreted, and semantically mediated. In this sense, the L2 Status account is not only about structural transfer; it also provides a plausible explanation for L2-based mediation in lexico-semantic access.

The strongest formalisation of this position came with Bardel and Falk (2007). They argued that there is a qualitative difference between the acquisition of a true second language and the acquisition of an L3, and that the previously acquired L2 may be privileged because of its non-native status and shared learning mode with the L3. Even though their evidence focused on syntax, the broader claim is highly relevant to lexico-semantic processing. If L2 and L3 share classroom-based vocabulary learning, explicit metalinguistic strategies, and similar domains of formal use, then L2-based lexico-semantic mediation becomes theoretically plausible. In this respect, the L2 Status Factor can be extended to the lexical domain as a weighting account in which prior non-native experience becomes a key determinant of L3 processing (Bardel & Falk, 2007; Falk & Bardel, 2010).

Support for the L2-based account is also found in broader reviews of third language acquisition. Falk and Bardel (2010) note that vocabulary is one of the main domains in which cross-linguistic influence has been most intensively studied. Their review is important because it makes clear that the lexical domain is one of the strongest sites in which the L1–L2 debate remains active. Even where evidence is mixed, lexical transfer and lexical access repeatedly emerge as areas in which L2 may play a particularly strong role, especially in foreign-language learning contexts where both L2 and L3 are shaped by explicit instruction and similar functional constraints.

Research on *lexical transfer in L3 production* also provides support for the L2-based view. Ringbom's work is often cited by both L1- and L2-oriented accounts because it shows that lexical transfer in L3 is sensitive to language status, recency, and learning history. What is important here is that later interpretations of this literature often distinguish between stronger L1 involvement in deep semantic organisation and frequent L2 involvement in overt lexical supply. This distinction is highly relevant for lexico-semantic processing because it suggests that the lexical route into L3 may often be L2-based even when conceptual grounding itself is more complex. In other words, the L2 may function as the most accessible prior foreign-language system for lexical access, vocabulary retrieval, and form–meaning matching under L3 conditions (Ringbom, 2001; Hammarberg, 2001).

The L2-based account also gains support from a broader multilingual perspective in which previously learned non-native languages are seen as especially influential in later acquisition. De Angelis (2007) argues that third or additional language acquisition cannot be explained solely through the first language, because other previously acquired languages may exert strong and sometimes underestimated influence. This is relevant to lexico-semantic processing because L2 often provides a ready-made non-native route for vocabulary learning, lexical association, and explicit semantic mapping. In instructional settings, where both L2 and L3 are linked to classroom learning and formal knowledge, the L2 may therefore become particularly influential as a semantic and lexical mediator.

Taken together, studies supporting the second language as a main source of L3 lexico-semantic processing converge on several points. First, the L2 may enjoy a privileged role because it is the previously acquired non-native system and therefore shares experiential features with the L3. Second, production studies have repeatedly shown that L2 often functions as a lexical supplier or helper language during L3 use (Williams & Hammarberg, 1998). Third, lexical transfer research frequently points to L2 as a major source of lexical

influence, especially in classroom-based multilingual acquisition. For the present dissertation, this line of research is particularly important because the translation recognition paradigm requires both lexical access and semantic evaluation in L3-triggered conditions. If the L2 constitutes the most accessible prior non-native route, an L2-based account of lexico-semantic influence remains a theoretically and empirically plausible alternative to an L1-based interpretation.

The literature reviewed in Sections 1.5.1 and 1.5.2 indicates that L3 lexico-semantic processing is unlikely to be governed by a single uniform source language. On the one hand, L1-based accounts emphasise the privileged role of early-established conceptual representations and deeply automatized semantic networks. On the other hand, L2-based accounts argue that the previously acquired non-native language may assume a special mediating role because of its shared acquisition mode and functional proximity to the L3. What follows from this contrast is that multilingual lexical access must be treated as an experience-weighted system in which several factors may interact, including age of acquisition, dominance, typological proximity, domain-specific use, and learning context. This conclusion is particularly important for the present dissertation, since the Kazakh–Russian–English trilingual configuration offers a case in which the background languages differ not only by order of acquisition across groups, but also by structural type and sociolinguistic status. The next section, therefore, narrows the discussion to the specific contrast between L1 Kazakh and L1 Russian and examines how typological distance and structural asymmetry may shape trilingual processing.

Based on the sociolinguistic and linguistic profiles of Kazakhstan and the L3 processing frameworks reviewed in Chapter 1, the present study formulates the following research questions and hypotheses.

RQ1. Are there differences in processing L3 translation candidates depending on whether the candidate belongs to the participant's L1 or L2? Do the sequence of learning and the functional status of L1 and L2 modulate the congruency effect during L3 processing?

H1. In the L1 Russian group, congruency sensitivity is expected to be reduced for L2 Kazakh relative to L1 Russian, reflecting greater distance in learning history and weaker functional integration of L2 with L3. In the L1 Kazakh group, a more balanced pattern is expected, with comparable congruency sensitivity across L1 and L2, consistent with a more integrated bilingual profile.

RQ2. Does processing L3 translation candidates recruit similar scalp regions across the two mirror-image groups, or does the spatial distribution of the congruency effect differ by group and candidate language?

H2. If learning sequence and language status modulate how background languages are recruited during L3 processing, then the N400 congruency effect is expected to show group-dependent differences in regional distribution. Specifically, congruency-related differentiation is expected to be more robust and more consistently distributed for the functionally stronger background language, while attenuated or redistributed for the less dominant or less integrated language.

Conclusion to Chapter 1

This chapter established the theoretical foundation for treating multilingual lexico-semantic processing as an integrated neurocognitive phenomenon rather than as the parallel operation of separate monolingual systems. Multilingual lexical access was conceptualised as a dynamic architecture in which several linguistic codes may become active simultaneously, interact through shared cognitive and neural resources, and require regulation when competing representations are available. This perspective provides the basis for the dissertation's central question: how lexical access and semantic integration unfold in trilingual

speakers and how they are shaped by language experience, language structure, and task demands.

The chapter first outlined the psycholinguistic and neurolinguistic principles relevant to multilingual processing. Language comprehension was described as an incremental and interactive process in which partial input continuously updates lexical and semantic interpretation. Within this framework, lexical access is understood as graded activation rather than simple retrieval, and competition is treated as a structural feature of multilingual processing. The chapter also clarified the metalanguage of the dissertation by defining key concepts such as activation, interference, competition, selection, integration, prediction, control, and lexico-semantic processing. This terminological foundation is necessary for maintaining conceptual consistency in the theoretical and empirical chapters that follow.

The chapter then situated the dissertation within the multilingual and institutional context of Kazakhstan. The co-presence of Kazakh and Russian, together with the growing role of English, creates a theoretically meaningful environment for the study of trilingual processing. This context is important because multilingual experience is shaped not only by the number of languages known but also by domains of use, literacy practices, exposure patterns, and language policy. The discussion of neurolinguistics in Kazakhstan, therefore, showed that the dissertation is grounded both in international theory and in the specific linguistic and scientific conditions of the Kazakhstani context.

Building on this foundation, the chapter synthesised models of bilingual lexical access with accounts of L3 processing. Bilingual models explain how cross-language activation arises and why lexical access may be non-selective, while L3 frameworks address how influence is distributed across two previously acquired languages. Together, these approaches support the view that trilingual lexical access is shaped by experience-dependent weighting, conceptual links, typological proximity, dominance, and control mechanisms.

Finally, the chapter introduced typological distance and structural asymmetry between Kazakh and Russian as central explanatory factors. The comparison between L1 Kazakh and L1 Russian groups was justified as theoretically necessary because it allows for an examination of how learning history and structural properties jointly affect trilingual lexico-semantic processing. Overall, Chapter 1 defined the theoretical targets of the dissertation and prepared the ground for the methodological chapter, where these constructs are operationalised through a translation recognition paradigm and EEG/ERP analysis.

CHAPTER 2. METHODOLOGY AND RESEARCH DESIGN

2.1 Psycholinguistics and Neurolinguistic Methods: Overview and Experimental

Paradigms

Psycholinguistics and neurolinguistic methods share a common inferential aim: to explain language as a time-dependent system of computations implemented in the brain, while acknowledging that the mechanisms of interest are not directly observable. Experimental methodology, therefore, functions as a theory-to-data mapping device. It specifies which aspect of processing is manipulated, which potential confounds are controlled, and which dependent measures can serve as valid indicators of underlying operations such as activation, competition, prediction, integration, selection, and control. Because language is fast, interactive, and context-sensitive, the field relies on converging evidence across paradigms rather than a single method, combining behavioural indices of performance with physiological indices that constrain the time course and, in some modalities, the spatial organisation of language-related computation (Traxler, 2012; Friederici, 2011; Price, 2012). In the present dissertation, this methodological logic is especially important because the research question concerns not only whether cross-language interaction occurs, but also when it emerges during lexico-semantic processing.

A foundational methodological distinction is between *end-state assessment* and *process-tracing*. End-state measures, such as comprehension accuracy on post-trial questions or explicit metalinguistic judgments, determine whether participants ultimately achieve a correct interpretation, but they provide limited leverage over how that interpretation emerged. Process-tracing approaches, by contrast, are designed to capture online dynamics and identify the point at which competing conditions diverge. This distinction is central in contemporary language science because many theoretical claims concern incremental computation, probabilistic expectation, and rapid integration, all of which can occur well before an overt

response is produced (Altmann & Kamide, 1999; Marslen-Wilson, 1987; Pickering & Gambi, 2018; Tanenhaus et al., 1995).

Behavioural paradigms remain indispensable because they provide interpretable measures of processing efficiency and the functional consequences of competition. Reaction time reflects the cumulative duration of multiple processing stages, including perceptual encoding, lexical access, semantic evaluation, response selection, and motor execution. Accuracy reflects the stability of processing under time pressure and is sensitive to strategic trade-offs when participants balance speed against correctness. Methodologically, this implies that behavioural effects must be interpreted relative to task demands, because different tasks place different weights on decision processes versus identification processes. Even when the same stimuli are used, a speeded decision task can exaggerate late decisional contributions, whereas comprehension questions can mask early processing difficulty if participants have sufficient time to recover. For this reason, behavioural research typically uses paradigms in which task goals are aligned with the theoretical construct of interest and interprets latency and error patterns as composite indicators rather than as direct readouts of a single stage (Traxler, 2012).

Two major behavioural paradigms are priming and interference. Priming paradigms infer representational connectivity and the spread of activation from systematic facilitation or inhibition. When prior exposure to a related item alters subsequent processing, it indicates that representations share form, meaning, or mappings, and that activation can propagate across a network rather than being confined to a single isolated entry. Interference paradigms deliberately place competing representations or response tendencies in conflict, quantifying the cost of resolving that competition. This logic is valuable because it operationalises competition and control as measurable processing costs, allowing theoretical constructs such as conflict, inhibition, and selection to be studied through controlled manipulations. In

multilingual research, these paradigms are particularly informative because cross-language overlap can be treated as a principled source of competition, while response requirements can be used to separate identification-level effects from decision-level effects (Green, 1998; Dijkstra & Van Heuven, 2002). In the present dissertation, the behavioural component of the translation recognition task serves precisely this function by capturing the performance consequences of semantic congruence and cross-language competition.

Eye-tracking methods extend process-tracing by measuring the allocation of visual attention during comprehension. In reading, fixation durations and regressions provide fine-grained indices of difficulty at specific points in the input stream, supporting inferences about when lexical variables (e.g., frequency, predictability) and contextual variables begin to exert influence. In spoken-language comprehension, the visual-world paradigm links language to gaze behaviour, showing how interpretation evolves incrementally and how listeners use partial linguistic information to anticipate likely referents and events. Methodologically, eye tracking is informative because it can reveal divergence between conditions before any explicit decision is made, thereby reducing confounding by response selection. Its inferential limits are equally important; gaze is an action measure influenced by attention and task strategy, so claims about linguistic computation are strongest when gaze patterns are interpreted as evidence of incremental constraint use and hypothesis updating rather than as direct neural signatures of specific computations (Rayner, 1998; Tanenhaus et al., 1995; Traxler, 2012). Although eye tracking is not employed in the present dissertation, it is relevant here as part of the broader methodological landscape of online language research.

Neurolinguistic methods strengthen mechanistic inference by measuring neural activity associated with language processing. These methods differ in their trade-offs between temporal resolution, spatial resolution, and physiological interpretability. Functional neuroimaging, especially *fMRI*, offers high spatial precision for identifying distributed

networks that participate in language tasks and for comparing network recruitment across conditions or groups. Its major limitation for language is that the haemodynamic response is slow relative to millisecond-scale linguistic computation, which means fMRI is strongest for identifying where processing differences are expressed at the network level rather than for specifying the precise time course of the computations that produced them. Accordingly, fMRI designs depend on carefully specified contrasts and baseline choices, and conclusions must be framed in terms of relative network engagement rather than direct timing of lexical or semantic operations (Price, 2012; Friederici, 2011). Although fMRI is not used in the present study, its strengths and limitations help clarify why EEG/ERP is methodologically more appropriate for the dissertation's focus on lexico-semantic evaluation timing.

Electrophysiological measures, especially EEG and ERPs, provide the temporal resolution needed to track the time course of language processing. ERPs are derived by time-locking the EEG to specific events, such as word onset and averaging across trials to isolate systematic responses. Methodologically, the main contribution of ERPs is temporal constraint. If experimental manipulation modulates neural activity in an early time window, the effect is more plausibly linked to activation and access dynamics. If it emerges later, it is more plausibly linked to integrative processes, re-evaluation, or decision-related operations. This temporal separation is essential in language research because behavioural measures can conflate early and late contributions within a single response time. ERP methodology, however, is only as strong as its design and preprocessing discipline. ERP effects are small relative to noise and are vulnerable to ocular and muscular artefacts, requiring careful trial structure, sufficient trial counts per condition, appropriate filtering, artefact handling, and principled definition of time windows and regions of interest. In practice, the value of ERPs is not to provide one-to-one “labels” for functions, but to constrain explanations by revealing when processing diverges under controlled manipulations (Luck, 2014). For the present

dissertation, EEG/ERP is methodologically preferable because the central question concerns the timing of semantic evaluation during translation recognition rather than only the spatial localization of network activity.

Within ERP research on meaning, the N400 has a central methodological role because it provides a robust and replicable index that is sensitive to lexico-semantic processing demands in context. N400 amplitude varies with contextual expectancy, semantic association, and the ease with which input fits an evolving interpretation, making it particularly useful for examining graded, probabilistic aspects of comprehension. The methodological implication is that semantic processing can be operationalised not only through overt behavioural measures, but also through time-resolved neural sensitivity to contextual constraint. Importantly, the N400 is not considered a simple anomaly detector. Its modulation by graded predictability factors supports the use of ERPs for testing theories in which comprehension is expectation-sensitive and continuously updated. At the same time, interpretation must remain theory-driven. Whether N400 effects are framed primarily as reflecting access, integration, or a broader interaction between memory-based activation and contextual constraint depends on task structure and manipulation, reinforcing the principle that ERP components are indices that constrain theory rather than fixed functional labels (Kutas & Hillyard, 1980; Kutas & Federmeier, 2011; Lau et al., 2008; Van Petten & Luka, 2012). Across psycholinguistic and neurolinguistic paradigms, methodological rigour depends on a set of shared design principles. First, *operational clarity* is required: manipulations must map cleanly onto theoretical variables, and alternative explanations must be minimised through control or counterbalancing. Second, *stimulus control* is essential because lexical variables such as frequency, length, neighbourhood density, and semantic association can independently influence both behavioural and neural responses. Third, *participant profiling* is not optional in multilingual research. Proficiency, dominance, age of acquisition, and domain of use shape

resting activation levels, mapping strength, and competition dynamics, and must be measured to support interpretable group comparisons and individual-difference analyses. Fourth, *timing precision and standardisation* are critical for process-tracing measures, particularly ERPs, because temporal jitter and inconsistent event marking directly reduce interpretability. Finally, the *analytic strategy* must match the measurement properties. Behavioural response times require distribution-sensitive analysis and careful handling of speed-accuracy trade-offs, while ERP analysis requires principled time-window definition, baseline handling, and control of multiple comparisons. When these principles are met, converging measures allow stronger inference: behavioural outcomes indicate whether and how processing costs manifest in performance, and neural measures constrain when and at what stage those costs emerge.

In sum, psycholinguistic and neurolinguistic methods provide a complementary toolkit for investigating the mechanisms of language processing. Behavioural paradigms quantify efficiency and the performance consequences of competition. Eye tracking traces incremental dynamics of comprehension with fine temporal granularity at the behavioural level. Neuroimaging identifies network-level recruitment. ERPs provide millisecond-scale constraints on the time course of lexico-semantic processing and are therefore particularly suited to investigating when cross-language interaction affects meaning-related computation. This methodological framework justifies the design of the present dissertation, in which theoretical constructs are operationalised through a translation recognition paradigm combining behavioural measures with ERP evidence to capture both the performance consequences and the temporal dynamics of multilingual lexico-semantic processing.

2.2 Research Design within the Translation Recognition Paradigm

The present dissertation adopts the *translation recognition paradigm* as the central experimental framework for investigating multilingual lexico-semantic processing under controlled conditions. In this paradigm, participants are presented with lexical items from

different languages and decide whether one item is the correct translation equivalent of another. Although the task appears simple at the behavioural level, it is theoretically informative because it requires the participant to map input onto lexical representations, activate meaning, and evaluate cross-language correspondence within a limited time window. For this reason, translation recognition is more than a test of explicit vocabulary knowledge. When implemented with appropriate stimulus control, it becomes a method for examining cross-language activation, semantic verification, and competition in the multilingual lexicon, and it has been used in bilingual research to investigate how lexical variables such as cognate status and multiple translation alternatives affect translation recognition performance (Boada et al., 2013). This is particularly relevant in models that assume that lexical items across languages are linked through shared conceptual representations and, depending on proficiency and experience, through asymmetrical lexical-conceptual pathways (Kroll & Stewart, 1994; Kroll et al., 2010).

From a conceptual perspective, the paradigm is grounded in two assumptions that are central to contemporary accounts of multilingual lexical access. First, lexical access is often *non-selective*, meaning that processing in one language may activate candidate representations in another language when there is overlap in form or meaning, or when task demands make cross-language relations relevant (Dijkstra & Van Heuven, 2002). Second, multilingual processing is shaped by *experience-dependent weighting*. The relative strength of lexical-to-conceptual mappings, the accessibility of the participating languages, and the efficiency with which competition is regulated depend on proficiency, dominance, and patterns of language use (Kroll et al., 2010). Translation recognition is especially suitable for the present dissertation because it operationalises these assumptions directly. A positive response requires convergence on a shared conceptual representation across languages, whereas a negative response requires rejection of a candidate despite the conceptual pre-activation induced by the

prime. In this way, the paradigm allows for the examination of not only whether cross-language activation occurs, but also how it affects semantic decision-making.

