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The Role of Age in Second Language Learning: Insights and Challenges

**Doğan Can Akçin,
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Abstract

This article reexamines the role of age in second language acquisition through a critical lens, challenging traditional interpretations of the Critical Period Hypothesis. While the hypothesis suggests age-related limitations in achieving native-like proficiency, contemporary evidence underscores the brain's lifelong adaptability and the significant roles of social, cognitive, and contextual factors. Drawing on insights from neurolinguistics, naturalistic, and classroom-based studies, this review reveals that late learners can achieve high levels of proficiency, often mediated by individual motivation, social integration, and quality input. It critiques the simplistic dichotomy of early versus late learning, emphasizing the nuanced interplay of variables like learner environment and instructional quality. Through the framework of Complex Dynamic Systems Theory, the article posits age as one of many dynamic and interdependent factors influencing second language acquisition, shifting focus from deterministic views to more holistic, adaptive perspectives. These findings call for a re-evaluation of age-centric policies in education, advocating for pedagogical strategies that align with learners' developmental and experiential contexts. The implications extend beyond theoretical discourse, urging educational practices to leverage the potential for language acquisition across the lifespan.

Keywords: language learning and age, age effects in language acquisition, critical period hypothesis, complex dynamic systems theory, neurolinguistics

Introduction

Age plays a pivotal role in the field of second language acquisition (SLA), significantly influencing various theories and educational policies regarding the optimal age for language learning. The idea of a 'critical period' has contributed to decades of controversy about whether age-related constraints actively prevent native-like attainment. Although Penfield and Roberts (1959) and Lenneberg (1967) have supported the idea of an innately determined period for language learning based on genetic origins, new discoveries have provided an alternative, more impressive argument, that is, the interaction between age and the influence of social, cognitive, and environmental factors.

The Critical Period Hypothesis (CPH) continues to impact both naturalistic and classroom SLA contexts. In studies involving immigrant populations, researchers typically observe an inverse relationship between age of arrival and ultimate language attainment. However, these studies typically do not separate the influence of individual sociocultural differences and motivational orientations. Furthermore, available research demonstrates that it is not necessarily beneficial to learn a language at an early age, which calls into question the effectiveness of policies supporting the teaching of a foreign language at an early age.

Despite considerable research, the age issue is not resolved because of the methodological limitations and the mixed nature of findings. Recent findings in neurocognitive linguistics point to an ongoing plasticity of the brain over the entire lifespan, thus raising doubts about age-related irreversibility of decline. The move to consider SLA as a dynamic, non-linear process also resists static, age-related models.

This review addresses two key questions:

1. To what extent does contemporary neurolinguistic evidence support or challenge the CPH in SLA?
2. How does Complex Dynamic Systems Theory (CDST) reconceptualize the role of age in SLA?

Drawing on CDST (Larsen-Freeman, 1997; 2015), this article reconsiders age not as a fixed determinant but as one variable in a complex system of interacting factors. By synthesizing diverse research, it offers a nuanced understanding of age in SLA, with implications for theory, practice, and lifelong learning.

Language Learning and Maturation

The relationship between age and SLA has long fascinated linguists, as exemplified in immigrant families where children generally surpass adults in acquiring the host language (Johnson & Newport, 1989). This difference is frequently attributed to children's better flexibility and social inclusion. Interacting socially has a lot to do with SLA as students interact with their surroundings, enabling the acquisition to progress (Lantolf & Thorne, 2006). Motivation, including the wish to integrate, likewise contributes to success (Gardner, 1985). Even though age is frequently considered a primary determinant, this fails to take into account the intricate relationship between social integration, motivation, and opportunities to use the minority language with a purpose in all ages.

The interest in linking these differences to age can largely be attributed to the continued impact of the CPH. The CPH, formulated in the 1950s, proposed that neurological change in late childhood restricts the flexibility of the brain, making it difficult or impossible for individuals to become fluent in a new language. Penfield argued that it becomes more difficult to learn languages after the age of 9, when the brain is no longer plastic (Penfield & Roberts, 1959). Yet, current studies have demonstrated that the brain is malleable throughout life (Gutchess, 2014; Ramírez Gómez, 2017) and therefore contest the claim that acquiring a language after childhood is “unphysiological.”

