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CRITICAL PERIOD HYPOTHESIS AND AGE-RELATED LANGUAGE ACQUISITION: A COMPARATIVE NEUROCOGNITIVE ANALYSIS

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Abstract: This article examines the neurocognitive mechanisms underlying language acquisition in children and adults through comparative analysis of contemporary research. The study explores neuroplasticity differences, cognitive processing strategies, and the critical period hypothesis framework. The findings support a nuanced understanding of age-related constraints in language learning, emphasizing the interaction between biological maturation and cognitive development.

Keywords: language acquisition, critical period hypothesis, neuroplasticity, explicit learning, neurocognitive mechanisms, L1 acquisition, L2 acquisition

Аннотация: В данной статье рассматриваются нейрокогнитивные механизмы, лежащие в основе освоения языка детьми и взрослыми, посредством сравнительного анализа современных исследований. В исследовании рассматриваются различия в нейропластичности, стратегии когнитивной обработки и гипотеза критического периода. Полученные результаты подтверждают детальное понимание возрастных ограничений в освоении языка, подчеркивая взаимодействие между биологическим созреванием и когнитивным развитием.

Ключевые слова: освоение языка, гипотеза критического периода, нейропластичность, эксплицитное обучение, нейрокогнитивные механизмы, освоение первого языка (L1), освоение второго языка (L2)

Annotatsiya: Ushbu maqola bolalar va o’smirlardagi tillarni o'zlashtirishning neyrokognitiv mexanizmlarini joriy tadqiqotlarning qiyosiy tahlili orqali ko'rib chiqadi. Tadqiqot neyroplastiklik, kognitiv qayta ishlash strategiyalari va tanqidiy davr gipotezasidagi farqlarni o'rganadi. Natijalar biologik yetuklik va kognitiv rivojlanish o'rtasidagi o'zaro ta'sirni ta'kidlab, tilni o'zlashtirishdagi yoshga bog'liq cheklovlarni batafsil tushunishni ko.

Kalit so'zlar: tilni o'zlashtirish, tanqidiy davr gipotezasi, nevroplastiklik, aniq o'rganish, neyrokognitiv mexanizmlar, birinchi tilni (L1) o'zlashtirish, ikkinchi tilni (L2) o'zlashtirishni ko’rsatadi.

INTRODUCTION

Language acquisition represents one of the most complex cognitive achievements in human development, with marked differences observed between child and adult learners. The critical period hypothesis, originally proposed by Penfield and Roberts and later refined by Lenneberg, posits that there exists a biologically determined window during which language acquisition occurs most efficiently [1]. This hypothesis has generated substantial debate within neurolinguistics and cognitive psychology, with contemporary research revealing increasingly sophisticated understandings of the neural and cognitive mechanisms differentiating child and adult language learning [2]. Children acquire their first language with remarkable ease and uniformity, achieving native-like proficiency without explicit instruction, whereas adults learning second languages typically exhibit variable outcomes and rarely achieve native-like competence despite conscious effort [3]. These observations raise fundamental questions about the nature of language learning mechanisms across the lifespan.

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METHODOLOGY AND LITERATURE REVIEW

This study employs a comprehensive literature review methodology, analyzing peer-reviewed research from neurolinguistics, cognitive psychology, and developmental psychology published primarily within the last two decades. The analytical framework integrates findings from neuroimaging studies, longitudinal developmental research, and comparative studies of first and second language acquisition. The literature search focused on studies examining neural correlates of language processing, age-related changes in brain plasticity, and cognitive mechanisms differentiating child and adult learners. Neuroimaging studies demonstrate that children exhibit greater synaptic density and more distributed neural activation patterns during language processing, whereas adults show more localized, left-hemisphere dominant activation [4].