Methodologically, translation recognition is particularly compatible with *ERP research* because it provides a precise temporal anchor for meaning-related processing at the onset of the second item in each pair. In typical implementations, the first word functions as a context-setting stimulus that activates a conceptual region and indirectly increases the availability of translation-relevant lexical candidates. The second word then either confirms this pre-activation, as in a congruent translation pair, or violates it, as in an incongruent pair. This structure makes it possible to interpret neural responses to the second word as reflecting the interaction between the conceptual expectations induced by the first word and the actual lexico-semantic properties of the second word. The N400 is particularly important in this respect because it is sensitive to the ease of lexico-semantic processing in context, including expectancy, semantic relatedness, and conceptual fit (Kutas & Federmeier, 2011; Lau et al., 2008). Thus, translation recognition provides an experimentally economical but theoretically rich way of examining semantic interaction across languages without requiring sentence-level materials.

In the present study, translation recognition is treated not as a single undifferentiated task, but as a structured contrast between *semantic correspondence* and *semantic mismatch*. At the behavioural level, the main dependent measures are *accuracy* and *reaction time*, which together provide an index of how efficiently multilingual participants verify cross-language equivalence under time pressure. At the neural level, the design focuses on ERP responses time-locked to target onset, allowing this study to determine whether the critical effects emerge during early lexico-semantic evaluation or during later decisional processing. This combined approach is important because behavioural outcomes alone are compatible with several interpretations. For example, slower responses may reflect slower semantic access,

stronger competition, increased response caution, or post-lexical verification demands. ERP evidence makes it possible to constrain these interpretations by locating more precisely when the congruency effect emerges in the processing stream (Luck, 2014).

A central design decision in translation recognition concerns the construction of *non-translation trials*, because these trials determine the type and degree of competition introduced by the paradigm. In the most basic version, a non-translation pair is created by combining the prime with an unrelated second word. Such trials typically create a clear semantic mismatch and often yield robust behavioural and neural effects, but they may also be relatively easy and therefore less sensitive to subtle variation in cross-language activation. In translation recognition research more broadly, non-translation trials may also be designed to create *partial compatibility* or controlled semantic conflict, for example, by using distractors that are semantically related to the correct translation or conceptually plausible within a broader domain while still being incorrect translations. Such manipulations are useful because they allow prime-induced conceptual activation to partially support the target while the task still requires rejection, thereby increasing competition and interpretive complexity.

In the present dissertation, however, non-translation candidates were selected to produce *clear semantic mismatch* while minimising alternative sources of facilitation. This design choice aimed to preserve interpretability and to ensure that the contrast between congruent and incongruent conditions could be understood primarily in terms of conceptual correspondence rather than graded associative plausibility. In other words, the goal was not to create subtle semantic ambiguity, but to establish a controlled contrast that would make it possible to test whether L3 English primes activate meaning strongly enough to facilitate correct translation decisions and to increase processing cost under mismatch. Under such conditions, congruent and incongruent trials can be compared more directly in terms of multilingual lexico-semantic processing, while the ERP data can indicate whether the

resulting effects arise at the level of semantic evaluation or at later stages of decisional processing.

Within multilingual frameworks, translation recognition also provides a useful platform for testing how *learning history* and *language status* shape cross-language influence. Models of bilingual memory predict that links between languages and conceptual representations are asymmetrical and develop with experience. The *Revised Hierarchical Model*, for example, proposes that less proficient non-native words rely more heavily on lexical mediation through a stronger language, whereas increased proficiency supports more direct conceptual access (Kroll & Stewart, 1994; Kroll et al., 2010). For trilingual speakers, this implies that translation recognition can reveal how efficiently the system accesses meaning across different language pairings and whether some pairings rely more strongly on lexical mediation than others. This logic is particularly relevant for the present dissertation because it compares two mirror-image trilingual groups in which Kazakh and Russian differ in first-language status while English remains the later-acquired language. Under this design, translation recognition makes it possible to test whether the observed cross-language effects align more closely with typological proximity, with L2 status and learning history, or with domain-specific dominance.

The methodological realisation of the paradigm in this dissertation follows standard principles designed to protect *interpretability*. Stimulus construction is constrained so that observed effects can be attributed as far as possible to the conceptual relation between prime and target rather than to basic lexical confounds. This includes control of factors such as word length, approximate frequency balance where feasible, minimisation of orthographic or phonological overlap where relevant, and avoidance of unintended associative links that could make incongruent decisions trivial or strategically predictable. Trial structure is standardised, with consistent timing parameters and clear event markers to support ERP averaging and

time-locking. The proportion of congruent and incongruent trials is controlled to reduce response bias, and item presentation is randomised with constraints to minimise local repetition and predictability. Where the design requires it, counterbalancing ensures that item-specific properties do not become confounded with experimental conditions. These features are essential because they allow condition differences to be interpreted as reflecting multilingual lexico-semantic processing rather than artefacts of stimulus design or response strategy.

Finally, translation recognition is well-suited to the *trilingual focus* of the dissertation because it can be implemented in a way that respects the complexity of the multilingual system while remaining experimentally controlled. The paradigm allows the same basic decision process to be examined across different language pairings, making it possible to compare how the system behaves when different prior languages are recruited under the same L3-triggered conditions. This is particularly important for the present design, which compares *L1 Kazakh* and *L1 Russian* groups while holding English constant as L3. Within such a framework, translation recognition provides a stable methodological basis for asking whether group differences emerge primarily during early semantic processing, consistent with differences in activation strength and lexical-conceptual weighting, or at later stages, consistent with differences in control and decisional strategy. In this sense, the paradigm operationalises the dissertation's central theoretical commitments in a form that is both conceptually transparent and methodologically appropriate: it creates a controlled environment in which multilingual meaning-related processing is necessary, competition can be systematically manipulated, and the temporal dynamics of lexico-semantic evaluation can be directly measured.

2.3 Participant Characteristics and Language Background Assessment

A total of 38 right-handed university students were recruited through campus-based advertisements at Al-Farabi Kazakh National University (Almaty, Kazakhstan), where all participants were enrolled at the time of testing. The study was based on around a mirror-image grouping logic reflecting the sociolinguistic reality of Kazakhstan, where Kazakh and Russian function as the two principal societal languages and English is typically acquired later as a foreign language (Sadulova et al., 2025). Accordingly, the sample comprised two groups of sequential trilinguals who shared the same language repertoire (Kazakh, Russian, and English) but differed in their first-acquired language, which allowed for the examination of how L1 configuration shapes multilingual lexico-semantic processing under controlled experimental conditions. The L1 Kazakh group consisted of 22 participants with Kazakh as their first-acquired language (6 males; M age = 23.95 years, SD = 3.90; range = 19–32). The L1 Russian group consisted of 16 participants with Russian as their first-acquired language (4 males; M age = 24.44 years, SD = 2.60; range = 18–29). All participants reported regular use of both Kazakh and Russian and high functional proficiency in their second societal language, consistent with functional bilingualism in the local sociolinguistic environment. English was acquired subsequently as a third language (chronologically L3), after the other societal language had already become part of the stable repertoire. This profile corresponds to sequential trilingualism, in which two languages are embedded in everyday communicative life, while the third language is acquired later primarily through formal instruction and has a more limited functional range.

The age range was restricted to young adulthood to reduce developmental and age-related variation in cognitive electrophysiology. ERP methodology guidelines note that many ERP components vary with age and recommend reporting both central tendency and age range; they also indicate that a typical adult range in many ERP studies lies approximately

between 18 and 40 years. Restricting the sample to ages 18–32, therefore, aligns with standard methodological practice and reduces age-related variance within and between groups. This decision is also theoretically relevant for this dissertation’s N400-based inference, because N400 effects and context use may shift with healthy ageing, and older adults may rely less consistently on predictive, top-down processing strategies in some paradigms (Kutas & Federmeier, 2011). By focusing on young adults, the study reduces the likelihood that group differences in N400 amplitude or scalp distribution are driven by age-associated processing changes rather than multilingual language-history factors.

Language background characterisation was treated as a methodological prerequisite for interpreting group-level behavioural and electrophysiological effects in multilingual processing. Prior to the experimental session, all participants completed a structured pre-experimental language background questionnaire based on an adapted version of the Language Experience and Proficiency Questionnaire (LEAP-Q). The LEAP-Q was developed to combine language-experience variables with self-reported competence measures, capturing dimensions known to shape bilingual and multilingual performance, including proficiency, dominance, preference, age of acquisition, mode of acquisition, prior exposure, and current language use across contexts (Marian et al., 2007). In the present study, the questionnaire was adapted to ensure relevance to the Kazakhstan-specific sociolinguistic setting and to the study’s grouping logic, while retaining the core LEAP-Q dimensions necessary for principled participant profiling.

The pre-experimental interview and questionnaire focused on four areas: (i) the order of acquisition of Kazakh, Russian, and English; (ii) the typical context of acquisition for each language, with particular attention to whether exposure was naturalistic or classroom-based; (iii) educational history and language of schooling; and (iv) present-day domain-specific language use, including communication at home, in university contexts, and in media

consumption. This screening procedure was intended to ensure that group assignment reflected documented developmental language trajectories and comparable educational exposure, rather than relying solely on self-identification. Across both groups, Kazakh and Russian functioned as regularly used languages in everyday life at the time of testing. Participants also reported relatively high functional proficiency in their second societal language, consistent with long-term immersion in a bilingual environment.

English, by contrast, functioned as a later-acquired third language with more limited everyday use for all participants. Importantly, all participants were university students who had reached an English proficiency level approximately corresponding to CEFR B1/B2, providing a practical minimum threshold to ensure that the English primes used in the experiment could be processed reliably. With respect to learning history, participants reported a broadly comparable onset of formal English instruction, beginning in the third grade of primary school in accordance with the national educational curriculum. In contrast, acquisition of the second societal language (Russian for participants in the L1 Kazakh group and Kazakh for participants in the L1 Russian group) typically occurred earlier through sustained exposure in the social and educational environment, resulting in learning conditions closer to naturalistic acquisition than to purely classroom-based foreign-language learning. Information on age of acquisition and learning context was obtained through the pre-experimental interview and participants' educational histories. This distinction is theoretically relevant because differences in learning context and long-term domain of use can shape the strength of lexico-semantic representations and the accessibility of form–meaning mappings during online processing, even when speakers share the same set of languages.

All participants reported normal or corrected-to-normal vision sufficient for visual word presentation and no neurological history relevant to EEG participation. Participation was voluntary, and written informed consent was obtained before data collection. The study

protocol was reviewed and approved by the Local Ethics Committee of Al-Farabi Kazakh National University. The Participant Information Sheet and Informed Consent Form are provided in Appendix B, and the ethics approval documents are provided in Appendix C.

Although the pre-experimental interviews provided detailed qualitative profiling and supported principled group assignment, future studies would benefit from the inclusion of standardised language proficiency testing in addition to self-report measures. This would allow more fine-grained quantification of dominance, modality-specific proficiency asymmetries (speaking, listening, reading, and writing), and domain-specific language use, thereby further strengthening the interpretability and generalizability of behavioural and ERP findings.

2.4 English Irregular Verbs as Stimulus Materials for Trilingual Lexico-Semantic Processing

Semantic priming is widely used in psycholinguistics and neurolinguistics to investigate how meaning is accessed and evaluated under time constraints. In priming paradigms, a prime is presented first to bias or pre-activate a conceptual representation, thereby shaping the processing of a subsequent item. When the manipulation concerns semantic relatedness or semantic fit, priming effects are commonly interpreted as evidence that lexical processing rapidly engages meaning representations and these representations constrain later evaluation. The classic demonstration that semantic incongruity modulates event-related brain potentials helped establish the broader logic that meaning-based expectations can be tracked in real time during comprehension (Kutas & Hillyard, 1980). In multilingual word recognition, priming is methodologically useful because the cognitive system contains multiple lexical inventories that may be co-activated during processing. Contemporary models of bilingual lexical access typically assume that early stages of word recognition are not fully language-selective and that lexical candidates from different

languages may become activated in parallel. At the same time, later decision and control mechanisms shape the final response (Dijkstra & Van Heuven, 2002). In this sense, priming makes it possible to ask not only whether meaning is accessed rapidly, but also whether such access recruits cross-language activation and competition in ways that can be observed behaviourally and neurophysiologically.

English irregular verbs were selected as semantic primes because verbs constitute a highly informative lexical class for studying multilingual lexico-semantic access under time pressure, particularly insofar as they encode event structure and relational meaning. Whereas many concrete nouns primarily denote entities, verbs typically denote event types and relations among participants in events. Even in isolation, verbs may activate structured representations involving causation, change, temporal contour, and typical thematic roles, which makes them especially suitable as primes in paradigms requiring rapid evaluation of conceptual compatibility. For this reason, verbs are well-suited to semantic congruency manipulations and may function as effective probes of lexico-semantic evaluation in behavioural and electrophysiological measures. In the present study, verbs were treated as lexico-semantic units rather than as morphosyntactic paradigms. The purpose of the materials was not to test inflectional knowledge directly, but to use a stable class of event-denoting words capable of supporting systematic cross-language mapping across Kazakh, Russian, and English.

Kazakhstani psycholinguistic research also provides relevant support for treating verb forms as a meaningful object of language-processing analysis. Vinnitskaya's study of the acquisition of verb forms examined verb-form development in child speech, including bilingual acquisition contexts, and is relevant here because it shows that verbs have already been treated in Kazakhstani psycholinguistics as a domain through which language acquisition and bilingual processing can be examined (Vinnitskaya, 1999). Comparative

research on the grammatical categories of the verb in Kazakh, Russian, and English further confirms that verb systems differ substantially across these three languages. This reinforces the need for careful stimulus control when researchers use verbs in trilingual research (Kenzhebekova & Sabitova, 2023, p. 43). In the present study, however, English irregular verbs are used not as grammatical paradigms to test inflectional production, but as lexico-semantic primes designed to activate event-based conceptual representations that can be evaluated through congruent and incongruent Kazakh and Russian candidate words.

To minimise ambiguity and reduce uncontrolled variability, all English verbs were presented in their infinitive form. Phrasal verbs were excluded because they often involve non-compositional meaning and unpredictable translation relations across languages. Highly polysemous items were also excluded to reduce the likelihood that participants could legitimately accept more than one candidate meaning and to ensure that congruent decisions reflected relatively stable translation equivalence rather than flexible interpretation. Because the materials were cross-linguistic, stimulus construction also considered language-specific properties that might affect perceptual processing. Kazakh and Russian share a Cyrillic-based writing system (Badanbekkyzy et al., 2023, p. 4), but Kazakh also uses additional characters representing language-specific phonemes and orthographic conventions. These properties were considered during stimulus selection and matching so that candidate words remained readable, visually comparable, and not systematically biased toward one language through marked orthographic forms or unusual letter sequences. This step was essential for protecting the interpretability of condition effects: the task was intended to elicit decisions based primarily on meaning rather than differences in orthographic familiarity.

It is important to formulate the cross-linguistic claim about irregularity with caution. The defensible point is not that Kazakh and Russian contain no irregularity at all. Rather, the claim is that the English irregular past-tense system, with its idiosyncratic mappings and

limited predictability, does not align with a single dominant productive template that can be transferred straightforwardly from Kazakh or Russian. This non-alignment is theoretically informative because it may bias L3 English irregular verbs toward a more lexicalised learning route, thereby strengthening the link between irregular verbs and item-based representational stability in the L3 lexicon (Baayen, 2007, p. 95). From the perspective of trilingual processing, this matters because prime-driven conceptual activation depends on the stability of the lexical representation that maps word form onto meaning. If English irregular verbs are learned under stronger item-specific constraints, then the prime set becomes a principled locus at which representational strength may vary, potentially affecting how reliably the prime constrains candidate evaluation. This is not a limitation of the materials; rather, it forms part of their theoretical motivation. A prime class that is sensitive to L3 learning conditions can serve as a meaningful probe of how conceptual activation is generated from L3 lexical access and how it interacts with evaluation in the more established candidate languages.

The stimulus set consisted of 105 English irregular verbs presented as primes. These primes were selected to provide broad coverage of irregularity types while maintaining lexical suitability for translation recognition. The 105 verbs were classified *a priori* into three standard pedagogical groups based on the formal structure of their inflectional paradigms: (1) verbs with identical base, past tense, and past participle forms (e.g., *cut–cut–cut*); (2) verbs with identical past tense and past participle forms but a distinct base form (e.g., *build–built–built*); and (3) verbs with three distinct forms (e.g., *sing–sang–sung*). Although only the infinitive form was presented during the experiment, this categorisation was retained as an index of underlying formal and mnemonic complexity associated with the irregular paradigm. Importantly, the classification was not intended to represent semantic difficulty. Rather, it captures differences in formal variability that are plausibly linked to memory and

representation strength in L3 learning and may therefore contribute to variability in how reliably a prime activates a stable conceptual representation in later-acquired English.

The choice of English irregular verbs as primes is further motivated by how irregularity is represented and learned in English. A broad and influential line of work distinguishes between highly productive regular morphology and irregular patterns that are less predictable and more dependent on item-specific learning (Marzi & Pirrelli, 2023, p. 462). Although theoretical accounts differ in their formal implementation, irregular forms are often argued to rely more strongly on lexical memory and associative learning, whereas regular patterns are more compatible with rule-based or schema-based generalisation (Pinker & Ullman, 2002; Ullman, 2001). This distinction remains relevant even when only the infinitive form is presented. In L3 acquisition contexts, English irregular verbs tend to be learned and represented as salient exception-rich lexical items, often taught and practised explicitly. As a result, irregular verbs provide a prime class that is semantically specific and meaning-bearing, while also displaying principled variability in representational strength. In a priming design, prime effectiveness depends on how rapidly and reliably the prime activates a stable concept. If a prime's lexical representation is weaker or less entrenched, conceptual activation may be noisier or less consistent across trials. Irregular verbs, therefore, provide a theoretically interpretable way to discuss variability in priming strength without redefining the study as a test of inflectional competence.

In this sense, the irregularity grouping offers a controlled way to characterise the stimulus set. It helps explain why irregular verbs can serve as diagnostically informative primes in a trilingual design. For each English prime, *Kazakh and Russian candidate words* were prepared to instantiate both congruent and incongruent decision conditions. In total, 210 Kazakh items and 210 Russian items were used. Within each language, half of the items were verified translation equivalents of the English irregular verbs and served as congruent

candidates. The remaining half served as incongruent candidates. Incongruent items were selected to be conceptually unrelated to the English prime and to its correct translations, ensuring that rejection decisions depended on semantic evaluation rather than on partial associative overlap. Stimulus matching was conducted to reduce basic lexical confounds. Incongruent candidates were matched to congruent translation equivalents on mean word length (approximately six letters in Kazakh and seven letters in Russian). A complete list of stimuli and their characteristics is provided in Appendix A, reproduced from Zhaksylykkyzy et al. (2026).