Lenneberg (1967) took this notion further by proposing that the critical period ended at puberty. He claimed that after this point, learning a new language becomes much more demanding, with the learner never being able to reach native-like pronunciation. He identified this with the lateralization of language functions—the operation of language is usually lateralized to one hemisphere by the time you're done with puberty. However, contemporary neuroscience observes this process with more nuance (Nenert et al., 2017), undermining Lenneberg's strict chronology. Though his claim for a plummet in language-learning potential in the adolescent age range appears not to be the case (Cummins, 1979), it has proved to be a powerful influence both on SLA research and in the wider world.

Rethinking Age Effects in Naturalistic Second Language Learning

The maturational perspective in SLA has also received much support from studies in immigrant and naturalistic settings (Hyltenstam, 1992; Piske et al., 2002), which are based on the significance of maturational limitations. Regarding the

phonetic acquisition, Piske et al. (2002) report that early exposure to the target language (L2) results in more correct production of vowels because of a higher amount of neuroplasticity, in accordance with the Speech Learning Model. Early age of onset also predicts more native-like proficiency in grammar and vocabulary, although non-native properties may persist (Hyltenstam, 1992). Late learners exhibit the phenomenon of fossilization and increased error rates, lending support to the sensitive period hypothesis. In any case, we should also consider individual variances, since even early learners typically do not sound natively adept. As previously discussed, motivation alone does not guarantee success in SLA (Dörnyei, 2009). Social, cultural, and cognitive influences, as well as the difference between immersive experiences and classroom-based learning, are significant, among other effects not sufficiently captured by the research. Being in a rich language environment offers additional opportunities for participants to use the language in tangible contexts, resulting in the growth of pragmatic and sociolinguistic skills (Jia & Aaronson, 2003; Freed, 1995). However, they interact in first language (L1) social networks for adolescents and work in L1-dominant workplaces for adult migrants, where L2 practice is limited.

Flege (2019) calls into question the belief that length of residence correlates with a higher L2 exposure, claiming that L2 input varies according to social networks, type of work, and interest. Large-leaved peonies are rare and under threat. The essence of wilderness, argued John Muir, is wildness. 2018). Jobs that involve little L2 use and little motivation reduce exposure even more (Marinova-Todd et al., 2000). Residence alone, therefore, offers no guarantee of immersion; effort and context also count. These results challenge the notion that the relationship between biological age and SLA success can be explained purely in terms of age. Age is increasingly seen as a 'macrovariable' entwined with multiple factors (Birdsong, 2018).

While early arrival usually brings benefits for SLA, not all children succeed fully, nor do all adults fail to do so. Kinsella and Singleton (2014) and Marinova-Todd (2003) challenge the deterministic CPH view. Kinsella and Singleton (2014) present examples of adult learners who achieved native-like French proficiency through long-term residence, regular native input, social integration, and motivation - factors which transcend age. Marinova-Todd (2003) equally emphasizes motivation, aptitude, and the quality of input. Nonetheless, some advocates of the CPH do not find convincing the evidence for an "intensely scrutinized nativelikeness" as a rigid criterion (Long, 2013; Abrahamsson & Hyltenstam, 2009). Birdsong (2014) challenges this norm, claiming that if denying the hypothesis requires perfect mastery,

the theory simply is unfalsifiable, arguing that the falsifiability criterion should be rejected, as in the case of belief in fairies. Even researchers in favour of the critical period perspective (DeKeyser, 2003; Johnson & Newport, 1989) concede that the role of the critical period is minor in formal instruction, which is characterised by its explicit, rule-based nature as opposed to naturalistic learning.

Age Effects: Gradual Decline or Definitive Cut-Offs?

Current knowledge about the role of age in SLA is incomplete, in part because of a lack of agreement about what is learned beyond the postulated maturational window. Suggested ages for this window can differ significantly, and it's not agreed upon what the clear indicators of a “critical” period are thought to be. Although one hypothesis is that post-maturational SLA is fundamentally incomplete, there are numerous reports in the literature of exceptions to this general pattern. A central issue is whether L2 learning decreases in a linear fashion throughout the lifespan or is marked by sudden break points – the characteristic of a true critical period.