The concept of experience-expectant versus experience-dependent plasticity proves central to understanding these differences: children's brains are primed to extract linguistic patterns from environmental input during specific developmental windows, while adult learning relies more heavily on experience-dependent mechanisms that require greater cognitive effort [5]. Cognitive processing distinctions constitute another fundamental difference between child and adult language learners. Children predominantly employ implicit learning mechanisms, acquiring grammatical structures and phonological patterns through unconscious pattern extraction without metalinguistic awareness [6]. This procedural learning engages subcortical structures including the basal ganglia and cerebellum, facilitating automatic language processing.

Conversely, adults approach language learning through explicit, declarative memory systems involving conscious rule application and metalinguistic knowledge, mediated primarily by hippocampal and prefrontal cortical networks [7]. The neurobiological basis for age-related differences extends to neurotransmitter systems and myelination patterns. Research indicates that the pruning of neural connections during adolescence, while enhancing processing efficiency in established neural circuits, simultaneously reduces the flexibility necessary for acquiring new linguistic systems with native-like proficiency [8]. Furthermore, the lateralization of language functions, which crystallizes during childhood, constrains the neural resources available for subsequent language learning in adulthood.

RESULTS AND DISCUSSION

Analysis of the comparative literature reveals several key findings regarding the neurocognitive mechanisms differentiating child and adult language acquisition. First, the evidence strongly supports the existence of sensitive periods rather than absolute critical periods, with gradual rather than abrupt declines in language learning capacity [9]. Neural plasticity does not terminate at a specific age but rather undergoes progressive reduction, with different linguistic components exhibiting distinct developmental trajectories. Phonological acquisition shows the earliest sensitivity to age effects, with native-like accent acquisition becoming increasingly difficult after early childhood, while syntactic and lexical learning remain more plastic into later developmental stages. Second, the findings indicate that children's superior language acquisition outcomes result from the convergence of multiple factors beyond neural plasticity alone.

Cognitive factors including reduced metalinguistic interference, less developed analytical thinking that might impede implicit pattern recognition, and greater exposure time in naturalistic contexts all contribute to children's advantages. Additionally, social and psychological factors such as reduced inhibition, greater willingness to engage in playful language use, and absence of foreign language anxiety facilitate children's language development in ways that extend beyond purely neural explanations. Third, the analysis reveals that adults possess certain cognitive advantages that can partially compensate for reduced neural plasticity. Metalinguistic awareness, developed literacy skills, and sophisticated learning strategies enable adults to achieve efficient vocabulary acquisition and conscious mastery of grammatical rules [10].

However, these explicit learning mechanisms rarely produce the automatic, intuitive language processing characteristic of native speakers, particularly in phonological and morphosyntactic

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domains requiring rapid, unconscious computation. The integration of these findings suggests a complex, multifactorial model of age effects in language acquisition, wherein biological constraints interact with cognitive development, learning context, and individual differences to produce the observed patterns. The implications extend to educational practice, suggesting that adult language instruction should acknowledge both the constraints imposed by reduced neural plasticity and the potential afforded by mature cognitive capabilities, designing pedagogical approaches that leverage explicit learning strengths while maximizing opportunities for implicit acquisition through intensive exposure and practice.

CONCLUSION

The comparative neurocognitive analysis presented in this article demonstrates that age-related differences in language acquisition reflect complex interactions between neurobiological maturation, cognitive development, and learning mechanisms rather than simple critical period effects. Children's superior language acquisition outcomes derive from heightened neural plasticity facilitating implicit procedural learning, while adults rely predominantly on explicit declarative systems constrained by reduced neuroplasticity but supported by metalinguistic awareness and strategic learning capabilities. The evidence supports conceptualizing age effects as reflecting sensitive periods with gradual transitions rather than absolute critical periods with sharp boundaries. These findings have important implications for both theoretical models of language acquisition and practical applications in language education, emphasizing the need for developmentally appropriate instructional approaches that acknowledge the distinct neurocognitive profiles of learners at different ages. Future research should continue investigating individual variation in age-related trajectories and the potential for pedagogical interventions to maximize language learning outcomes across the lifespan.

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