2.5 Experimental Procedure and Neurophysiological Data Acquisition and

Preprocessing

This section describes how the translation recognition paradigm was implemented in practice, how EEG was recorded during task performance, and how the continuous signal was transformed into artefact-controlled ERP waveforms suitable for hypothesis-driven analysis. Reporting these steps in detail is essential for methodological transparency, because the logic of the task, the timing of events, the acquisition parameters, and the preprocessing pipeline jointly determine what kinds of inferences can be drawn from behavioural and ERP outcomes (Clayson et al., 2019). The experimental setting was organised to ensure a controlled and minimally distracting environment for behavioural and EEG data collection. Participants were tested individually in a quiet laboratory room and were seated at a fixed distance from the stimulus monitor. The computer display was positioned directly in front of the participant, while the EEG amplifier was placed on the experimenter's side. The 64-channel EEG cap was fitted before the task began, and electrode impedances were checked and maintained within the required range prior to recording. The arrangement of the testing room and the participant's position during EEG recording are shown in Figure 1. This setup was intended to

reduce visual and auditory distraction, support stable posture, and ensure reliable stimulus presentation and EEG acquisition throughout the translation recognition task.

Figure 1

Experimental setup for the EEG-based translation recognition task.



Note. Panel A shows the testing room arrangement, including the stimulus monitor, response keyboard, EEG cap, amplifier, and recording laptop. Panel B shows the participant seated during task performance while wearing the 64-channel EEG cap. The participant is shown from the back to preserve anonymity. Photographs were taken by the author for methodological documentation.

The paradigm was designed for sequential trilinguals with the language repertoire Kazakh, Russian, and English. Two mirror-image groups were examined (L1 Kazakh vs. L1 Russian), differing in their first language background while sharing the same trilingual language set. Each trial began with the presentation of an English irregular verb prime displayed centrally in black font on a white background for a fixed duration of 2500 ms. The prime was followed by four candidate words presented sequentially. For each candidate,

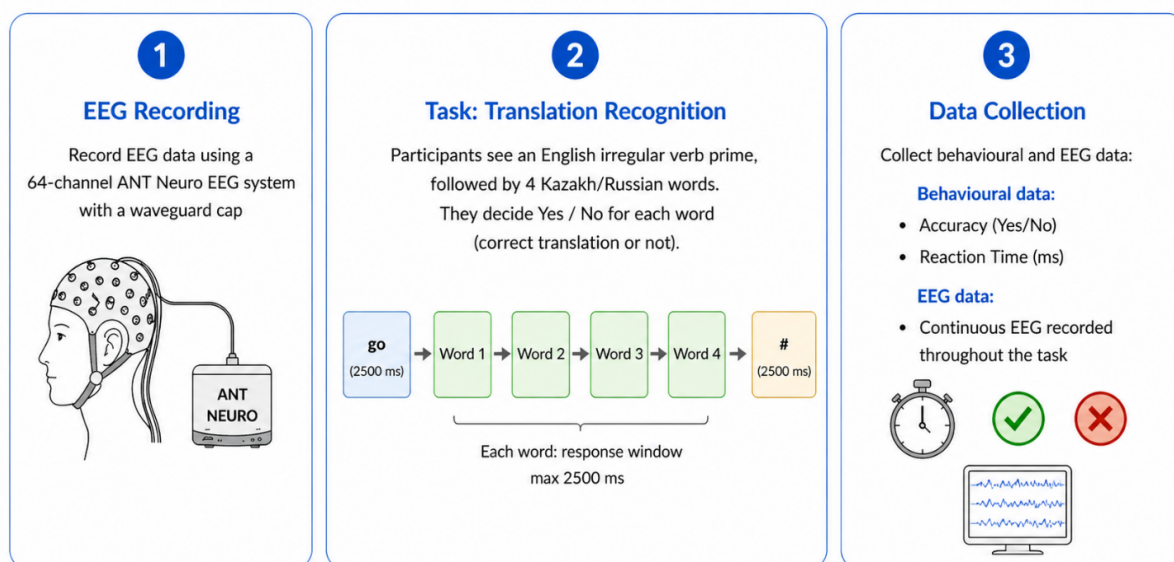
participants made a binary decision on whether the item was a correct translation equivalent of the English prime. Responses were entered via keyboard, with the key “1” indicating a congruent translation equivalent and the key “3” indicating an incongruent non-translation. For each candidate word, the maximum response window was 2500 ms, and the reaction time was recorded from candidate onset to the participant’s response. Candidate words were presented in Kazakh or Russian and included both congruent translation equivalents and incongruent distractors. For example, the English verb *go* could be paired with its correct translations (Kazakh *бару*, Russian *идти*) as well as with semantically unrelated items. Incongruent distractors were manually selected to be conceptually unrelated to the English prime and to its correct translations. In addition, distractors were selected to be non-cognates across Kazakh, Russian, and English, reducing the possibility that responses could be supported by form overlap rather than semantic evaluation. The order of candidate presentation within each trial was randomised to reduce serial-order effects and minimise predictability. Presenting four candidates per prime was intended to sustain attention across trials and discourage strategic responding based on candidate position rather than meaning-based verification.

The experimental session consisted of one main block comprising 105 English prime verbs, preceded by a short practice block of six trials to ensure that instructions and response mapping were fully understood. After the fourth candidate word, a fixation symbol (“#”) was presented centrally for 2500 ms, after which the next trial began automatically (see Figure 2). The task was administered using E-Prime 2.0 (Psychology Software Tools, Inc., 2012) on a Windows 10 computer (Intel Core i5) with a 13-inch HD monitor (60 Hz refresh rate). Participants were seated approximately 60 cm from the screen. To reduce lexical familiarity confounds in the target languages, congruent and incongruent candidate words were matched as closely as possible for lexical frequency within Kazakh and Russian, following standard

recommendations for frequency control in psycholinguistic stimulus construction (Brysbaert & New, 2009).

Figure 2

Schematic overview of the EEG-based translation recognition experiment.



Note. The figure summarises the three main components of the experimental procedure: EEG recording with a 64-channel ANT Neuro system, the translation recognition task with an English irregular verb prime followed by Kazakh/Russian candidate words, and the collection of behavioural and EEG data. The figure was prepared by the author based on the experimental protocol used in the study.

EEG data were collected while participants performed the translation recognition task in a quiet testing room with minimal auditory and visual distraction. Participants were seated comfortably at a fixed viewing distance from the stimulus display and were instructed to maintain a stable posture and minimise head and body movement throughout the recording. Because ocular artefacts are a major source of noise in language tasks involving visual word processing, participants were additionally encouraged to avoid excessive blinking during target presentation and to blink naturally during inter-trial intervals whenever possible. These instructions follow standard ERP practice for optimising signal quality while preserving natural task performance (Keil et al., 2014; Luck, 2014; Picton et al., 2000). Continuous EEG

was recorded using a *64-channel ANT Neuro system*. Ag/AgCl electrodes were mounted according to the International 10–20 system with intermediate sites. This montage provides adequate spatial sampling across anterior, central, and posterior scalp regions and supports both component-level ERP interpretation and ROI-based analytic strategies commonly used in cognitive and language ERP studies (Keil et al., 2014; Luck, 2014; Picton et al., 2000). Impedances were maintained below 5 k Ω for all electrodes. Maintaining low impedances reduces channel noise and improves recording stability, which is particularly important when examining subtle condition effects in components such as the N400.

EEG signals were referenced online to AF8 and rereferenced offline to linked mastoids (M1 and M2). Offline rereferencing to linked mastoids is widely used in ERP research because it provides a relatively neutral reference and facilitates the interpretation of scalp distributions across participants and conditions (Luck, 2014; Picton et al., 2000). The mean of AFz and CPz served as the ground electrode. To monitor ocular activity and enable artefact correction, frontal channels were used as proxy channels for EOG activity. Specifically, Fp1 served as a proxy for vertical ocular activity, including blinks, and AF7 served as a proxy for horizontal eye movements. Although dedicated EOG electrodes may be used in ERP studies, the present configuration provided sufficient information for ICA-based identification of blink- and saccade-related components, especially when combined with topographic and temporal criteria during component classification (Jung et al., 2000; Keil et al., 2014; Luck, 2014; Makeig et al., 1996).

The sampling rate was 1000 Hz, providing high temporal resolution and supporting accurate time-locking of ERPs to stimulus onset, which is essential for evaluating semantic processing in the N400 time range. During recording, the system's default bandpass filter was set to 0.016–200 Hz. A relatively broad online filter is common during acquisition because it preserves the frequency content needed for later preprocessing and ERP extraction while

avoiding unnecessary waveform distortion before artefact correction and segmentation (Keil et al., 2014; Picton et al., 2000; Widmann et al., 2015). EEG preprocessing was conducted in BrainVision Analyzer 2.0.1. The goal of preprocessing was to maximize signal-to-noise ratio and ensure that averaged ERPs reflected stimulus-locked neural activity rather than non-neural artefacts. This is particularly important in multilingual ERP research, where between-participant variability and condition effects may be subtle and where interpretation depends on reliable estimation of component amplitude within predefined time windows (Keil et al., 2014; Luck, 2014; Picton et al., 2000). Continuous EEG data were filtered offline using a 0.1–30 Hz bandpass filter. The high-pass cutoff at 0.1 Hz reduces slow drift and baseline instability caused by skin potentials, sweating, and gradual electrode polarization, while preserving slow ERP components relevant to language processing. The low-pass cutoff at 30 Hz attenuates high-frequency noise and muscle activity that can distort ERP waveforms, particularly in frontal channels, without removing the spectral content that typically carries ERP components such as the N400 (Luck, 2014; Widmann et al., 2015). Because filter settings can influence ERP morphology and may introduce artefacts when applied inappropriately, the selected filter range follows common ERP practice and aligns with methodological guidance emphasizing cautious high-pass choices in language ERP studies (Tanner et al., 2015; Widmann et al., 2015).

After filtering, ocular artefacts were corrected using *Independent Component Analysis (ICA)*. ICA decomposes the EEG signal into statistically independent components that may correspond to separable sources, including blinks and eye movements. Components reflecting ocular activity were identified using a combination of criteria: their characteristic frontal scalp topography, their time course around blink and saccade events, and their relation to the ocular proxy channels (Fp1 for vertical activity and AF7 for horizontal activity). Identified ocular components were removed, and the cleaned EEG signal was reconstructed from the remaining

components (Delorme & Makeig, 2004; Jung et al., 2000; Makeig et al., 1996). ICA-based correction is widely used in ERP research because it reduces ocular contamination while allowing more trials to be retained than procedures based exclusively on trial rejection, which is especially advantageous in multi-condition designs where balanced trial numbers are important (Keil et al., 2014; Luck, 2014). Following ICA correction, each participant's data were visually inspected to ensure that residual artefacts were excluded prior to averaging and statistical analysis. Visual screening served two purposes. First, it allowed identification of non-ocular artefacts that ICA may not fully resolve, including muscle bursts, movement-related noise, and abrupt voltage steps. Second, it provided quality control by verifying that artefact correction had not left systematic contamination in particular channels or time windows. Trials containing clear muscle artefacts or residual eye-movement or blink activity during the critical analysis interval were manually rejected. Only artefact-free trials were retained for averaging and subsequent statistical modelling. This combined approach was adopted to balance signal quality with trial retention in a multi-condition ERP design and is consistent with established methodological recommendations for ERP studies (Keil et al., 2014; Picton et al., 2000). The cleaned continuous EEG data were segmented into stimulus-locked epochs from -200 to 1000 ms relative to the onset of the critical target item, that is, the candidate word which participants evaluated as congruent or incongruent. Segmenting epochs around target onset enables direct quantification of time-resolved neural responses elicited by semantic correspondence or mismatch. Baseline correction was applied using the -200 to 0 ms pre-stimulus interval. This procedure reduces between-trial variability in voltage offsets and controls for slow drift, ensuring that condition differences in ERP amplitude reflect stimulus-locked activity rather than pre-stimulus fluctuations (Luck, 2014; Picton et al., 2000).

In summary, EEG data were recorded continuously using a 64-channel montage under controlled testing conditions. Preprocessing in BrainVision Analyzer included offline bandpass filtering (0.1–30 Hz), ICA-based correction of ocular artefacts, visual inspection with conservative manual rejection, stimulus-locked epoching (–200 to 1000 ms), baseline correction using the pre-stimulus interval, and a priori definition of the N400 analysis window (400–600 ms). This pipeline was designed to yield reliable ERP estimates suitable for testing congruency effects and group-related modulations of semantic processing in Kazakh–Russian–English trilinguals.

All statistical analyses were conducted in R (version 4.1.2) using RStudio (R Core Team, 2021; RStudio Team, 2021). Data handling and visualization relied on tidyverse conventions (Wickham et al., 2019), and inferential modelling was implemented within a mixed-effects framework using lme4 (Bates et al., 2015), with supplementary utilities for model reporting and table formatting (Alday, 2018; Zhu, 2019). Follow-up comparisons and estimated marginal means were computed with emmeans (Lenth, 2019). Additional diagnostics and regression utilities were supported by car and associated regression resources (Fox & Weisberg, 2019), and figures were assembled using cowplot functionality (Wilke, 2019). For categorical predictors, sum coding was applied so that model coefficients reflected deviations from the grand mean, enabling symmetric interpretation of main effects and interactions in factorial designs (Schad et al., 2020).

Conclusion to Chapter 2

This chapter established the methodological foundation of the dissertation by translating the theoretical claims of Chapter 1 into an experimentally controlled design capable of testing multilingual lexico-semantic processing through both behavioural and neurophysiological evidence. Its overarching methodological commitment was inferential transparency: each element of the research design was specified so that observable outcomes

could be interpreted as consequences of underlying processing mechanisms rather than as artefacts of task structure, stimulus properties, or uncontrolled participant variability. In this sense, the chapter functioned as a bridge between theory and empirical evidence, defining what counts as evidence for cross-language activation and how such evidence can be localised in time through ERP methodology.

The first contribution of the chapter was to justify the choice of *psycholinguistic and neurolinguistic methods* as complementary tools for mechanistic inference. Behavioural measures were treated as functional indices of processing efficiency and decision stability, whereas electrophysiological measures were treated as constraints on the time course of processing, making it possible to distinguish early meaning-related dynamics from later evaluative and response-related processes. This combination is particularly important in multilingual research because competition between languages may influence several processing stages simultaneously. The chapter therefore emphasized that robust inference requires converging measures rather than reliance on a single dependent variable. The second contribution was to explain why the *translation recognition paradigm* is both conceptually appropriate and methodologically tractable for the dissertation's central questions. Translation recognition requires participants to map between languages via meaning and can be designed to create controlled contrasts between semantic compatibility and semantic mismatch. In the present study, these contrasts were implemented in a way that minimised form-based strategies using non-cognate distractors and conceptually unrelated incongruent items. As a result, the task was optimized to target meaning-based evaluation in a trilingual system, making it suitable for testing whether cross-language interaction modulates lexico-semantic processing under conditions in which semantic access is necessary for correct responding. A third contribution concerned *participant characterisation and grouping logic*. The chapter specified a mirror-image design (L1 Kazakh vs. L1 Russian) grounded in Kazakhstan's

bilingual ecology and intended to isolate the role of L1 configuration within a shared language repertoire. By documenting language histories and current usage profiles, the study aimed to ensure that group differences in behavioural and ERP findings could be interpreted in relation to theoretically meaningful language-background factors rather than treated as uncontrolled variability. Such profiling is methodologically essential in multilingual research because proficiency, dominance, and language-use patterns shape resting activation levels and mapping strength, thereby influencing the magnitude and timing of cross-language effects. The fourth contribution was to describe *stimulus selection* as a methodological instrument. English irregular verbs were selected as primes because they constitute a controlled class of *event-denoting lexical items* with strong conceptual content and clear translation relations across languages. The chapter clarified that these verbs were used as lexico-semantic probes rather than as morphosyntactic paradigms, and that the stimulus set and candidate words were constructed to reduce ambiguity and control basic lexical characteristics. This design helps ensure that any observed congruency effects in behaviour or ERPs can be attributed primarily to semantic compatibility rather than to superficial stimulus differences.

Finally, the chapter detailed the *ERP recording, preprocessing, and analysis strategy* that makes the empirical claims of Chapter 3 possible. By specifying acquisition parameters, artefact-correction procedures, epoching and baseline choices, and the rationale for focusing on the N400 time window, the dissertation established the methodological conditions required for interpreting ERP modulation as evidence about the timing of semantic processing in a trilingual system. The analytic strategy, including mixed-effects modelling, was selected to support inference that generalises beyond participants and items, thereby aligning the statistical framework with the structure of the design. Taken together, Chapter 2 provides the *operational framework* through which multilingual lexico-semantic processing is measured in this dissertation. It defines the experimental conditions under which cross-language activation

and congruency sensitivity can become observable, and it specifies the standards of control and analysis that make behavioural and ERP evidence interpretable. With this methodological foundation in place, Chapter 3 turns to the empirical findings and evaluates whether the predicted patterns of cross-language interaction emerge in behavioural performance and, crucially, whether they are expressed in the timing and distribution of the N400 as an index of lexico-semantic processing dynamics.

CHAPTER 3. EMPIRICAL FINDINGS: BEHAVIOURAL AND ERP EVIDENCE FOR TRILINGUAL LEXICAL PROCESSING

3.1 Behavioural Evidence Consistent with Cross-Language Activation in Trilingual Word Recognition

This section introduces the behavioural evidence for cross-language activation in trilingual word recognition obtained in the translation recognition paradigm. Behavioural performance in this task is theoretically informative because it reflects the functional consequences of multilingual lexical organisation under time pressure. In multilingual systems, lexical access is not restricted to the retrieval of a single target-language representation. Rather, it may involve the parallel activation of multiple candidate representations across languages, with observable performance differences emerging when these representations converge, compete, or require selective verification (Dijkstra & Van Heuven, 2002; Green, 1998; Kroll et al., 2010). In this sense, reaction time and accuracy are not merely surface-level outcome measures. They provide functional indices of how efficiently the system resolves lexico-semantic competition under experimentally controlled conditions.

In the present design, behavioural evidence is particularly important because the task requires participants to evaluate whether a Kazakh or Russian candidate word is the correct translation equivalent of an English prime. This decision necessarily engages meaning-based comparison across languages. A congruent candidate should benefit from convergence between the conceptual representation activated by the prime and the meaning of the candidate, whereas an incongruent candidate should impose greater verification demands because the participant must reject a word that is processed against an already activated semantic context. From this perspective, behavioural congruency effects can be interpreted as evidence that the system is not operating through superficial form matching alone, but

through cross-language lexico-semantic evaluation. If multilingual lexical access is indeed non-selective, then changes in reaction time and accuracy across conditions provide an initial window into the extent to which different language representations are co-activated during the task (Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994).