Cut-off points historically have been associated with puberty, but of course, this is quite a variable age. But newer research indicates even wider limits. For instance, Dollmann et al. (2020) reported age-related maturational changes in pronunciation from age nine. By contrast, Chen and Hartshorne (2021), with a dataset of more than a million participants, reported a steep decline in L2 syntax learning around age 18. Additional peer-reviewed studies, such as Sebastián-Gallés et al. (2005), reported that different responses to phoneme discrimination were observed prior to four years of age. These inconsistent findings suggest that the developmental windows may differ for individual components of a language. But claimed age ranges regularly contradict, sometimes in the same area (Singleton, 2005). Birdsong (2018) posits that, at present, based on the evidence, it is incorrect to propose an integrated model formed of multiple critical periods. This is not to deny the impact of age on SLA but to imply that it might be better accounted for by the wider, more coindexed effects of ageing rather than the narrow developmental parameters that are evident.

The Impact of Age on Classroom L2 Learning

In the middle of the 20th century, early L2 schooling was advocated in schools (Murphy, 2014). Ironically, this flies in the face of decades of research, which has

indicated that early L2 learning doesn't usually reap sustainable dividends (Singleton & Leśniewska, 2021). The fact that early learners progress may not be higher than that of late learners, and late learners can even surpass early learners although the former has spent more time in language learning (Muñoz & Singleton, 2011) is undeniable, and has been confirmed in research since the 1970s when examining which starting age is more effective in L2 learning. Also in immersion settings, older learners frequently either catch up with or even exceed younger ones (Pfenninger & Singleton, 2019), which CPH backs. Formal education is not comparable to exposure, nor is it likely to result in the same early-start advantage, according to Johnson & Newport (1989). Additionally, DeKeyser (2003) argued in favour of age-appropriate training because classroom language learning is less susceptible to maturation. Ironically, in spite of these drawbacks, the CPH has significantly influenced global policy and practice, eliminating any possibility of late start, particularly in the English language. Although cross-generational comparisons have been made possible by these actions, extensive research has not discovered any long-term advantages for early starts.

Recent studies suggest that early starters may have an advantage initially, especially in receptive language skills, but that the edge appears to wane. In a subsequent investigation, Jaekel et al. (2017) found that while by Attainment Year 5, ELLs in Germany had already caught up with their monolingual peers, this had no longer been the case by Year 7. Baumert et al. (2020), based on a study of almost 20,000 students, concluded that there was limited variation by Year 9. Pfenninger and Singleton (2017) also note that instruction and progression were crucial (i.e., poor starters often caught up in subsequent testing). Baumert et al. (2020), who analysed c.20,000 students and found minimal variation by year 9, speculated that this was because of a lack of differentiation in the secondary school. Pfenninger and Singleton (2017) also drew attention to the role of instruction and/or progression (i.e., students starting at a later point often 'caught up' in follow-up or post-testing).

Huang (2016), synthesizing 42 studies from 1964 to 2014, examined early instruction in formal settings. It included an examination of vocabulary, grammar, and phonology in the short, medium, and long term. Results put in question the dominance of the "the earlier the better" as older learners frequently performed better than their younger peers, probably because of the greater cognitive ability and strategy possession. While there is some evidence that younger learners may benefit more from auditory processing, the evidence was not uniform across

the experiments. The meta-analyses highlight the influence of both instructional quality and the learning context, as well as the learning context and context of instruction, on outcomes.

Some studies, like the Barcelona Age Factor Project (Muñoz, 2003a), noted a slight early advantage in listening. With equal exposure, older learners, under equal exposure, were superior to younger ones in most L2 domains, while older and younger learners did not differ significantly in listening. While early training may help to further auditory skills, evidence is inconclusive (cite). Closely mirroring discoveries made in naturalistic SLA, recent research in instructed SLA emphasizes input as a critical predictor of successful learning. Huang et al. (2020) characterized input, environment, aptitude, and motivation in early bilinguals of Mandarin and English in Taiwan. Through tests and questionnaires, research concluded that present out-of-class input was a strong predictor of listening comprehension. Speech production, in contrast, was more influenced by environmental influences, including SES and parents' English proficiency. The study emphasizes the greater influence of current out-of-class input than that of early instruction, with differences between L2 domains.

