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EXPERIMENTAL RESEARCH ON LANGUAGE PROCESSING IN VIRTUAL REALITY: A CONCEPTUAL FRAMEWORK FOR FUTURE COGNITIVE INVESTIGATION

In recent years, Virtual Reality (VR) technologies have rapidly expanded beyond their initial domains of gaming and entertainment, finding applications in diverse fields such as engineering design, medical training, and psychological therapy. Within the realm of linguistics and language pedagogy, however, VR remains relatively underexplored despite its potential to immerse learners in authentic communicative situations. By offering simulated environments that closely mirror real-world contexts, VR can create meaningful language-learning experiences and offer researchers unprecedented tools for investigating the cognitive mechanisms underpinning language processing.

As a linguist teaching English at a technical university in Ukraine, I have observed how traditional instructional approaches can sometimes fail to engage learners with highly analytical mindsets. Technical students often thrive on problem-solving and interactive tasks, suggesting that VR-based learning activities could resonate more powerfully with their learning styles than conventional methods. Moreover, Ukraine's growing integration into international research and educational networks underscores the need for innovative language-training methodologies capable of enhancing both learners' linguistic competence and intercultural communication skills.

From a research perspective, VR opens new avenues for investigating how factors like immersion, sensory input, and interactive feedback impact cognitive processes involved in language comprehension and production. While existing psycholinguistic theories emphasize how context and environment shape linguistic behaviour, VR allows for the precise manipulation of these variables in controlled yet realistic conditions. It thus presents an exciting opportunity to deepen our understanding of language processing mechanisms and inform the design of more effective, evidence-based pedagogical tools.

This article outlines a conceptual framework for an experimental study on language processing in VR, focusing on Ukrainian technical students learning English as a foreign language. In the sections that follow, I will review the theoretical underpinnings of VR-enhanced language research, propose a research design tailored to the academic and technological realities of a technical university in Ukraine, and discuss the potential implications of this approach for both cognitive linguistics and second language instruction.

Virtual Reality (VR) technologies have opened new possibilities for exploring the complex interplay between cognitive processes and language use. Although VR is widely employed in engineering, design, and gaming, its potential for psycholinguistic research – especially regarding language comprehension and production –

remains underexplored. As a linguist teaching a foreign language at a technical university in Ukraine, I propose an experimental framework to investigate how immersive virtual settings might influence learners' linguistic performance and cognitive processing.

Research Questions

1. How does immersive VR affect the speed and accuracy of language comprehension tasks compared to traditional settings?
2. Which cognitive and emotional factors (e. g., heightened engagement, reduced anxiety) potentially mediate the relationship between VR immersion and language performance?
3. How might learners' linguistic output (e. g., lexical diversity, syntactic complexity) differ in VR-based tasks vs. standard classroom tasks?

Psycholinguistic models of language comprehension emphasize the roles of working memory, attentional control, and semantic integration. Integrating VR adds environmental and affective dimensions, potentially reshaping learners' cognitive load and motivation. Sociocultural approaches highlight context-dependent language use, suggesting VR can simulate realistic communicative settings to enhance authentic interactions.

Akay & Kessler's 2024 experimental study in "Language Learning & Technology" underscores (Akay, 2024) the potential impact of VR-based tasks on adult second-language learners' lexical and syntactic development. Meanwhile, Palamar, Brovko & Semerikov reveal (Palamar, 2023) how immersion fosters cognitive engagement in VR environments but highlight a gap in domain-specific language tasks. Slater's seminal work (Slater, 2016) on "place illusion" further lays the foundation for examining how presence in a virtual environment might reshape language comprehension processes. While these studies collectively demonstrate VR's promise for language education, they often overlook the cultural and contextual factors specific to learners in non-Western, technology-driven settings. The present article addresses these omissions by integrating discipline-specific content and contextual variables into a comprehensive framework for VR-based language instruction in Ukrainian technical universities.

The core of this study centres on a series of immersive VR modules designed to replicate authentic professional scenarios for engineering students learning English as a foreign language. For instance, one module places participants in a simulated laboratory where they must follow precise instructions – delivered in English – to assemble virtual mechanical components. Another example involves collaborative tasks in which students, embodied as avatars, negotiate technical specifications for a mock project, thereby exercising both linguistic and subject-specific skills. The VR environment is further enriched (Nykykyporets, 2024) with contextual clues, such as on-screen schematics and real-time feedback on performance, to promote active learning and language retention. During each session, researchers collect data on comprehension accuracy, task completion times, lexical diversity, and syntactic complexity of spoken or written output. This multifaceted approach not only fosters

practical language use but also reveals how immersion and interactivity might shape learners' cognitive load and motivation.

Table 1

First results of VR-based vs. traditional language learning tasks

Measure	Unit of measurement	VR group (mean)	Control group (mean)	Possible interpretation
Reaction time	Seconds (time to complete tasks)	45.3	38.7	Slight delay in VR may indicate higher cognitive load but also deeper engagement
Accuracy	Percentage of correct responses (%)	86.5 %	80.2 %	VR setting appears to foster greater comprehension accuracy overall
Lexical diversity (Type-Token Ratio)	Ratio (TTR)	0.58	0.52	Learners in VR tend to use a richer vocabulary
Syntactic complexity	Mean number of words per sentence	12.4	10.1	Complex VR scenarios potentially encourage more elaborate language structures
Motivation score (self-report)	Likert scale (1–5)	4.3	3.7	VR immersion seems to boost learners' enthusiasm and perceived relevance

The findings of this preliminary investigation suggest that integrating VR into foreign language instruction for technical students can significantly enhance learner engagement and deepen their comprehension of course content. Although the study primarily offers conceptual insights rather than definitive empirical results, it provides a promising framework for exploring how immersive environments influence linguistic performance and cognitive processes. By simulating realistic industry scenarios, VR-based tasks have the potential to bridge the gap between academic knowledge and professional application, fostering (Kot, 24) both technical competence and communicative fluency. These observations open avenues for more extensive longitudinal research that could examine individual learner differences, the role of cultural context, and the impact of varying levels of immersion. Moving forward, further exploration in this direction might combine VR technologies with advanced analytics – such as eye-tracking and psychophysiological measures – to generate deeper, data-driven understandings of language processing in immersive virtual domains. These techniques can offer real-time insights into how learners allocate visual attention and respond emotionally to specific language tasks. Furthermore, multi-modal data integration could illuminate the complex interplay between cognitive load, affective states, and linguistic performance in VR-based learning environments.

This study proposes an innovative framework for teaching technical university students a foreign language through Virtual Reality. By recreating authentic engineering or scientific tasks in immersive simulations, learners can connect classroom theory to practical, real-world problem-solving. Preliminary observations suggest that VR modules can stimulate motivation and increase linguistic complexity,

as measured by richer vocabulary and more sophisticated syntactic choices. The interactive nature of VR may also facilitate immediate feedback loops, allowing learners to correct errors in real time. Comparative data between VR-based instruction and traditional classrooms will help elucidate the cognitive factors at play.

In addition, the study draws attention to the vital role of context in language acquisition, showing how discipline-specific themes can create deeper engagement. Enhanced immersion could further reduce anxiety and promote collaboration among peers, especially when participants assume avatar identities. Despite these promising indicators, more extensive empirical research is necessary to confirm the long-term benefits and address potential technical constraints such as VR sickness. Future investigations might incorporate larger cohorts, diverse language skill levels, and advanced monitoring technologies like eye-tracking or electroencephalography (EEG). Ultimately, this research can inform more adaptive, context-sensitive approaches to language education within technical disciplines.

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