Behavioural data are especially valuable in the present dissertation because they allow the study to test whether cross-language interaction varies as a function of *candidate language* and *participant group*. The mirror-image design of the experiment makes this comparison theoretically meaningful. All participants share the same three-language repertoire but differ in the language that occupies the L1 position. If learning history and language status shape lexical accessibility, then performance should not only differ between congruent and incongruent trials but may also vary depending on whether the candidate belongs to the participant's L1 or L2. Under this logic, behavioural asymmetries are informative because they can reveal whether one background language is more readily recruited than the other during L3-triggered processing. Such asymmetries would be consistent with models that treat multilingual lexical access as experience-dependent and differentially weighted rather than uniformly distributed across the repertoire (Bardel & Falk, 2007, p. 459; Kroll et al., 2010, p. 373; Zirnstein et al., 2019). More specifically, the behavioural logic of the present study rests on the assumption that *congruent translation equivalents* should be easier to verify than *incongruent distractors*. Congruent candidates are expected to produce faster and more accurate responses because their meanings converge with the semantic representation activated by the English prime. Incongruent candidates, by contrast, are expected to generate longer reaction times and lower accuracy because they require rejection under conditions of semantic mismatch and cross-language competition. At the same time, the size of this congruency effect may vary across Kazakh and Russian candidates and across the two participant groups. Such variation would be behaviourally significant because it would

suggest that multilingual lexico-semantic processing is shaped not only by semantic compatibility, but also by the relative status and accessibility of the background languages within the participant's repertoire (Kroll & Stewart, 1994; Kroll et al., 2010). Accordingly, behavioural measures in the present study are treated as an initial empirical level at which cross-language activation can become observable. They do not by themselves determine the precise stage at which a processing difference arises, because slower or less accurate responses may reflect lexico-semantic competition, decisional difficulty, or both. Nevertheless, they provide essential evidence about whether multilingual processing costs emerge under the conditions established by the paradigm. For this reason, the behavioural results reported in the next section are interpreted not as isolated performance outcomes, but as indicators of how semantic verification unfolds in a trilingual system shaped by co-activation, competition, and language-history effects. The following section, therefore, turns to the *model-based analysis of accuracy and reaction time*, where these behavioural predictions are tested quantitatively.

In this dissertation, behavioural predictions are treated not as post hoc hypotheses, but as the inferential bridge between the theoretical architecture developed in Chapter 1 and its operationalisation in the translation recognition design presented in Chapter 2. Because reaction time and accuracy are composite outcomes that reflect multiple processing stages, predictions must be formulated in terms of systematic patterns rather than as claims about a single stage of processing. The relevant theoretical question is therefore not simply whether sequential trilinguals can complete the task, but how performance varies as a function of *congruency*, *candidate language*, and *L1 configuration* within a mirror-image design. Models of cross-language activation converge on the assumption that multiple language systems may be co-active during word recognition, while differing in the mechanisms through which one language exerts stronger influence than another under specific task demands (Dijkstra & Van

Heuven, 2002; Green, 1998; Kroll et al., 2010). Accordingly, the present section begins from a shared baseline assumption of non-selective access and competition and then specifies how experience-dependent weighting principles and control demands are expected to translate into measurable behavioural differences in the present paradigm.

A first general prediction follows from *interactive activation approaches* to bilingual and multilingual word recognition. In architectures that assume non-selective lexical access, an English prime is expected to activate a conceptual representation that increases the availability of translation equivalents in the background languages (Dijkstra & Van Heuven, 2002). When a candidate matches the activated meaning, evidence accumulation should be facilitated because prime-driven conceptual activation and candidate-driven lexico-semantic activation converge on the same conceptual representation. When a candidate is incongruent, this convergence is reduced, and competition increases because the semantic region supported by the prime conflicts with the meaning of the candidate. Behaviourally, this yields the core prediction of a *congruency effect*: congruent translation equivalents should be accepted more quickly and more accurately than incongruent non-translations, whereas incongruent candidates should produce longer reaction times and lower accuracy because the participant must detect mismatch and stabilise rejection under residual prime-induced activation (Dijkstra & Van Heuven, 2002; Kroll & Stewart, 1994). This prediction is methodologically important because it establishes that the task engages meaning-based evaluation and that behavioural measures are sensitive to semantic compatibility in a multilingual context. Beyond the basic congruency effect, models of cross-language activation predict that congruency sensitivity should be modulated by *candidate language* and by the participant's *language background*, because multilingual systems are not neutral with respect to their component languages. Even when early lexical access is non-selective, the participating languages may differ in baseline activation, representational strength, and efficiency of mapping between form and meaning.

In behavioural terms, such differences can influence both overall processing efficiency and the magnitude of congruency costs. Within the present design, candidates appear in Kazakh or Russian, and participants belong to one of two mirror-image groups. This creates a principled basis for predicting *language-by-group interactions*, such that the behavioural profile of Kazakh versus Russian candidates may differ depending on whether the candidate language functions as L1 or L2 for the participant (Dijkstra & Van Heuven, 2002; Kroll et al., 2010). A second set of predictions follows from *experience-weighted accounts* of multilingual lexical access, especially those that emphasize learning history, functional status, and the distinction between native and non-native systems. Both groups in the present study are sequential trilinguals who share English as L3 but differ in which societal language is L1 and which is L2. Extending the logic of the L2 Status account to lexico-semantic performance yields a constrained expectation: the system may recruit L2 more strongly during an L3-driven task because L2 and L3 share non-native learning conditions and are often managed through similar metalinguistic routines (Bardel & Falk, 2012, p. 77; Falk et al., 2015, p. 228). Under this interpretation, behavioural performance may show disproportionately strong involvement of the L2 during translation recognition. This may be expressed in one of two theoretically meaningful ways. If L2 representations are strongly co-activated and effectively linked to meaning in the context of an L3 task, congruency effects may be pronounced for L2 candidates because congruent decisions benefit from stronger convergence and incongruent decisions suffer from stronger conflict. Alternatively, if L2 mappings are less stable for rapid automatic semantic access than L1 mappings, congruency effects may be attenuated for L2 candidates, reflecting reduced efficiency in activating and verifying semantic equivalence. In both cases, the relevant prediction is not a simple main effect of L2, but a structured *group-by-language interaction* indicating that the behavioural profile of Kazakh versus Russian candidates depends on whether the language functions as L1 or L2 for the participant (Bardel

& Falk, 2007, 2012; Kroll et al., 2010). A third set of predictions follows from *control-based accounts* that treat multilingual processing as the management of competition rather than passive retrieval. Under non-selective access, incongruent trials impose higher control demands because the participant must reject a candidate that is processed against a prime-induced conceptual context. Control accounts, therefore, predict that *incongruency costs* will be amplified when competition is stronger or when regulation is less efficient (Green, 1998; Green & Abutalebi, 2013). This yields a particularly informative prediction for the mirror-image design: incongruency costs should not be uniform across candidate languages or groups. If one background language has higher baseline accessibility in each group, it may show a dual profile. On congruent trials, higher accessibility may facilitate acceptance and increase the congruency advantage. On incongruent trials, the same accessibility may increase interference and therefore increase rejection costs and error probability. Behaviourally, this would be reflected as a *congruency-by-language interaction*, potentially moderated by group, indicating that performance is shaped by the interaction between activation strength and competition demands rather than by congruency alone (Green, 1998; Green & Abutalebi, 2013). A further prediction concerns the *within-trial dynamics* across the four candidate positions. Although the same conceptual decision is required for each candidate, attentional and decisional context may change across positions. For example, once a correct translation has been encountered, subsequent candidates may be processed under altered decisional confidence or response bias. Because candidate order was randomised, such effects do not systematically confound congruency or language, but they may contribute structured variance and may interact with congruency and candidate language. For this reason, *stimulus position* is treated as a theoretically relevant factor rather than as random noise, and predictions are formulated in a way that acknowledges position-dependent shifts in the baseline decision environment while keeping the focus on the theoretically central interactions.

In summary, behavioural predictions derived from models of cross-language activation can be expressed as three core expectations. First, a robust *congruency effect* is expected, reflecting facilitated processing for translation equivalents and increased cost under semantic mismatch. Second, congruency sensitivity is expected to be modulated by *candidate language* and by *L1 configuration*, yielding interactions that index experience-dependent weighting of background languages within a shared trilingual system. Third, *incongruency costs* are expected to reflect competition and regulation demands and may therefore show differential profiles across languages and groups rather than remaining uniform. These predictions define what the behavioural data are designed to test and provide the interpretive framework for the model-based analyses reported in the next section. If behavioural differences reflect early lexico-semantic processing, corresponding modulation should be expected in the N400 time window; if they primarily reflect later decision and response processes, ERP differences may emerge later and with a different topographic profile (Kutas & Federmeier, 2011).

3.2 Model-Based Analysis of Behavioural Performance: Accuracy and Reaction Time

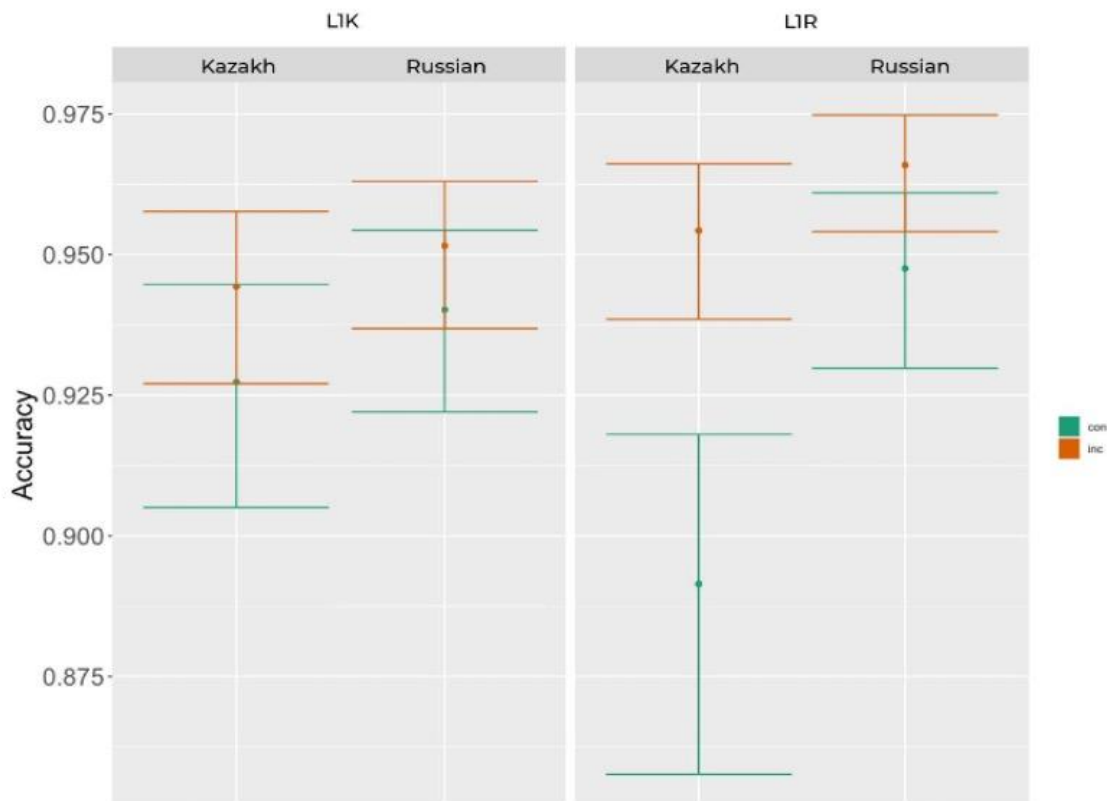
This section reports behavioural performance in the translation recognition task using mixed-effects modelling. In multilingual decision paradigms, accuracy and reaction time reflect partially overlapping, but not identical, stages of processing. Accuracy indexes decision stability under competition, whereas reaction time reflects the cumulative cost of perceptual encoding, lexical access, semantic verification, response selection, and motor execution. Because the present task involves the sequential evaluation of four candidate words per trial, performance was expected to vary systematically not only as a function of congruency, but also as a function of candidate language (Kazakh vs. Russian), candidate position, and verb group. These predictors were therefore treated as theoretically meaningful factors rather than as nuisance variance.

Accuracy. Mean accuracy was 87% ($SD = 34\%$) in the L1 Kazakh group and 87% ($SD = 33\%$) in the L1 Russian group. Accuracy was analysed with generalised linear mixed-effects models. Iterative model fitting indicated that the final model included log-transformed reaction time as a predictor and contained by-subject and by-item random intercepts as well as by-subject and by-item random slopes for congruency: $[glmer(acc \sim 1 + cong*log(rt + 1)*group + lang + pos + verb + (1 + cong|subj) + (1 + cong|item))]$. The Type II Wald test revealed significant main effects of congruency [$\chi^2(1) = 16.29, p < .001$], $\log(rt + 1)$ [$\chi^2(1) = 44.17, p < .001$], candidate language [$\chi^2(1) = 62.66, p < .001$], position [$\chi^2(1) = 36.08, p < .001$], and verb group [$\chi^2(1) = 20.47, p < .001$], as well as a significant interaction between reaction time and congruency [$\chi^2(1) = 28.71, p < .001$] and an interaction between congruency and group [$\chi^2(1) = 5.41, p < .05$].

The main effect of congruency confirms that participants' decisions were meaning-sensitive: congruent translation equivalents were verified more accurately than incongruent non-translations, consistent with semantic evaluation under prime-induced conceptual activation. The candidate-language effect indicates that accuracy differed systematically between Kazakh and Russian candidates, implying that the two background languages are not behaviourally equivalent within this trilingual system. Crucially, the congruency-by-group interaction indicates that congruency sensitivity depended on L1 configuration, aligning with the dissertation's mirror-image logic and suggesting group-specific differences in how semantic mismatch is detected and rejected under competition. This interaction is illustrated in Figure 3, which visualises accuracy as a function of congruency and candidate language separately for the L1 Kazakh and L1 Russian groups (83% confidence intervals; non-overlap corresponds approximately to significance at the 5% level).

Figure 3

Mean Accuracy Rates by Congruency, Group, and Candidate Language



Note. The figure shows mean accuracy rates for congruent and incongruent trials in the L1 Kazakh and L1 Russian groups, with candidate language shown separately for Kazakh and Russian words. Reproduced from Zhaksylykkyzy et al. (2026).

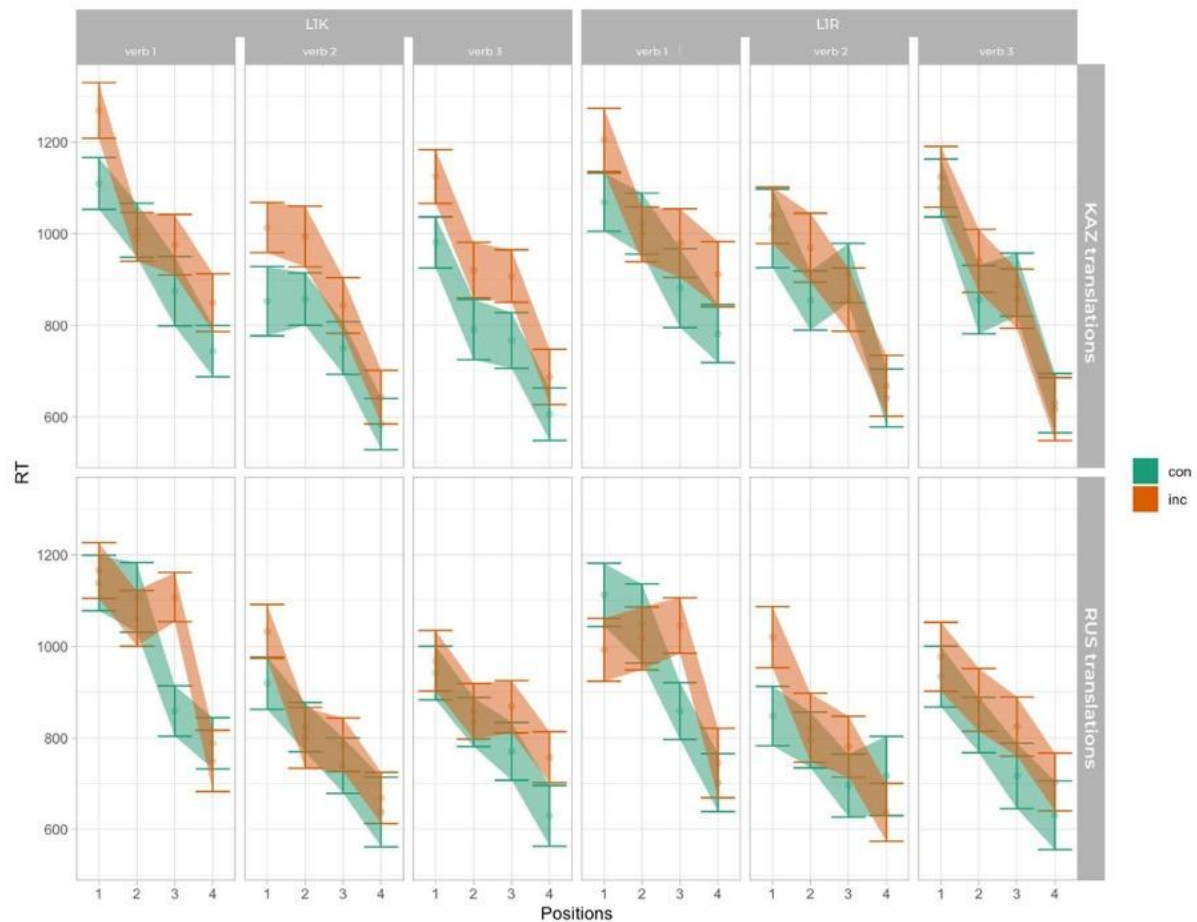
The accuracy results are theoretically informative because they indicate that translation recognition in the present task was not based on superficial response routines. If participants had relied only on approximate familiarity or response heuristics, congruency effects would be expected to be weaker or less systematic. Instead, the observed congruency effect suggests that participants were sensitive to semantic correspondence between the English prime and the candidate word. Moreover, the group-related modulation of congruency supports the view that background-language involvement in L3-triggered processing is not uniform but shaped by the participant's language-history configuration.