Challenging the Critical Period Hypothesis: Insights from Neuroscience

Lenneberg (1967) based his original statement of the CPH on biological and neural developments. Subsequent to its proposal, numerous investigations were conducted on age and L2 learning outcomes to confirm the proposed theory. As previously mentioned, however, these efforts were inconclusive. Although initial criticisms were reported (e.g., Krashen, 1973: 65), decades passed before the development of neurolinguistic technology that made it possible to test CPH directly. The last two decades have seen major developments in the use of EEG/ERP and fMRI, resulting in greater insight into the involvement of the brain in learning a new language.

EEG, on which ERP is based, records electrical activity in the brain in response to some sort of stimulus. In language, native speakers usually display neural patterns—N600 for morphosyntax, and N400 for semantics. Comparing L1 and L2 responses within an individual can indicate if disparate neural mechanisms are utilized and hence contribute to our understanding of bilingual processing. fMRI, in turn, observes blood flow surges to make inferences about neural activity and identify brain areas activated during language exercises. Although limited adult brain

plasticity has been demonstrated in some studies (Bergmann et al., 2015), the de facto reality is that the adult brain remains highly plastic. DeLuca et al. (2019) summarized findings that support the idea that native-like ERP effects emerge with higher levels of L2 proficiency. fMRI data also demonstrates alterations in language-associated regions (such as the inferior frontal and superior temporal gyri). These provide evidence that L1 and L2 are more similar to each other and that their two outcomes are more influenced by one or more external factors—such as input and immersion—rather than by strict neurological limitation.

Kasparian and Steinhauer (2016, 2017) investigated L2 Italian learners, bilinguals and monolinguals. Highly advanced L2 learners had ERPs similar to those of native monolinguals. Steinhauer and Kasparian (2020) claim that posterior ERP studies have confounded age with proficiency, but new and better methods are revealing greater evidence against CPH predictions.

fMRI is also an important tool for the study of neuroplasticity. Whereas MRI provides an image of the brain's structure, fMRI shows how it is functioning. Studies have shown that L2 learning can be associated with higher gray and white matter volume, as well as with greater neural connectivity. While limited, fMRI research in the natural setting has demonstrated that late learning is associated with brain changes similar to those of early bilinguals. Pliatsikas et al. (2015) observed white matter development in L2 learning in adulthood that was similar to that of early childhood bilinguals. Summarizing this work, DeLuca et al. (2019) claim that “claims about psych velocity and its relationship to age are directly testable through neuroimaging—and the current evidence base argues against them.”

Discussion

Lenneberg's (1967) original concept of CPH was based on neurological maturation. After years of research, the age issue in SLA is not yet resolved, but it has had an impact on language instruction policy, especially the promotion of an early start to L2 education. But evidence indicates that early starters' edges erode frequently, as late starters catch up to, or even excel, them in proficiency. Early start of instruction in a second/foreign language does not ensure better long-term results, as suggested by many studies.

Regarding Research Question 1, this article has explored the contested nature of the critical period and argued that a fixed biological window cannot fully explain SLA outcomes. While some late learners achieve near-native proficiency, most do

not. Still, language learning outcomes are shaped by a range of factors—exposure, context, motivation, and individual traits—not just age (Singleton & Leśniewska, 2021). SLA is a complex, multifactorial process, and older learners are not inherently incapable of success.

With respect to RQ1, this paper has discussed the contested nature of the critical period and shown that a biological window cannot be the only determinant of SLA attainment. Some late learners do reach near-native proficiency, though the majority do not. Yet second language learning results are determined by more than just age (Singleton & Leśniewska, 2021), a variety of factors, including exposure, context, motivation, and individual differences, play a role. SLA is a complex, multivariate process, and older learners are not intrinsically lightweights.