Reaction time. Mean reaction time was 879.63 ms ($SD = 437.79$) in the L1 Kazakh group and 876.81 ms ($SD = 484.27$) in the L1 Russian group. Reaction times were analysed

with linear mixed-effects models. The Type II Wald test revealed significant main effects of congruency [$\chi^2(1) = 113.06, p < .001$], candidate language [$\chi^2(1) = 16.74, p < .001$], position [$\chi^2(3) = 1510.70, p < .001$], and verb group [$\chi^2(2) = 40.06, p < .001$], as well as a significant higher-order interaction $\text{cong} \times \text{lang} \times \text{verb} \times \text{pos}$ [$\chi^2(6) = 13.55, p < .05$]. The robust congruency effect in reaction time provides strong behavioural evidence for increased processing cost under semantic mismatch: across groups and candidate languages, incongruent candidates elicited longer decision latencies than congruent translation equivalents. This pattern is expected if incongruent trials require additional verification and conflict resolution because prime-driven conceptual activation supports a semantic region different from that provided by the candidate. Reaction time also differed as a function of candidate language, indicating differential processing efficiency for Kazakh versus Russian candidates at the verification stage. Position effects were substantial, with faster responses for later candidate words, consistent with within-trial adaptation in decision dynamics. Importantly, the significant four-way interaction indicates that congruency costs were not constant across the task. Rather, the size of the congruency effect varied as a function of candidate language, verb group, and stimulus position, demonstrating that within-trial structure and prime properties jointly modulated the behavioural expression of semantic mismatch. These patterns are illustrated in Figure 4, which plots reaction times across positions (1–4) separately for verb groups and candidate languages in each participant group, showing longer latencies for incongruent than for congruent conditions together with systematic modulation by verb group and position (83% confidence intervals).

Figure 4

Mean Reaction Times by Congruency, Candidate Language, Verb Group, and Position



Note. Reaction times are shown in milliseconds for congruent and incongruent trials, separately by candidate language, verb group, and stimulus position. Candidate language includes Kazakh and Russian words. Reproduced from Zhaksylykkyzy et al. (2026).

Whereas accuracy reflects the stability of the final decision, reaction time provides a more graded index of processing cost during semantic verification. In the present study, the robust reaction-time congruency effect indicates that even when participants responded correctly, incongruent candidates imposed additional processing demands. This is particularly important in multilingual research, because lexico-semantic competition may be expressed not only in overt errors, but also in delayed processing caused by co-activation and conflict resolution (Kroll et al., 2013). The reaction-time findings, therefore, complement the accuracy results by showing that semantic mismatch affects both decisional outcome and the temporal dynamics of behavioural performance.

The combined accuracy and reaction time findings indicate that incongruent candidates produced both reduced accuracy and increased latency, which is inconsistent with a simple speed-accuracy trade-off. If participants had merely sacrificed accuracy for speed on incongruent trials, one would expect faster responses paired with more errors. Instead, incongruent trials were both slower and less accurate, consistent with genuine processing difficulty during semantic verification. The group-dependent modulation of congruency in accuracy (Figure 3) and the complex interaction structure in reaction times (Figure 4) further suggest that the behavioural costs of mismatch are shaped by the weighting of the background languages and by the evolving decision context across the four candidate positions. These findings motivate the ERP analyses reported in the following sections, where temporal constraints can determine whether group and language differences emerge at the level of lexico-semantic processing (N400 window) or at later decision-related stages.

Taken together, the behavioural findings provide initial empirical support for the claim that L3-triggered translation recognition engages a multilingual lexico-semantic system in which background languages are co-activated and differentially weighted. The fact that incongruent candidates produced both lower accuracy and longer reaction times indicates that mismatch generated genuine verification difficulty rather than a trivial response bias. At the same time, the modulation of these effects by candidate language, group, position, and verb group suggests that behavioural performance in trilingual word recognition is shaped by an interaction of semantic congruency, language-history configuration, and task-internal dynamics. These behavioural findings do not by themselves determine the precise stage at which cross-language interaction occurs, but they establish the functional presence of multilingual competition and therefore provide the necessary basis for the electrophysiological analyses that follow.

3.3 Electrophysiological Evidence for Cross-Language Activation

Behavioural indices in translation recognition provide an essential functional description of performance, but they do not uniquely identify the processing stage at which cross-language interaction exerts its influence. In a trilingual task, slower responses and reduced accuracy may reflect early lexico-semantic activation dynamics, but they may also arise from later processes such as response verification, decisional uncertainty, or strategic control under time pressure. Electrophysiological evidence is therefore necessary for a dissertation that aims to explain multilingual processing mechanistically. By tracking neural activity time-locked to candidate onset, event-related potentials (ERPs) allow the present study to locate cross-language effects within the temporal stream of processing and to determine whether bilingual and trilingual interaction emerges at a meaning-sensitive stage rather than only at an explicit decision stage (Kutas & Federmeier, 2011; Luck, 2014). Within the translation recognition paradigm used here, the logic of ERP inference is straightforward. The English prime provides a controlled conceptual context that increases the availability of translation-relevant semantic information. Each subsequent candidate word triggers a rapid sequence of computations that includes perceptual encoding, lexical access, activation of semantic features, and evaluation of conceptual compatibility with the prime. If cross-language activation is a stable property of multilingual lexical access, then candidate processing should be shaped by the degree to which prime-driven activation converges with the semantic content of the candidate (Dijkstra & Van Heuven, 2002; Kroll et al., 2010). If cross-language activation is experience-weighted, the strength and timing of this convergence may vary as a function of language history and the functional status of the background languages, even when task structure and stimulus design are held constant across groups. At this level, the contribution of ERPs is not to replace behavioural measures, but to constrain interpretation. ERP responses provide a temporally fine-grained window onto processing that

unfolds before the overt response is executed. This makes it possible to distinguish meaning-related processing from later decision-related activity and to determine whether the observed behavioural congruency effects reflect early semantic mismatch detection, later decisional processes, or a combination of both (Luck, 2014). The electrophysiological component of the study, therefore, functions as a bridge between the theoretical framework developed in Chapter 1 and the methodological operationalisation presented in Chapter 2. Theoretically, Chapter 1 motivates the expectation that multilingual lexical access is interactive, and that cross-language activation may occur even when only one language is task-relevant. Methodologically, Chapter 2 ensures that incongruent candidates are conceptually unrelated and non-cognate across the three languages, allowing electrophysiological effects to be interpreted primarily as meaning-based rather than form-based. Taken together, these foundations justify the use of ERPs as a mechanism-level test of cross-language interaction in trilingual word recognition.

The electrophysiological logic of this dissertation is grounded in the assumption that cross-language activation in trilingual word recognition can influence processing at the level of lexico-semantic access and meaning evaluation, rather than only at later decisional stages. Event-related potentials (ERPs) are methodologically well suited for testing this assumption because they provide millisecond-level temporal constraints on when processing differences emerge during word recognition (Luck, 2014). Within the ERP literature on language, the N400 is the most established and theoretically informative index of meaning-related computation during comprehension. It is typically observed as a negative-going deflection peaking at approximately 400 ms after stimulus onset and showing a characteristic centroparietal distribution in visual word processing. Its amplitude varies systematically with semantic expectancy, contextual fit, and associative relatedness, making it an appropriate neural marker for testing whether candidate words are processed as conceptually compatible

with an activated context (Kutas & Federmeier, 2011; Kutas & Hillyard, 1980; Van Petten & Luka, 2012). A central reason for focusing on the N400 is that it has consistently been shown to index lexico-semantic processing difficulty across a wide range of paradigms. Since its original identification in response to semantically incongruent sentence-final words, the component has been repeatedly linked to the degree of contextual support available to an incoming word and to the ease with which that word can be related to an activated representation of meaning (Kutas & Hillyard, 1980; Kutas & Federmeier, 2011). In this respect, the N400 is not limited to sentence processing alone. It is also sensitive to lexical-level semantic relations, including semantic priming, expectancy, and conceptual fit. This broader sensitivity makes it especially relevant for the present study, because the translation recognition paradigm relies on concept-level comparison between an English prime and a subsequently presented Kazakh or Russian candidate. Evidence from semantic priming research further supports the relevance of the N400 for the present paradigm. In word-pair studies, the second item typically elicits a reduced N400 when it is semantically related to the prime compared with unrelated pairings, indicating facilitated processing under conceptual pre-activation (Van Petten & Luka, 2012). Although the present task differs from classic semantic priming in that it requires an explicit translation decision rather than passive lexical recognition, it relies on the same general principle: processing of the second item is shaped by the semantic context induced by the first. In the present design, the English prime activates a conceptual region, and the candidate word must then be evaluated as either semantically corresponding to that activated concept or not corresponding to. This makes the N400 especially informative for testing whether congruent and incongruent candidates diverge at the level of meaning-based evaluation.

In the present study, the translation recognition paradigm therefore provides a controlled context in which semantic processing is obligatory. An English prime is expected

to activate a conceptual representation, and each subsequent candidate word must be evaluated as either expressing the same concept (congruent translation equivalent) or not (incongruent distractor) (De Groot & Comijs, 1995). The core electrophysiological prediction is that incongruent candidates should elicit a larger, that is, more negative, N400 than congruent translation equivalents. This is expected because semantic mismatch reduces the degree of convergence between prime-driven conceptual activation and candidate-driven lexico-semantic activation (Brown & Hagoort, 1993). The prediction follows directly from the broader principle that the N400 is sensitive to the ease of semantic processing in context, where “context” includes not only sentence-level constraints but also experimentally induced conceptual pre-activation. Importantly, this dissertation treats N400-based predictions as *pattern predictions* rather than as evidence of a one-to-one mapping between an ERP component and a single cognitive function. Although the N400 was originally identified in response to a semantic anomaly, subsequent work has shown that it is modulated in a graded fashion by probability, expectancy, and semantic association (Aurnhammer et al., 2021). It therefore indexes an interaction between stored lexico-semantic knowledge and contextual constraints rather than a simple anomaly-detection mechanism (Kutas & Federmeier, 2011; Van Petten & Luka, 2012). Theoretical debate has focused on whether the N400 more directly reflects facilitated lexico-semantic access from long-term memory or the integration and updating of meaning within an evolving representation. For the purposes of the present dissertation, the central methodological point is that N400 modulation provides a temporally specific constraint indicating that the experimental manipulation affects meaning-related processing during candidate evaluation, rather than only later response selection or post-lexical decision processes (Lau et al., 2008; Luck, 2014). The choice of an *N400-focused time window* is additionally motivated by the time scale of the computations required in the present task. Translation recognition requires rapid mapping from orthographic input to lexical

representations and activation of semantic features sufficient to verify cross-language equivalence. These operations are expected to unfold within the first several hundred milliseconds following candidate onset, aligning with the canonical N400 latency range for meaning-related effects in visual word recognition (Kutas & Federmeier, 2011; Luck, 2014). Accordingly, the N400 window provides a principled interval for testing whether congruency is expressed as an early semantic mismatch response. This is especially valuable because behavioural measures in translation tasks may conflate early lexico-semantic processing with later decisional and motor components (Luck, 2014).

Finally, the present design strengthens the interpretability of N400 effects by minimising *form-based explanations* for congruency differences. Incongruent distractors were selected to be conceptually unrelated and non-cognate across the three languages, reducing the likelihood that congruency effects can be attributed to orthographic similarity or superficial overlap. Under such constraints, systematic N400 differentiation between congruent and incongruent candidates supports the claim that the paradigm is sensitive to meaning-based evaluation under cross-language activation. In addition, if the magnitude or distribution of the N400 effect differs across groups or candidate languages, such differences can be interpreted as evidence that semantic mismatch is processed within an experience-weighted multilingual system rather than within a uniform, language-neutral mechanism. This rationale directly motivates the analysis strategy described in the following subsection, where these predictions are operationalised through epoch definition, baseline correction, regional analysis, and time-window selection.

3.4 ERP Analysis Strategy: Regional Analysis and Time-Window Selection

Spatial analysis strategy: ROIs and scalp distribution. ERP components are defined not only by latency, but also by scalp topography. Accordingly, the analysis strategy incorporated spatial structure in a principled way to evaluate whether effects displayed theoretically

expected distributions and to improve measurement stability. Electrode channels were grouped into nine regions of interest (ROIs) by averaging across predefined symmetric electrode clusters. ROI averaging reduces the multiple-comparison burden relative to channel-by-channel testing while preserving meaningful variation along two dimensions that are particularly relevant for language ERPs: the anterior-to-posterior gradient and left-to-right lateralisation (Keil et al., 2014; Luck, 2014). This framework supports formal tests of whether congruency effects show the expected central-posterior prominence and whether topographic patterns differ as a function of candidate language or language-history group. The ROIs were computed by averaging predefined electrode clusters corresponding to anterior, central, and posterior scalp regions across the left, middle, and right hemispheric divisions. The anterior left ROI included F7, F5, F3, FC7, FC5, and FC3; the central left ROI included T7, C5, C3, TP7, CP5, and CP3; and the posterior left ROI included P7, P5, P3, PO7, PO5, PO3, and O1. The anterior middle ROI included F1, Fz, F2, FC1, FCz, and FC2; the central middle ROI included C1, Cz, C2, CP1, and CP2; and the posterior middle ROI included P1, Pz, P2, POz, and Oz. The anterior right ROI included F4, F6, F8, FC4, FC6, and FT8; the central right ROI included C4, C6, T8, CP4, CP6, and TP8; and the posterior right ROI included P4, P6, P8, PO4, PO6, PO8, and O2. The ROIs were treated as averaged spatial clusters, and the modelling strategy was specified so that spatial predictors remained interpretable and non-redundant. The spatial organisation of the nine regions of interest used for ERP analysis is illustrated in Figure 5. The map shows the anterior–central–posterior and left–middle–right grouping of electrodes used to calculate mean amplitudes in the N400 time window.

Figure 5

Region-of-interest layout used for ERP analysis

Single-trial mixed-effects approach. ERP amplitudes were analysed using single-trial modelling rather than relying exclusively on grand-average waveforms. Single-trial mixed-effects models preserve trial-to-trial variability and can improve statistical sensitivity by allowing hierarchical variance attributable to both participants and lexical items to be modelled directly. This is particularly important in language experiments, where both subject-level and item-level heterogeneity are expected (Bates et al., 2015; Keil et al., 2014).

Fixed-effects structure. Single-trial mean amplitudes were modelled with fixed effects for the theoretically relevant predictors: group (L1 Kazakh vs. L1 Russian), congruency (congruent vs. incongruent), candidate language (Kazakh vs. Russian), stimulus position, verb group (formal inflectional complexity grouping), and ROI (AL, CL, PL, AM,

CM, PM, AR, CR, PR). Interactions were specified to test the dissertation's core hypotheses, focusing primarily on congruency effects and their modulation by group and candidate language. ROI interactions were included where necessary to evaluate whether effects varied in scalp distribution, which is informative for characterising N400 topography and possible group-dependent modulation.

Random-effects structure and model stability. Models included random intercepts for participants and items to account for baseline amplitude differences. Where supported by the data, random slopes were included for key within-unit predictors, particularly congruency, reflecting the expectation that mismatch sensitivity may vary across participants and items. In cases where maximal random-effects structures led to convergence difficulties, the structure was simplified to prioritise stable estimation and interpretable inference, following standard recommendations for mixed-effects modelling in psycholinguistic research (Bates et al., 2015).

Time-window definition and focus on the N400. Time windows for ERP analysis were determined from prior literature and pilot observations, with primary focus on the N400 interval between 400 and 600 ms. The N400 is a robust and well-established component linked to lexico-semantic processing and to semantic mismatch. Semantically expected or congruent stimuli typically elicit reduced N400 amplitudes; whereas semantically incongruent stimuli elicit larger N400 amplitudes (Fjaellingsdal et al., 2016). Because the translation recognition paradigm explicitly manipulates semantic correspondence, N400 modulation provides a theoretically grounded neural index of semantic evaluation during trilingual word recognition (Kutas & Federmeier, 2011; Kutas & Hillyard, 1980; Luck, 2014). Selecting an *a priori* N400 interval also supports methodological transparency and reduces analytic flexibility, thereby strengthening the interpretability of condition effects in the dissertation (Keil et al., 2014; Luck, 2014).

Inferential linkage to dissertation hypotheses. The analytical framework was designed to connect ERP results directly to the dissertation's theoretical claims without preempting the later results sections. Behavioural congruency costs establish that semantic mismatch affects performance, but they do not specify whether the cost reflects early semantic processing or later decision-level dynamics (Meade et al., 2021). ERP analyses address this gap by testing whether congruency effects and group-by-language modulation arise in the N400 window and how they are distributed across ROIs. In this sense, ERPs function as a temporal constraint on interpretation, distinguishing between meaning-level and later evaluative accounts of behavioural differences.

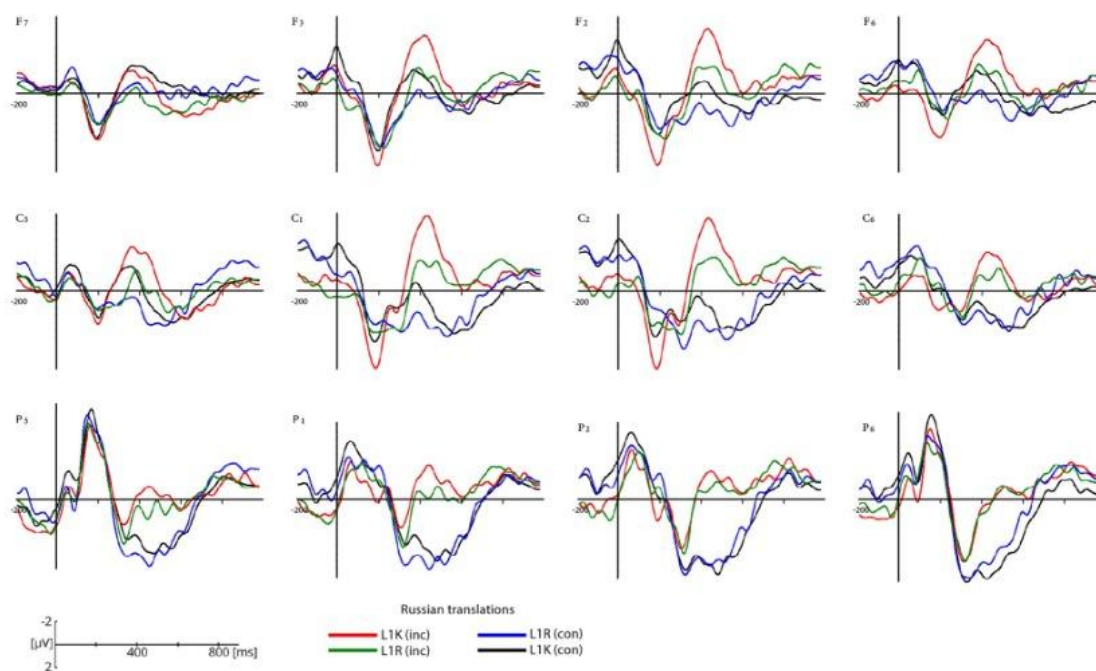
3.5 N400 Congruency Effects and Group-Specific Modulation in Trilingual Word Recognition

Grand-average ERP waveforms for Russian candidates in the L1R and L1K groups are shown in Figure 6, and corresponding waveforms for Kazakh candidates are shown in Figure 7. Figure 8 presents scalp topographies of mean amplitudes in the N400 time window for the congruent condition (upper row) and the incongruent condition (lower row). The present analyses focus on the 400–600 ms interval, corresponding to the canonical N400 component. Within the translation recognition paradigm used here, congruent candidates represent correct translation equivalents of the English prime, whereas incongruent candidates represent semantic mismatch. Accordingly, a larger, more negative N400 for incongruent items is predicted if participants engage meaning-based evaluation during candidate processing rather than relying only on superficial decision heuristics (Kutas & Hillyard, 1980; Kutas & Federmeier, 2011; Luck, 2014). Across both mirror-image groups, the ERP waveforms reveal a clear negative-going deflection for incongruent words within the 400–600 ms interval (see Figures 6-8). The magnitude of the difference between the congruent and incongruent conditions indicates that semantic mismatch modulated neural processing in the time range

associated with lexico-semantic computation. This pattern supports the validity of the experimental manipulation as a semantic congruency contrast. It also suggests that, in the present trilingual context, candidate evaluation engages lexico-semantic processing early enough to influence the N400 component rather than being confined exclusively to later, post-lexical decisional stages. This point is especially important in translation recognition tasks, where participants may, in principle, adopt deliberate verification routines. The reliable divergence observed in the N400 interval, therefore, indicates that incongruent candidates elicited increased semantic processing demands during online evaluation, consistent with the broader ERP literature showing that greater N400 negativity is associated with reduced semantic fit and increased integration demands (Kutas & Federmeier, 2011; Van Hell & Kroll, 2013; Van Petten & Luka, 2012). Figures 6 and 7 illustrate this effect separately for Russian and Kazakh candidates, allowing visual assessment of the congruency contrast within each candidate language and within each participant group. Figure 8 complements the waveform plots by visualising the condition difference as scalp topographies, thereby providing an overview of the spatial distribution of the congruency effect. Because ERP amplitudes are strongly modulated by electrode location and regional signal characteristics, topographic visualisation is informative for evaluating whether the congruency effect shows a distributed pattern typical of N400 responses. It also motivates the ROI-based modelling used in the subsequent analyses, since scalp distribution may vary across conditions and participant groups even when the direction of the congruency effect remains consistent.

Figure 6

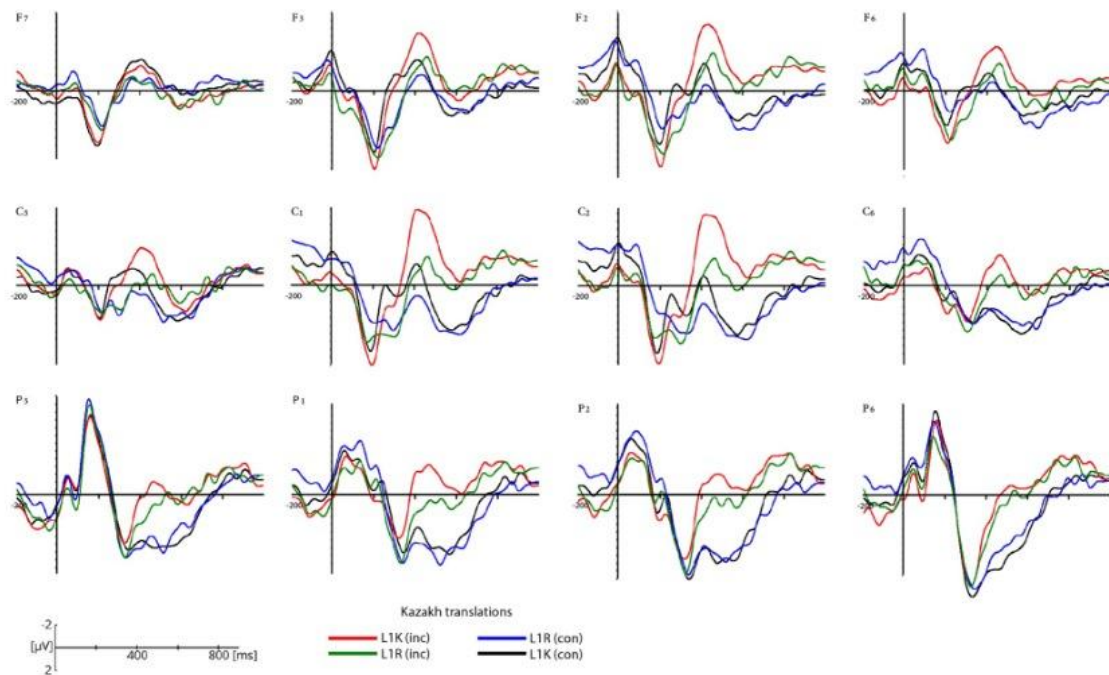
Grand-Average ERP Waveforms for Russian Candidates by Group and Congruency



Note. ERP waveforms are shown for Russian candidate words in the L1 Kazakh and L1 Russian groups, plotted separately for congruent and incongruent conditions. Traces are presented for 12 representative electrodes within the predefined ROIs: F7, F3, F2, F6, C5, C1, C2, C6, P5, P1, P2, and P6. The time axis spans –200 to 1000 ms relative to stimulus onset; negative voltage is displayed upward. Reproduced from Zhaksylykkyzy et al. (2026).

Figure 7

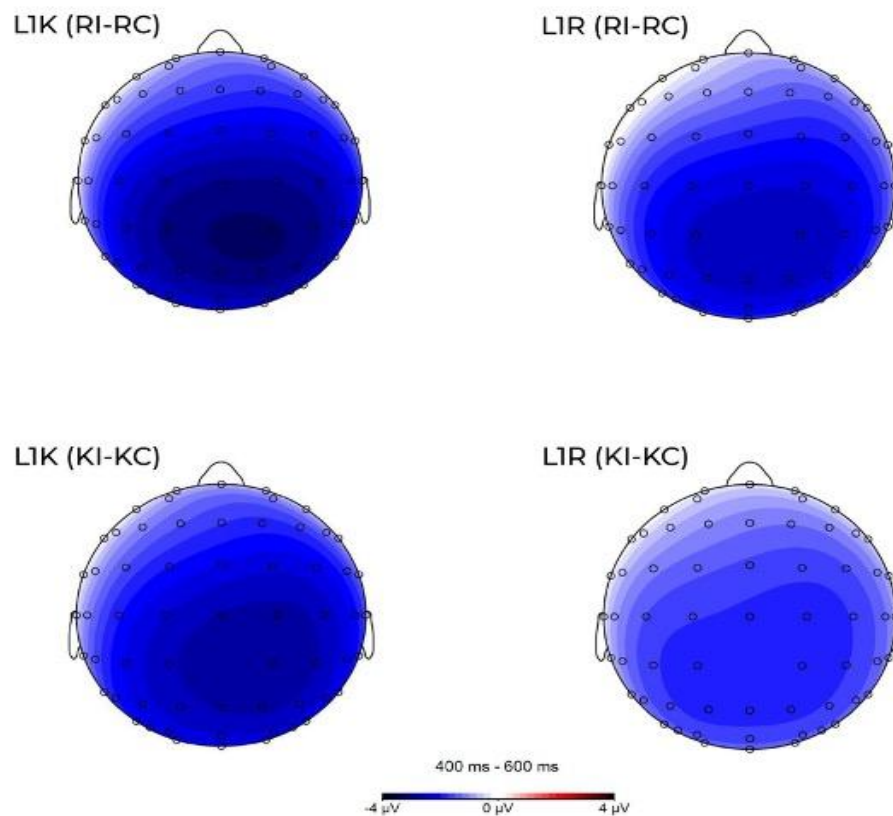
Grand-Average ERP Waveforms for Kazakh Candidates by Group and Congruency



Note. ERP waveforms are shown for Kazakh candidate words in the L1 Kazakh and L1 Russian groups, plotted separately for congruent and incongruent trials. Traces are presented for 12 representative electrodes corresponding to the predefined ROI structure: F7, F3, F2, F6, C5, C1, C2, C6, P5, P1, P2, and P6. Data are time-locked to stimulus onset from –200 to 1000 ms, with negative polarity plotted upward. Reproduced from Zhaksylykkyzy et al. (2026).

Figure 8

Scalp Distribution of N400 Condition Effects by Group and Candidate Language



Note. Scalp maps of condition effects (voltage differences were computed by subtracting the congruent from the incongruent conditions in Kazakh and Russian groups) averaged across the N400 (L1K and L1R (upper row), the incongruent condition and L1K and L1R (lower row), the translation equivalent condition). Scale from $-4 \mu\text{V}$ (blue) to $4 \mu\text{V}$ (red). Reproduced from Zhaksylykkyzy et al. (2026).

The ERP data were analysed using linear mixed-effects models, which allow trial-level N400 mean amplitudes to be modelled as a function of experimental predictors while accounting for random variability attributable to participants and lexical items. This modelling framework is particularly appropriate in multilingual ERP research because it supports inference that generalises beyond the specific sample and stimulus set, while reducing the risk that averaged waveforms obscure systematic variance linked to individual differences or item-specific properties. The primary fixed effects entered the model corresponded to the key theoretical factors of interest in this dissertation, namely group (L1K

vs. L1R), congruency (congruent vs. incongruent), and candidate language (Kazakh vs. Russian), while additional predictors captured structured variance related to stimulus characteristics (verb group) and scalp distribution (region of interest). Statistical significance of model terms was assessed using Type II Wald tests, which provide an inferential summary of each effect while controlling for the presence of the other predictors in the model. Table 2 summarises effects in the N400 time window, as determined by Type II Wald tests.

Consistent with the descriptive waveforms, the analysis yields a robust main effect of congruency, indicating that incongruent candidates elicited systematically greater negativity in the N400 interval relative to congruent translation equivalents. This effect establishes the presence of a reliable semantic mismatch response in the neural signal and confirms that the congruency manipulation successfully targeted semantic processing in the expected time range. In addition, significant main effects of candidate language, verb group, and ROI indicate that mean N400 amplitude varied across the two candidate languages, across lexical stimulus categories, and across scalp regions, respectively. These effects are consistent with a trilingual design in which the two non-English languages differ in usage history and representational strength, and in which N400 amplitude is known to show systematic topographic structure (Kutas & Federmeier, 2011). Crucially, group effects are not expressed as a simple baseline difference in amplitude. The main effect of the group is not significant, suggesting that overall N400 magnitude was broadly comparable between L1K and L1R participants when collapsing across conditions. Instead, the group factor contributes through its interactions with the experimental manipulations. The significant group $\times$ congruency interaction indicates that the magnitude of the mismatch effect differed between the mirror-image groups, implying that language-history configuration modulated neural sensitivity to semantic mismatch during lexico-semantic evaluation. The significant congruency $\times$ language interaction indicates that the mismatch effect differed between Kazakh and Russian

candidates, suggesting language-specific modulation of semantic processing demands. Most importantly for the dissertation's central question, the significant group $\times$ congruency $\times$ language interaction indicates that group differences in mismatch sensitivity depended on which candidate language was being processed. From the perspective of multilingual lexical processing, this interaction is especially informative because it suggests that semantic mismatch is not processed in a uniform way across the trilingual system. Rather, the neural expression of congruency appears to depend on how strongly a given background language is functionally integrated into L3-triggered evaluation, a pattern consistent with experience-dependent accounts of multilingual lexical access (Dijkstra & Van Heuven, 2002; Kroll et al., 2010). Additional higher-order interactions involving the verb group and ROI further indicate that the experimental effects varied as a function of lexical category and scalp distribution. In particular, the presence of group $\times$ ROI and congruency $\times$ ROI interactions suggests that condition and group differences were not uniform across the scalp, which is consistent with the fact that N400 effects may vary in magnitude across regions and may show distributional shifts depending on task demands and participant characteristics. Because the dissertation's core hypothesis concerns how group and candidate language modulate the congruency effect, the interpretation prioritises the highest-order interaction that jointly contains these factors.

Table 2

Summary of Effects in the N400 Time Window: Type II Wald Tests

Effects	Chisq	Df	Pr(>Chisq)
group	0.6068	1	0.436
cong	7060.8718	1	0.001
lang	9.0253	1	0.003
verb	409.7087	2	0.001
roi	19830.3820	8	0.001

Effects	Chisq	Df	Pr(>Chisq)
group:cong	139.6412	1	0.001
group:lang	2.0607	1	0.151
cong:lang	4.2355	1	0.039
group:verb	629.4834	2	0.001
cong:verb	39.1927	2	0.001
lang:verb	52.6343	2	0.001
group:roi	1490.8787	8	0.001
cong:roi	790.5313	8	0.001
lang:roi	30.2510	8	0.001
verb:roi	251.5903	16	0.001
group:cong:lang	8.3207	1	0.003
group:cong:verb	8.4257	2	0.015
group:lang:verb	9.5682	2	0.008
cong:lang:verb	18.0522	2	0.001
group:cong:roi	17.3266	8	0.027
group:lang:roi	32.3764	8	0.001
cong:lang:roi	11.2709	8	0.187
group:verb:roi	101.6852	16	0.001
cong:verb:roi	7.1414	16	0.970
lang:verb:roi	8.7617	16	0.923
group:cong:lang:verb	0.5718	2	0.751
group:cong:lang:roi	3.2040	8	0.921
group:cong:verb:roi	0.4625	16	1.000
group:lang:verb:roi	0.5916	16	1.000

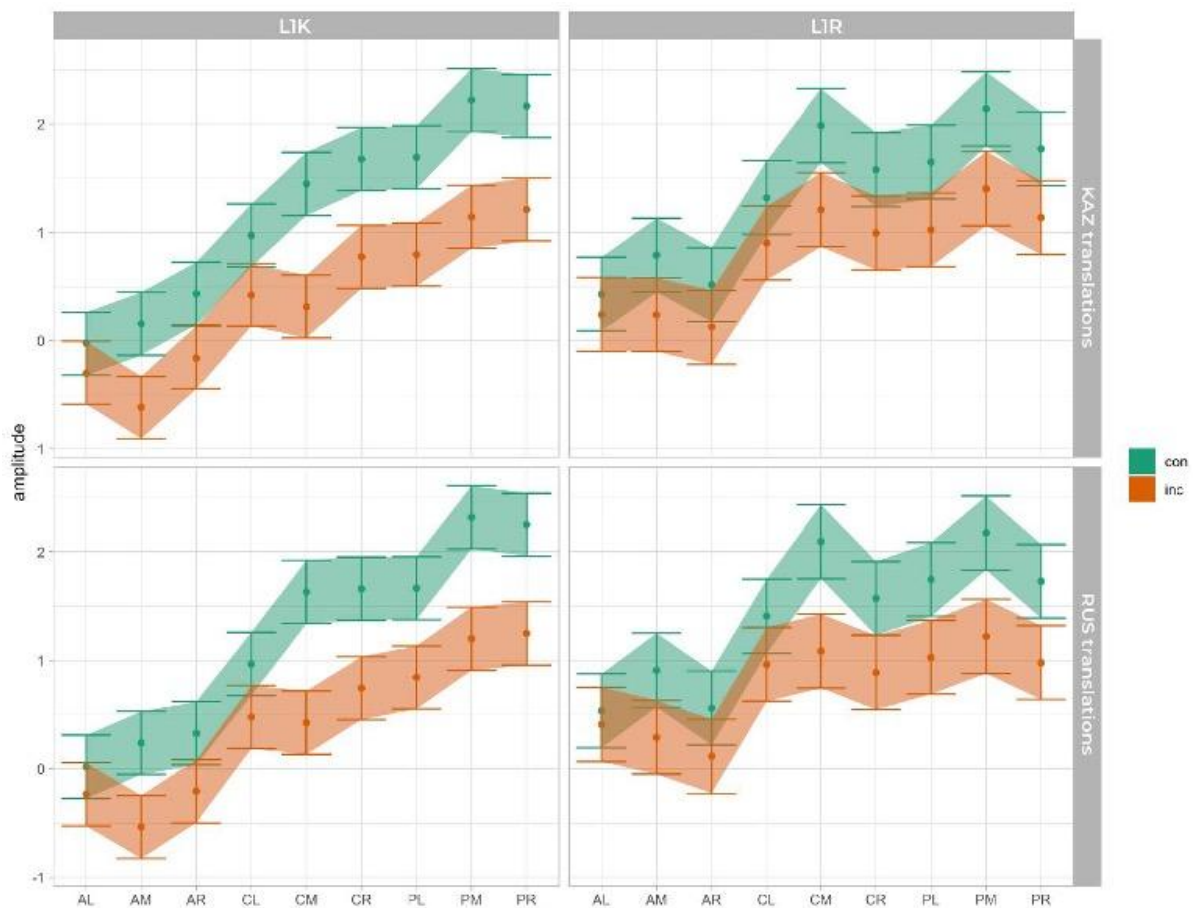
Effects	Chisq	Df	Pr(>Chisq)
cong:lang:verb:roi	6.2649	16	0.985
group:cong:lang:verb:roi	0.8417	16	1.000

Note. Reproduced from Zhaksylykkyzy et al. (2026).

In line with the dissertation's hypotheses, the interpretation focuses on the interaction among group, congruency condition, and candidate language. To clarify the form of this interaction, Figure 9 presents model-based estimated marginal means with 83% confidence intervals. Estimated marginal means are reported because they provide model-based condition estimates while controlling for the other predictors in the model, thereby supporting principled interpretation of complex interactions. The use of 83% confidence intervals follows established recommendations for visual inference in factorial designs and facilitates interpretation of differences at conventional significance thresholds. Because the full model includes multiple interacting predictors, direct inspection of raw means alone would not be sufficient for interpreting the theoretically central pattern. Model-based estimates, therefore provide a clearer representation of how congruency varies as a function of group, candidate language, and scalp region.

Figure 9

Model-Based Estimated Marginal Means of N400 Amplitude by Group, Candidate Language, ROI, and Congruency



Note. Reproduced from Zhaksylykkyzy et al. (2026).

In view of the multiple interacting predictors included in the full model, direct inspection of raw condition means is not sufficient for interpreting the theoretically central effects. Model-based estimated marginal means therefore provide a clearer representation of how congruency varies as a function of group, candidate language, and scalp region, while controlling for the other factors included in the model. This is particularly important in the present study because interpretation of the N400 effect depends not only on whether incongruent items differ from congruent ones, but also on how this difference is modulated by language-history configuration.