The focus on determinant window of opportunity has resulted in an unbalanced emphasis on early learning and attainment with little discussion of language learning in later life. There is relatively little research on the third age, but it has attracted increasing interest. The presumption that older adults are destined to fail, product of CPH, has overshadowed useful findings regarding language learning capacity in later life.

Singleton and Zaborska (2021) try to fill this void by focusing on older adults' language learning experience. And although there are some constraints, including reduced plasticity and decreased hearing ability, they emphasize that people can and do make large gains after childhood. They also describe cognitive payouts with improved executive function and postponed cognitive decay, as well as affective payoffs, such as higher levels of cultural participation and social integration. Personal desire, interest, and social engagement (intrinsic motivation) are powerful drivers of continued language learning in seniors.

Turning to Research Question 2, CDST offers a compelling alternative to linear age-based models (De Bot et al., 2007; Larsen-Freeman, 2015). CDST views SLA as a dynamic, nonlinear process, shaped by interactions among motivation, aptitude, context, and other factors. While younger learners may have phonological advantages, older learners benefit from cognitive maturity and metalinguistic awareness. Age is thus one of many interdependent variables in a learner's trajectory.

Pfenninger et al. (2023) further challenge age-focused paradigms, emphasising that age must be viewed alongside cognitive, affective, social, and experiential factors. They argue that age interacts with variables such as gender, socioeconomic status (SES), and bilingualism to shape individual learning paths. This holistic approach

redefines age not as a fixed constraint but as a dynamic, evolving influence within a complex system of lifelong language learning.

Conclusion

This paper presents a critical analysis of age in second language acquisition (SLA) by eschewing the deterministic views of the CPH. Whereas older models of SLA have considered age as a cut-off for the biological ability to learn a second language and first language learning as qualitatively different from second language learning, current theoretical developments and research from neurolinguistics, naturalistic, and classroom studies have demonstrated that the brain remains significantly plastic. The results show that motivation, social integration, the quality and quantity of input, and the learning environment are crucial determinants of SLA success and frequently mediate or override the effect of age per se. CDST framework also highlights that age is a single component in a complex, interacting system contributing to shaping pathways of language learning. As a result, the concept of a strict critical period is becoming increasingly untenable, and educational policy should adjust to the complex, multifactorial nature of SLA. After all, lifelong language acquisition is possible, and age is not the ultimate predictor of the ability to develop high proficiency among highly motivated learners.

Limitations

Despite attempting to provide a comprehensive overview of the literature, this review acknowledges several limitations: Methodological diversity among studies poses a significant obstacle, as virtually no agreement has been reached on defining the “critical period” or on the ranges of age and linguistic aspects of interest. This absence of uniformity makes direct comparison difficult and generalisation of conclusions difficult. In addition, it is challenging for many studies to distinguish the effects of age from other potentially important variables (e.g., motivation, social integration, socioeconomic status, and language input in terms of quality and quantity). Thus, it is challenging to attribute the effects of age solely to language learning. A further limitation, compounded by a focus on end-state (e.g., attainment of native-like proficiency), is that ideals of what counts as success or restriction may be less than comprehensive to encompass the learner’s achievements and learner goals. Moreover, research on older adults and language learning still presents a significant empirical gap. Nevertheless, recent evidence has shown the

social and cognitive benefits of acquiring a foreign language in later life. Lastly, the generalisation of results from a naturalistic immersion context may be restricted to instructed or classroom settings, where exposure and learning conditions can differ markedly.

Recommendations for Future Research

With these caveats in mind, future studies should focus on multivariate approaches, considering the relationships between age and other cognitive, affective, social, and contextual variables, rather than merely as a predictor. Longitudinal research following language development from early to later years of life, as well as in and beyond older adulthood, is especially desirable to explore the dynamic processes involved in SLA at various ages. It will increase the generalizability of the findings to consider diverse learning settings, forms of learning, including formal instruction, and different socio-cultural contexts in future research endeavours. Furthermore, normalisation measures must extend beyond the narrow concept of native-like proficiency and consider other aspects of communicative proficiency, including pragmatics and the individual learner's goals. By incorporating findings from neuroimaging and cognitive neuroscience, we can gain a deeper understanding of the potential for brain plasticity and language learning in both youth and adults. Lastly, there is a need for policy-relevant research to guide educational policy and practice in making language learning developmentally appropriate and accessible to learners across the lifespan.