Conclusion to Chapter 3

Chapter 3 provided a unified empirical account of trilingual lexical processing in Kazakh–Russian–English sequential trilinguals by combining behavioural evidence from

translation recognition with electrophysiological evidence from ERPs. Its central contribution is both methodological and theoretical. Specifically, the chapter demonstrates that cross-language interaction in this population is observable both as an outcome-level cost in performance and as a time-locked neural signature consistent with meaning-based processing, thereby supporting an interpretation in which trilingual word recognition reflects interactive, experience-weighted lexico-semantic dynamics rather than isolated language-specific access.

At the behavioural level, the results established robust sensitivity to semantic congruency. Across groups, incongruent candidates produced lower accuracy and longer reaction times than congruent translation equivalents, indicating that mismatch trials imposed genuine processing difficulty rather than reflecting a trivial response bias. Importantly, this pattern is inconsistent with a simple speed–accuracy trade-off: participants were not merely responding faster at the cost of making more errors on difficult trials; instead, mismatch increased both latency and error probability, consistent with increased demands during semantic verification under prime-induced conceptual activation. The modelling strategy further showed that performance was structured by factors inherent to the paradigm, including candidate language, stimulus position, and verb group, demonstrating that the observed effects reflected not only congruency manipulation but also systematic within-trial and item-level dynamics. The congruency $\times$ group interaction in accuracy (see Figure 2) provided evidence consistent with the idea that the behavioural expression of mismatch sensitivity depends on L1 configuration in the mirror-image design, thereby supporting the dissertation's premise that language-history configuration shapes the functional consequences of cross-language activation.

Reaction-time modelling extended this conclusion by showing that congruency costs were not constant across the task context. The significant congruency $\times$ language $\times$ verb $\times$ position interaction (see Figure 3) indicates that decision latencies were modulated by the

interaction of candidate language, stimulus structure, and within-trial dynamics. This pattern strengthens the theoretical interpretation of the behavioural findings as reflecting graded competition and verification demands rather than a single uniform “translation difficulty” effect. Taken together, the behavioural results show that translation recognition in these trilinguals is meaning-sensitive, that semantic mismatch produces measurable processing cost, and that the magnitude and profile of that cost vary systematically as a function of language status and task structure, as predicted by models of non-selective access, experience-dependent weighting, and control demands. Chapter 3 also established the electrophysiological rationale required to interpret the behavioural findings mechanistically. Section 3.3 explained why ERPs are necessary for distinguishing between meaning-level and decision-level accounts of behavioural costs and why the N400 is the most theoretically informative component for the dissertation’s aims. The N400-focused framework developed there supports the interpretation that a congruency effect expressed in the 400–600 ms interval reflects semantic mismatch during online candidate evaluation rather than merely later response-verification processes (Kutas & Hillyard, 1980; Kutas & Federmeier, 2011; Luck, 2014). In this way, Chapter 3 positioned electrophysiology not as a parallel descriptive tool, but as a temporal constraint that directly informs the interpretation of behavioural interaction patterns.

In sum, Chapter 3 yielded three outcomes that define the empirical foundation of the dissertation. First, it demonstrated that cross-language activation has measurable behavioural consequences during trilingual translation recognition, expressed as congruency-related costs in both accuracy and reaction time. Second, it showed that these costs are systematically modulated by language status and trial dynamics, consistent with the mirror-image logic of the design and with experience-weighted models of multilingual access. Third, it established a principled electrophysiological framework for testing whether these behavioural effects

reflect early lexico-semantic processing indexed by the N400 or later decision-related processes. Taken together, these conclusions provide the basis for the dissertation's final integrative interpretation, in which behavioural outcomes and time-resolved neural evidence are brought together to explain how candidate language and L1 configuration shape trilingual lexico-semantic processing.

CONCLUSION

In line with the central hypothesis of this dissertation, it was expected that the N400 component would be enhanced in the incongruent condition, reflecting increased difficulty of recognition and semantic evaluation when the candidate word failed to match the meaning activated by the English prime. The incongruent condition was treated as the strongest and most informative test of co-activation of the two background languages during L3-triggered processing because it required the system to resolve semantic mismatch and stabilise a rejection response under conceptual pre-activation, while doing so in the absence of overt orthographic overlap between the English prime and the Kazakh or Russian candidates, and without systematic form overlap between the two background languages. On this logic, any reliable congruency-related modulation in behavioural performance and N400 amplitude can be interpreted as evidence that semantic-level activation and competition are engaged during translation recognition, rather than the task being solved exclusively through superficial or strategic decision routines. Within existing literature, this dissertation contributes an underexplored empirical configuration by combining a trilingual translation recognition paradigm with electrophysiological measurement in a Kazakh–Russian–English stimulus set, thereby offering a mechanism-oriented perspective on how language history and system configuration shape lexico-semantic processing. With respect to behavioural performance, the findings provide important constraints while also highlighting the complexity of multilingual decision outcomes. In the accuracy data, performance in L1-related conditions did not yield a uniform group or language advantage that could be interpreted as a simple dominance effect across the entire task. Instead, the most informative result emerged in the interaction structure. In particular, the congruency-related modulation associated with the L2 channel in the L1 Russian group suggests that semantic mismatch in that channel was associated with greater processing difficulty and a higher probability of incorrect responses. This pattern is consistent

with the interpretation that, for this group, mismatch resolution during L2 candidate evaluation is less stable under L3-triggered activation. At the same time, the reaction-time data do not support the presence of a broad group difference in overall speed. The absence of a clear main effect of group in response latency indicates broadly comparable time investment across the two mirror-image profiles, which is consistent with the idea that both groups were able to perform the task efficiently at a general level, while the fine structure of congruency sensitivity depended on language configuration and specific processing constraints (see Figures 6 and 7).

The behavioural modelling also revealed effects involving *verb type*. Given that the verb type was not the primary theoretical target of the dissertation and all verb items were presented in the infinitive to preserve cross-language comparability, these effects must be interpreted cautiously. Nevertheless, the presence of verb-related variance indicates that formal and mnemonic properties of lexical items can contribute meaningfully to behavioural outcomes in translation recognition even under controlled semantic matching. This observation motivates future work in which inflectional form is manipulated more directly, and lexical characteristics are controlled more tightly, so that the role of formal complexity can be evaluated as a systematic factor rather than treated as residual variance.

The electrophysiological evidence provides the most direct neurolinguistic constraint on the interpretation of cross-language activation in the present study. Mean-amplitude analyses in the 400–600 ms interval, corresponding to the canonical N400 time window, revealed robust congruency-related effects in regions consistent with established N400 distributions, particularly within central and posterior midline areas. At the level of L1 candidate processing in both groups, significant effects were observed in comparable regions of interest, notably central middle (CM) and posterior middle (PM), which is consistent with the view that semantic mismatch engages broadly similar meaning-evaluation dynamics in

dominant-language candidate processing across the two mirror-image profiles. Importantly, the pattern became more asymmetric when attention shifted to L2 processing. In one group, the L2 channel showed a congruency response that overlapped with the ROI pattern observed for L1, whereas in the other group the L2 channel displayed reduced differentiation or a less clearly separable congruency signature. This asymmetry indicates that the neurolinguistic expression of semantic mismatch is shaped by language-history configuration and suggests that the system's sensitivity to semantic congruency is not uniformly distributed across the two background languages. In this sense, the results support the conclusion that the trilingual system can exhibit comparable L1-level sensitivity across groups while also showing group-dependent constraints on how effectively L2 candidates are evaluated under L3-triggered activation (see Figure 9).

These patterns make it difficult to maintain a purely associative interpretation of translation recognition in which performance could be explained only by direct word-to-word links. If L3 input were mediated exclusively through lexical association, or if words from the less dominant background language were unable to activate the relevant conceptual representation, then one would not expect systematic congruency-related modulation in the N400 window under conditions that minimise form overlap. Instead, the present findings are more compatible with accounts that assume access to meaning-level representations and competition among translation-relevant candidates, consistent with approaches in which conceptual mediation plays an important role in bilingual lexical architecture (Kroll & Stewart, 1994; Talamas et al., 1999; Kroll et al., 2002). The group-specific pattern is especially informative in this respect. For the L1 Russian group, mixed-effects modelling indicated significant N400 differentiation between congruent and incongruent candidates in the dominant language, but weaker or less reliable differentiation in the second language, suggesting reduced neural sensitivity to semantic mismatch during L2 processing in this

configuration. This profile is consistent with the interpretation that the semantic verification response in this group is more strongly expressed in the dominant channel, whereas the L2 channel is less responsive to congruency under L3-triggered conditions. By contrast, the L1 Kazakh group exhibited a more balanced neurocognitive profile across the two background languages, which may reflect differences in dominance balance, exposure, and everyday language ecology. In practical terms, the data are consistent with the view that the L1 Kazakh group may recruit both background languages more efficiently during meaning evaluation in an L3-triggered setting, whereas the L1 Russian group shows a more asymmetrical organisation in which L2 candidates are less efficiently differentiated from incongruent controls at the processing stage indexed by the N400. A broader theoretical implication of the dissertation is that the degree and direction of background-language involvement during L3 processing are shaped by learning history and system configuration, rather than being reducible to a single universal supplier language. Research on third language acquisition has long debated whether cross-language influence is preferentially sourced from L1 or from L2, and whether one background language operates as a default provider of transfer or interference. Some studies have reported strong L1 effects in particular domains, including lexicon and morphosyntax, whereas others have argued for a privileged role of L2, consistent with the *L2 Status Factor*, especially where L2 and L3 share learning contexts, age-of-acquisition profiles, and metalinguistic routines (Ringbom, 1987; Hammarberg, 2001; Bardel & Falk, 2007; Falk & Bardel, 2011; Bardel & Falk, 2012). More recent frameworks challenge any simple hierarchy by proposing that cross-language influence can draw on the full repertoire in a property-specific manner, as in accounts that emphasise structural proximity, cumulative access, or representational availability (Slabakova, 2017; Westergaard et al., 2017; Westergaard, 2019). The present dissertation contributes to these debates by showing that the neurolinguistic signature of cross-language activation is sensitive to system configuration

consistent with an *experience-weighted architecture*. The data support the position that both background languages can be co-activated during L3-triggered semantic evaluation, but that the functional consequences of co-activation depend on how strongly and directly the system can map between lexical forms and shared conceptual representations across languages. One of the central interpretive contributions of the dissertation is the proposal that *mirror-image trilingual configurations* can differ in the efficiency of semantic access routes under L3-triggered processing, producing two distinguishable functional profiles. In this context, the conceptual distinction developed in the dissertation between “*forked*” and “*roundabout*” access may serve as a compact explanatory summary of the mirror-image contrast (Zhaksylykkyzy et al., 2026). The findings are consistent with the interpretation that when learning sequence and system configuration yield relatively transparent access routes across the background languages in relation to L3, the system may operate in a way resembling a *forked route*, in which L3-triggered conceptual activation supports efficient recruitment of both background languages and permits clearer differentiation between congruent translations and incongruent controls within the N400 window. Conversely, when the functional distance is greater and the L2 channel is less transparent relative to the dominant route, the system may resemble a *roundabout access pattern*, in which L3-triggered processing does not consistently support efficient L2 differentiation and may rely more strongly on mediation through the dominant language. In this sense, the present findings are consistent with the view that the observed behavioural imbalance between congruent and incongruent candidates reflects the interaction of language distance, learning sequence, and system-level weighting during translation recognition.

The dissertation also builds on classic work concerning lexical organisation and the relationship between lexical connections and conceptual mediation. Potter et al. (1984) articulated a framework for distinguishing lexical and conceptual involvement in bilingual

processing, while earlier accounts such as Weinreich (1953) described bilingual lexical structures associated with learning contexts in which one language is acquired with the assistance of another. Within the interpretive framework adopted here, the mirror-image contrast is consistent with the possibility that one learning sequence fosters stronger integration of L3 into a shared conceptual network with more direct access across languages, whereas the other sequence yields weaker direct links between the two non-dominant systems, thereby reducing facilitation and weakening congruency differentiation in the L2 channel. Under this interpretation, the L1 Russian group's reduced L2 differentiation in the N400 window is consistent with a profile in which L2 receives less effective activation during L3-triggered processing and in which conceptual verification in L2 is less robust under conditions of mismatch, potentially reflecting weaker direct connectivity and greater reliance on dominant-language mediation (cf. Gollan et al., 2005). By contrast, the L1 Kazakh group shows a pattern more compatible with parallel activation of semantic representations across the two background languages, in line with evidence supporting non-selective access and parallel activation in bilingual processing more broadly (Grainger & Beauvillain, 1987; Beauvillain, 1992; Grainger & Dijkstra, 1992; Grainger, 1993; Li, 1996; Spivey & Marian, 1999; Marian & Spivey, 2003). Taken together, the dissertation provides converging evidence that trilingual translation recognition engages *meaning-level evaluation*, and that cross-language activation is expressed not only in behavioural outcomes but also in time-resolved neural markers of semantic mismatch. At the same time, the results indicate that co-activation does not imply uniform efficiency across all channels. Rather, the system's ability to differentiate congruent translations from incongruent controls in the N400 window may be modulated by learning sequence, dominance balance, and the strength of conceptual mapping in the L2 channel. While participants were broadly comparable in educational background and English proficiency, the absence of direct standardised proficiency testing, detailed language-

of-instruction histories, and measures of cognitive individual differences, such as working memory, constrains the strength of causal inference. These limitations mean that group differences cannot be attributed exclusively to acquisition order or language distance without careful qualification. Future work should therefore incorporate standardised language assessments, richer language-history documentation, and cognitive profiling to strengthen the explanatory resolution of neurolinguistic differences across mirror-image trilingual profiles.

In conclusion, the dissertation supports the claim that the congruency imbalance observed in translation recognition reflects an experience-weighted lexico-semantic architecture shaped by language distance and learning sequence. Where L2 is relatively less transparent, and the functional distance between L3 and the background languages is greater, the system may show a *roundabout* profile, characterised by reduced differentiation of L2 translation equivalents from incongruent controls during L3-triggered processing. Where system configuration yields more transparent mapping and stronger integration across the repertoire, the system may show a *forked* profile, supporting clearer N400 differentiation and more efficient semantic verification across the two background languages. A particular strength of the dissertation lies in the language combination examined. Kazakh, Russian, and English differ substantially in typology, morphological structure, and sociolinguistic status, thereby providing a valuable testing ground for models of multilingual lexical access that have largely been developed on more closely related language pairs. The study is necessarily constrained by sample size and group balance, and the findings should therefore be treated as theoretically informative and methodologically demonstrative rather than strictly confirmatory. Nevertheless, the consistent N400 modulations observed here demonstrate the feasibility and value of neurolinguistic investigation of trilingual processing in under-researched populations and provide a foundation for larger follow-up studies aimed at refining models of cross-linguistic influence and multilingual lexico-semantic organisation.

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APPENDIX A

Experimental Stimulus List

№	English verbs	Kazakh	Kazakh	Russian	Russian
		Congruent	Incongruent	Congruent	Incongruent
		Translation	Translation	Translation	Translation
1	come	келу	көшу	приходить	пугать
2	find	табу	тасу	находить	нарушать
3	drink	ішу	ілу	пить	петь
4	let	рұқсат беру	ретсіз кіру	разрешать	расстилать
5	hit	ұру	ұту	ударить	удалять
6	broadcast	баяндау	бағдарлау	вещать	вешать
7	show	көрсету	көтеру	показывать	покалывать
8	wet	ылғалдандыру	ыңғайсыздану	увлажнять	уважать
9	smell	иіскеу	иіру	нюхать	нудить
10	leave	қалдыру	қолдану	оставить	отдавать
11	learn	оқу	ою	учить	усечь
12	catch	ұстап алу	ұштастыру	ловить	ладить
13	burst	жарылу	жабылу	лопнуть	лопать
14.	know	білу	бүру	знать	зреть
15	say	айту	аңду	сказать	скакать
16	ring	шырылдау	шырыштау	звонить	зубрить
17	take	алу	ашу	взять	врать
18	mow	ору	орау	косить	копить
19	knit	тоқу	толу	вязать	вянуть
20	quit	тастау	тосу	бросать	бродить

№	English verbs	Kazakh	Kazakh	Russian	Russian
		Congruent	Incongruent	Congruent	Incongruent
		Translation	Translation	Translation	Translation
21	wear	кию	күлу	носить	нежить
22	hear	есту	есу	слушать	служить
23	grow	өсу	өлу	расти	рассечь
24	slide	сырғанау	сыбырлау	скользить	скрепить
25	sell	сату	сақтау	продавать	помогать
26	swell	ісіну	іздену	распухать	раскрывать
27	sing	өлең айту	өкпе айту	петь	пасть
28	tear	жырту	жығу	разрывать	разбивать
29	shear	қырку	қысу	стричь	счесть
30	lose	жоғалту	жорғалау	терять	терпеть
31	slit	кесу	кету	разрезать	разделить
32	recast	түрлендіру	түрегелу	видоизменять	владычествовать
33	feed	тамақтандыру	тұрақтандыру	кормить	корчить
34	creep	еңбектеу	егелеу	ползти	потеть
35	steal	ұрлау	ұштау	красть	крыть
36	underbid	бағаны төмендету	баяндама тапсыру	сбивать цену	сброшюровать
37	seek	іздеу	ілу	искать	испечь
38	saw	аралау	арлану	пилить	плакать
39	get	алу	азу	получить	приучать
40	sew	тігу	тізу	шить	жить
41	sink	бату	бағу	тонуть	терпеть

№	English verbs	Kazakh	Kazakh	Russian	Russian
		Congruent	Incongruent	Congruent	Incongruent
		Translation	Translation	Translation	Translation
42	run	жүгіру	жеткізу	бежать	белить
43	go	жүру	жету	идти	играть
44	spend	өткізу	өтіну	тратить	травить
45	lie	жату	жамау	лежать	легчать
46	cast	лақтыру	лапылдау	кидать	кивать
47	dream	армандау	арқалау	мечтать	молчать
48	shut	жабу	жату	закрывать	задавать
49	begin	бастау	баптау	начать	нажать
50	inset	қондыру	қостыру	вставлять	вставать
51	break	сындыру	секіру	сломать	создать
52	sleep	ұйықтау	ұмыту	спать	спечь
53	win	жеңу	жегу	выиграть	выявлять
54	throw	тастау	таптау	бросить	бродить
55	upset	ренжіту	рухтану	огорчать	ограждать
56	outbid	қайта сатып алу	қарсылық таныту	перекупать	перечитать
57	sweep	сыпыру	сұрыптау	подметать	потребить
58	fall	құлау	құрау	падать	палить
59	spread	тарату	түсіну	распространять	регистрировать
60	have	ие болу	икемдену	иметь	издать
61	burn	жағу	жұту	жечь	жать
62	build	құрастыру	құшақтасу	строить	спилить