References

- Abrahamsson, N., & Hyltenstam, K. (2009). Age of onset and nativelikeness in a second language: Listener perception versus linguistic scrutiny. *Language Learning*, 59(2), 249-306. <https://doi.org/10.1111/j.1467-9922.2009.00507.x>
- Baumert, J., Fleckenstein, J., Leucht, M., Köller, O., & Möller, J. (2020). The long-term proficiency of early, middle, and late starters learning English as a foreign language at school: A narrative review and empirical study. *Language Learning*, 70(4), 1091-1135. <https://doi.org/10.1111/lang.12414>
- Bergmann, C., Meulman, N., Stowe, L., Sprenger, S., & Schmid, M. (2015). Prolonged L2 immersion engenders little change in morphosyntactic processing of bilingual natives. *Neuroreport*, 26(17), 1065-1070. <https://doi.org/10.1097/WNR.0000000000000469>
- Birdsong, D. (2014). The Critical Period Hypothesis for second language acquisition: Tailoring the coat of many colors. 1 In M. Pawlak and L. Aronin (Eds.) *Essential topics in applied linguistics and multilingualism* (pp. 43-50). Springer. https://doi.org/10.1007/978-3-319-01414-2_3
- Birdsong, D. (2018). Plasticity, variability and age in second language acquisition and bilingualism. *Frontiers in Psychology*, 9, <https://doi.org/10.3389/fpsyg.2018.00081>
- Bowden, H. W., Steinhauer, K., Sanz, C., & Ullman, M. T. (2013). Native-like brain processing of syntax can be attained by university foreign language learners. *Neuropsychologia*, 51(13), 2492-2511. <https://doi.org/10.1016/j.neuropsychologia.2013.09.004>
- Chen, T., & Hartshorne, J. K. (2021). More evidence from over 1.1 million subjects that the critical period for syntax closes in late adolescence. *Cognition*, 214, 104706. <https://doi.org/10.1016/j.cognition.2021.104706>
- Cook, V., & Singleton, D. (2014). *Key topics in second language acquisition*. Multilingual Matters.
- De Bot, K., Lowie, W., & Verspoor, M. (2007). A Dynamic Systems Theory approach to second language acquisition. *Bilingualism: Language and Cognition*, 10, 7-21. <https://doi.org/10.1017/S1366728906002732>
- DeKeyser, R. (2003). Implicit and explicit learning. In C. Doughty & M. Long (Eds.), *Handbook of second language acquisition* (pp. 313-348). Blackwell. <https://doi.org/10.1002/9780470756492.ch11>
- DeLuca, V., Miller, D., Pliatsikas, C., & Rothman, J. (2019). Brain adaptations and neurological indices of processing in adult second language acquisition. In *The handbook of the neuroscience of multilingualism* (pp. 170-196). John Wiley & Sons. <https://doi.org/10.1002/9781119387725.ch8>
- Dollmann, J., Kogan, I., & Weißmann, M. (2020). Speaking accent-free in L2 beyond the critical period: The compensatory role of individual abilities and opportunity structures. *Applied Linguistics*, 41, 787-809. <https://doi.org/10.1093/applin/amz029>
- Dörnyei, Z. (2009). *The psychology of second language acquisition*. Oxford University Press.