№	English verbs	Kazakh	Kazakh	Russian	Russian
		Congruent	Incongruent	Congruent	Incongruent
		Translation	Translation	Translation	Translation
63	cost	тұру баға	тығу	стоять	строчить
64	see	көру	көктеу	видеть	витать
65	stand	тұру	тұлеу	стоять	стрелять
66	wed	үйлену	үйрену	жениться	жертвовать
67	cut	кесу	керу	резать	решать
68	bite	тістеу	тыстау	кусать	кутить
69	bend	бүгілу	бөлісу	согнуть	собрать
70	reset	қайта орнату	құпия сақтау	вправлять	вписать
71	split	жару	жаттау	колоть	корать
72	spoil	бүлдіру	бекіну	портить	познать
73	hew	шабу	шағу	рубить	решать
74	forecast	болжамдау	бекемдеу	прогнозировать	пронумеровать
75	overcast	бүркену	бүлдіру	покрыться	погреться
76	make	жасау	жару	делать	делить
77	keep	сақтау	санау	хранить	храпеть
78	sweat	терлеу	торлау	потеть	потечь
79	shed	төгу	тебу	пролить	пробить
80	rid	құтылу	құрғату	избавляться	избаловать
81	feel	сезу	сыру	чувствовать	чествовать
82	thrust	итеру	игеру	толкать	топтать
83	swim	жүзу	жұту	плавать	плавить
84	spit	түкіру	түсіру	плевать	пачкать

№	English verbs	Kazakh	Kazakh	Russian	Russian
		Congruent	Incongruent	Congruent	Incongruent
		Translation	Translation	Translation	Translation
85	think	ойлау	оқтау	думать	дубить
86	bust	бұзу	безу	взломать	взвесить
87	dig	қазу	қосу	копать	коптеть
88	sow	себу	септеу	сеять	сереть
89	fit	сәйкес келу	сықылықтау	ссоответствовать	совершенствовать
90	blow	үрлеу	үсу	дуть	драть
91	hurt	жаралау	жалығу	ранить	родить
92	strew	шашу	шалу	сыпать	сыскать
93	spring	секіру	сепкілеу	прыгнуть	прыснуть
94	bet	бәстесу	бекіту	держать пари	деревенеть
95	hold	ұстау	ұрлау	держать	дергать
96	telecast	тарату	тоқтату	передавать	переделывать
97	forget	ұмыту	ұмтылу	забыть	зевать
98	choose	таңдау	тоқтау	выбрать	воевать
99	set	орнату	отыру	устанавливать	усиливаться
100	earn	табыс табу	таныс табу	зарабатывать	зарумянивать
101	fight	күресу	керілу	драться	дуться
102	offset	ығыстыру	ынталану	сместать	сменить
103	beset	қоршау	қорғау	окружать	окрылять
104	hide	тығылу	таңырқау	прятать	прыснуть
105	buy	сатып алу	сарғылттану	купить	кутать

APPENDIX B

Participant Information Sheet and Informed Consent Form for Participation in a Neurolinguistic Study (English Translation and Original Kazakh and Russian Versions Used in the Study)

Dear participant,

This experiment is conducted to examine the language skills of trilingual speakers.

The restrictions for participation in this study are as follows:

- presence of neurological disorders, including epilepsy, seizure syndrome, schizophrenia, psychosis, or other relevant conditions;
- use of psychoactive medication within two weeks before participation;
- in case of visual impairment, optical correction is required, such as corrective glasses, contact lenses, or other vision-correction aids.

Study procedure

After reading the aims of the study and signing the informed consent form, you will be invited to the Brain Institute of Al-Farabi Kazakh National University to participate in the study, which consists of two parts.

Part 1. Interview

You will be asked to answer several questions.

Part 2. EEG recording during a computer-based cognitive task

The second part of the study involves completing a computer-based task while EEG is recorded simultaneously. EEG recording will be carried out using equipment produced by the Russian company Neurosoft. This equipment is completely safe for your health.

Confidentiality of the data obtained from you

Confidentiality of the study is guaranteed. Access to the research data, coded by numerical identifiers, will be available only to the research team listed below. Each participant may receive only the results of their own participation.

Right to withdraw from the study

Your participation is voluntary, and you may withdraw from the study at any stage without consequences. The researchers also have the right to exclude you from the study at any stage if you violate the study instructions.

We invite you to participate in this neurolinguistic study.

Registration for participation in the study is available by phone: +7XXXXXXXXXX

CONSENT TO PARTICIPATE IN A SCIENTIFIC STUDY

Dear participant,

This experiment is conducted to assess the language skills of trilingual speakers. It is anonymous and conducted strictly for scientific purposes. Participation in the study is voluntary.

Please read the information provided about the experiment carefully. If you have any questions, please ask the experimenter before the experiment begins. Following this, please provide your personal details to confirm your consent to participate in the experiment.

1. I confirm that I have read and understood the information about the experiment being conducted.
2. I understand that my participation is voluntary and that I have the right to withdraw at any time without giving a reason.
3. I agree to participate in the study described above.
4. I understand that my data will be used for scientific research purposes and will be deleted after the completion of the study.

5. I agree that the obtained results may be used in scientific publications.

Full name

Signature

_____ Date: _____

Phone number

Note: The results of the assessment may be provided to you upon request after the completion of the study or as your data are being processed.

If you have any questions, you may contact:

1. Zhaksylykkyzy Karlygash

Email: zhaksylykkyzy.k@kaznu.kz

Tel.: +7 XXX XXXXXX

НЕЙРОЛИНГВИСТИКАЛЫҚ ЗЕРТТЕУГЕ ҚАТЫСУҒА АРНАЛҒАН АҚПАРАТТЫҚ ПАРАҚ ЖӘНЕ АҚПАРАТТАНДЫРЫЛҒАН КЕЛІСІМ

Құрметті зерттеуге қатысушы,

Бұл эксперимент үштілді тұлғалардың тілдік дағдыларын анықтау мақсатында жүргізіледі.

Осы зерттеуге қатысуға қойылатын шектеулер:

- неврологиялық аурулар, оның ішінде эпилепсия, құрысу синдромы, шизофрения, психоздар немесе басқа да тиісті жағдайлар;
- зерттеуге қатысудан екі апта бұрын психоактивті препараттарды қолдану;
- көру қабілетінде мәселелер болған жағдайда көруді түзетуге арналған оптикалық құралдарды, мысалы, түзетуші көзілдірік, линза немесе басқа да түзету құралдарын пайдалану қажет.

Зерттеуді жүргізу тәртібі

Зерттеудің мақсаттарымен танысып, зерттеуге қатысуға арналған ақпараттандырылған келісімге қол қойғаннан кейін, Сіз әл-Фараби атындағы Қазақ ұлттық университетінің Ми институтына зерттеуге қатысу үшін шақырыласыз. Зерттеу екі бөлімнен тұрады.

1-бөлім. Сұхбат

Сізге бірнеше сұраққа жауап беру қажет болады.

2-бөлім. Компьютерлік когнитивтік тапсырманы орындау кезіндегі ЭЭГ жазбасы

Зерттеудің екінші бөлімі компьютерлік тапсырманы орындаудан және осы уақытта ЭЭГ жазбасын синхронды түрде жүргізуден тұрады. ЭЭГ жазбасы ресейлік «Нейрософт» фирмасының аппараты арқылы жүргізіледі. Бұл аппарат Сіздің денсаулығыңыз үшін толық қауіпсіз.

Сізден алынған деректердің құпиялылығы

Зерттеудің құпиялылығы кепілдендіріледі. Реттік нөмірлермен кодталған зерттеу деректеріне тек төменде көрсетілген зерттеушілер тобы ғана қол жеткізе алады. Әрбір қатысушы тек өзінің зерттеу нәтижелерін ала алады.

Зерттеуге қатысудан бас тарту құқығы

Сіздің қатысуыңыз ерікті сипатқа ие, және Сіз зерттеудің кез келген кезеңінде ешқандай салдарсыз қатысудан бас тарта аласыз. Сондай-ақ, зерттеу нұсқаулықтарын бұзған жағдайда, зерттеушілер Сізді зерттеудің кез келген кезеңінде зерттеуден шығару құқығына ие.

Сізді нейролингвистикалық зерттеуге қатысуға шақырамыз.

Зерттеуге қатысуға жазылу телефоны: +7 XXXXXXXXXX

ҒЫЛЫМИ ЗЕРТТЕУГЕ ҚАТЫСУҒА АРНАЛҒАН КЕЛІСІМ

Құрметті экспериментке қатысушы,

Бұл эксперимент үштілді тұлғалардың тілдік дағдыларын анықтау мақсатында жүргізіледі. Эксперимент анонимді түрде және тек ғылыми мақсатта өткізіледі.

Зерттеуге қатысу ерікті болып табылады.

Эксперимент туралы ұсынылған ақпаратпен мұқият танысып шығыңыз. Егер Сізде сұрақтар туындаса, эксперимент басталғанға дейін оларды эксперимент жүргізушіге қоюыңызға болады. Осыдан кейін экспериментке қатысуға келісіміңізді растау үшін жеке деректеріңізді толтыруыңызды сұраймыз.

Мен жүргізілетін эксперимент туралы ақпаратпен танысқанымды растаймын.

Менің қатысуым ерікті екенін және кез келген уақытта себеп түсіндірмей зерттеуден бас тартуға құқығым бар екенін түсінемін.

Мен жоғарыда сипатталған зерттеуге қатысуға келісемін.

Менің деректерім ғылыми зерттеу мақсатында пайдаланылатынын және зерттеу аяқталғаннан кейін жойылатынын түсінемін.

Алынған нәтижелердің ғылыми жарияланымдарда пайдаланылуына келісім беремін.

Аты-жөні

Қолы

_____ Күні: _____

Телефон нөмірі

Ескерту: Жүргізілген зерттеу нәтижелері Сіздің қалауыңыз бойынша зерттеу толық аяқталғаннан кейін немесе деректеріңіз өңделген соң ұсынылуы мүмкін.

Сұрақтар туындаған жағдайда төмендегі байланыс деректері бойынша хабарласуға болады:

1. Жақсылыққызы Қарлығаш, МА

Email: zhaksylykkyzy.k@kaznu.kz

Тел.: +7 XXX XXXXXX

ИНФОРМАЦИОННЫЙ ЛИСТ О СОГЛАСИИ НА УЧАСТИЕ В НЕЙРОЛИНГВИСТИЧЕСКОМ ИССЛЕДОВАНИИ

Уважаемый участник эксперимента, данный эксперимент проводится с целью определения языковых навыков трилингвов.

Ограничениями в принятии участия в данном исследовании являются следующие:

- наличие неврологических заболеваний (эпилепсия, судорожный синдром, шизофрения, психозы или др.);
- применение психоактивных препаратов за 2 недели до участия;
- при наличии проблем со зрением необходимы оптические аксессуары для коррекции зрения (корректирующие очки, корректирующие линзы и др.);

Процедура проведения исследования

После ознакомления с целями нашего исследования и подписания согласия на участие в исследовании Вы будете приглашены в Институт Мозга КазНУ им. аль-Фараби, на начало исследования в двух частях:

Часть 1. Интервью

Вам необходимо будет ответить на несколько вопросов.

Часть 2. ЭЭГ запись при выполнении компьютерной когнитивной задачи

Вторая часть исследования заключается в выполнении компьютерной задачи с синхронной записью ЭЭГ. Запись ЭЭГ будет проводиться на аппарате российской фирмы «Нейрософт». Данный аппарат является полностью безопасным для Вашего здоровья.

Конфиденциальность полученных от вас данных

Конфиденциальность исследования гарантирована. Доступ к кодированным порядковой нумерацией данным исследования будут иметь только нижеуказанная

группа исследователей. Каждый участник может получить только результаты своего исследования.

Права на отказ от исследования

Ваше участие носит добровольный характер, и Вы можете отказаться от участия в исследовании на любом из его этапов без каких-либо последствий. Исследователи имеют также право исключить Вас из исследования на любом из его этапов в случае нарушения Вами инструкций исследования.

Приглашаем Вас принять участие в нейролингвистическом исследовании.

Запись на участие в исследовании производится по телефонам: + 7XXXXXXXXXX

СОГЛАСИЕ НА УЧАСТИЕ В НАУЧНОМ ИССЛЕДОВАНИИ

Уважаемый участник эксперимента, данный эксперимент проводится с целью определения языковых навыков трилингвов. Данный эксперимент проводится анонимно, в сугубо научных целях. Участие в исследовании добровольное.

Внимательно ознакомьтесь с предоставленной Вам информацией об эксперименте.

Если у Вас возникли вопросы, задайте их экспериментатору до начала эксперимента.

После того просим заполнить ваши данные о согласии на участие в эксперименте.

1. Я подтверждаю, что я ознакомлен(-а) с информацией о проводимом эксперименте;
2. Я понимаю, что мое участие является добровольным и что я имею право уйти в любое время без объяснения причин;
3. Я согласен участвовать в описанном выше исследовании;
4. Я ознакомлен(-а) с тем, что мои данные будут использованы в научном исследовании и будут удалены, после завершения исследования;
5. Я согласен на использование полученных результатов в научных публикациях.

ФИО _____ Подпись _____

Номера телефона _____ Дата: _____

Примечание: Результаты проведенного обследования по Вашему желанию будут предоставлены Вам по завершении исследования (или по мере обработки Ваших данных).

В случае возникновения вопросов можно обращаться по следующим контактам:

1. Жақсылыққызы Қарлығаш

Email: zhaksylykkyzy.k@kaznu.kz ;

Tel: +7 XXX XXXXXX

APPENDIX C

Ethics Approval Documents

«ӘЛ-ФАРАБИ АТЫНДАҒЫ ҚАЗАҚ ҰЛТТЫҚ УНИВЕРСИТЕТІ» КОММЕРЦИЯЛЫҚ ЕМЕС АКЦИОНЕРЛІК ҚОҒАМЫ ҒЫЛЫМ ЖӘНЕ ИННОВАЦИЯЛЫҚ ҚЫЗМЕТ ЖӨНІНДЕГІ ДЕПАРТАМЕНТІ ЖЕРГІЛІКТІ ЭТИКАЛЫҚ КОМИТЕТ	 ЖЭК ЛЭК	НЕКОММЕРЧЕСКОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО «КАЗАХСКИЙ НАЦИОНАЛЬНЫЙ УНИВЕРСИТЕТ ИМЕНИ АЛЬ-ФАРАБИ» ДЕПАРТАМЕНТ ПО НАУКЕ И ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ ЛОКАЛЬНЫЙ ЭТИЧЕСКИЙ КОМИТЕТ
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От 20.05.25 № 119
На № _____ от _____

Одобрение Локального Этического Комитета

Протокол № IRB-A843
(IRB00010790 al-Farabi Kazakh National University IRB #1)

Название исследовательского проекта: **«Развитие интегративных научных исследований по нейронауке»**
Дата одобрения: 20.05.2025 г.
Дата завершения одобрения: 19.05.2026г.

20 мая 2025 г. на заседании Локального Этического комитета КазНУ имени аль-Фараби был рассмотрен отчет проекта **«Развитие интегративных научных исследований по нейронауке»**, подготовленный сотрудниками Казахского Национального университета имени аль-Фараби в рамках конкурса на программно-целевое финансирование по научным, научно-техническим программам на 2024-2026 годы по приоритетному направлению 5. «Наука о жизни и здоровье», пункт 8. «Нейронаука», научный руководитель – PhD Жолдасова М.К. После изучения представленных документов было принято решение продлить одобрение данного проектного исследования.

Исследователи обязаны информировать Локальный Этический Комитет о любых предполагаемых изменениях в протоколе заранее и предоставлять необходимые документы для рассмотрения, за исключением тех случаев, когда подобные изменения необходимы для немедленного предотвращения вреда для участников исследования. О любых серьезных и неожиданных неблагоприятных событиях или других осложнениях, представляющих риск для субъектов исследования, должно быть доложено Локальному Этическому Комитету в кратчайшие сроки.

Заявки на продление одобрения вместе с отчетом о проделанной работе за минувший период действия одобрения должны подаваться за 30 дней до даты истечения срока одобрения данного исследования.

Председатель ЛЭК




Усатаева Г.М.

000590

«ӘЛ-ФАРАБИ АТЫНДАҒЫ
ҚАЗАҚ ҰЛТТЫҚ УНИВЕРСИТЕТІ»
КОММЕРЦИЯЛЫҚ ЕМЕС АКЦИОНЕРЛІК ҚОҒАМЫ

ҒЫЛЫМ ЖӘНЕ ИННОВАЦИЯЛЫҚ
ҚЫЗМЕТ ЖӨНІНДЕГІ ДЕПАРТАМЕНТІ
ЖЕРГІЛІКТІ ЭТИКАЛЫҚ КОМИТЕТ



НЕКОММЕРЧЕСКОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО
«КАЗАХСКИЙ НАЦИОНАЛЬНЫЙ
УНИВЕРСИТЕТ ИМЕНИ АЛЬ-ФАРАБИ»

ДЕПАРТАМЕНТ ПО НАУКЕ
И ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ
ЛОКАЛЬНЫЙ ЭТИЧЕСКИЙ КОМИТЕТ

От 30.04.2026 № 823

На № 823 от 30.04.26

Conclusion of the Local Ethics Committee

1	Full name of PhD student	Zhaksylykkyzy Karlygash
2	Specialty (educational programme) of doctoral studies	8D02303 – Linguistics
3	Period of Doctoral Studies (PhD Programme)	2019-2022
4	Thesis Title and Date of Approval	Neurolinguistics of trilingualism: markers of lexico-semantic processing in cross-language interaction, 06.04.2026
5	Information about scientific supervisors — Full Name (if applicable), position and place of employment, academic degree, and citizenship	Ibrayeva Zhanar Kulmatovna, Doctor of Philology, Associate Professor at Al-Farabi Kazakh National University, the Republic of Kazakhstan Kustubayeva Almira Melsovna, Candidate of Biological Sciences, Professor at Al-Farabi Kazakh National University, the Republic of Kazakhstan Holly Myers, PhD, Professor at the University of Delaware, USA
6	Research objects	the processes of cross-language interaction and lexico-semantic processing under conditions of trilingualism, based on Kazakh, Russian, and English
7	Violations during the planning, evaluation, selection, and conduct of research	No violations identified
8	Violations during the dissemination of research results	No violations identified
9	How were the rights, safety, and well-being of the research objects protected (in the case of living organisms and the environment)?	There were no wildlife or habitat objects in the study
10	Absence or presence of the use of artificial intelligence technologies in the preparation of the dissertation research	No artificial intelligence technologies were used in the preparation of the dissertation research
11	Approval number	IRB – A2030
12	Date of research approval	23.04.2026

Chair of LEC



[Signature]

G. Ussatayeva

Secretary of LEC

[Signature]

S. Madiyev