- Flege, J. E. (2019). A non-critical period for second-language learning. In A. Mette Nyvad, M. Hejná, A. Højen, A. Bothe Jespersen & M. Hjortshøj Sørensen (Eds.), *A sound approach to language matters: In honor of Ocke-Schwen Bohn* (p. 501–541). Aarhus University.
- Freed, B. F. (Ed.). (1995). *Second language acquisition in a study abroad context*. John Benjamins Publishing. <https://doi.org/10.1075/sibil.9?locatt=mode:legacy>
- Gutchess, A. (2014). Plasticity of the aging brain: new directions in cognitive neuroscience. *Science*, 346(6209), 579–582. <https://doi.org/10.1126/science.1254604>
- Huang, B. H. (2016). A synthesis of empirical research on the linguistic outcomes of early foreign language instruction. *International Journal of Multilingualism*, 13(3), 257–273. <https://doi.org/10.1080/14790718.2015.1066792>
- Huang, B., Chang, Y.-H. S., Niu, L., & Zhi, M. (2018). Examining the effects of socio-economic status and language input on adolescent English learners' speech production outcomes. *System*, 73, 27–36. <https://doi.org/10.1016/j.system.2017.07.004>
- Huang, B. H., Chang, Y.-H. S., Zhi, M., & Niu, L. (2020). The effect of input on bilingual adolescents' long-term language outcomes in a foreign language instruction context. *International Journal of Bilingualism*, 24(1), 8–25. <https://doi.org/10.1177/1367006918768311>
- Hyltenstam, K. (1992). Non-native features of non-native speakers: On the ultimate attainment of childhood L2 learners. In R.J. Harris (Ed.), *Cognitive processing in bilinguals* (pp.351-368). Elsevier. [https://doi.org/10.1016/S0166-4115\(08\)61505-8](https://doi.org/10.1016/S0166-4115(08)61505-8)
- Gardner, R. C. (1985). *Social psychology and second language learning: The role of attitudes and motivation*. Edward Arnold.
- Jaekel, N., Schurig, M., Florian, M., & Ritter, M. (2017). From early starters to late finishers? A longitudinal study of early foreign language learning in school. *Language Learning*, 67(3), 631–664. <https://doi.org/10.1111/lang.12242>
- Jia, G., & D. Aaronson (2003). A longitudinal study of Chinese children and adolescents learning English in the United States. *Applied Psycholinguistics* 24, 131–161. <https://doi.org/10.1017/S0142716403000079>
- Johnson, J. & Newport, E. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*, 21(1), 60–99. [https://doi.org/10.1016/0010-0285\(89\)90003-0](https://doi.org/10.1016/0010-0285(89)90003-0)
- Kasparian, K., & Steinhauer, K. (2016). Confusing similar words: ERP correlates of lexical-semantic processing in first language attrition and late second language acquisition. *Neuropsychologia*, 93, 200–217. <https://doi.org/10.1016/j.neuropsychologia.2016.10.007>
- Kasparian, K., & Steinhauer, K. (2017). When the second language takes the lead: Neurocognitive processing changes in the first language of adult attriters. *Frontiers in Psychology*, 8. <https://doi.org/10.3389/fpsyg.2017.00389>
- Kinsella, C., & Singleton, D. (2014). Much more than age. *Applied Linguistics*, 35(4), 441–462. <https://doi.org/10.1093/applin/amu032>

- Klimova, B., & Pikhart, M. (2020). Current research on the impact of foreign language learning among healthy seniors on their cognitive functions from a positive psychology perspective: A systematic review. *Frontiers in Psychology*, 11, 765. <https://doi.org/10.3389/fpsyg.2020.00765>
- Krashen, S. (1973). Lateralisation, language learning and the critical period: Some new evidence. *Language Learning* 23(1), 63–74. <https://doi.org/10.1111/j.1467-1770.1973.tb00097.x>
- Lantolf, J. P., & Thorne, S. L. (2006). *Sociocultural theory and the genesis of second language development*. Oxford University Press.
- Larsen-Freeman, D. (1997). Chaos/complexity science and second language acquisition. *Applied Linguistics*, 18(2), 141–165. <https://doi.org/10.1093/applin/18.2.141>
- Larsen-Freeman, D. (2015). Complexity theory. In B. VanPatten & J. Williams (Eds.), *Theories in second language acquisition* (2nd ed., pp. 227–244). Routledge.
- Lenneberg, E.H. (1967). *Biological foundations of language*. Wiley.
- Long, M. (2013). Maturation constraints on child and adult SLA. In G. Granena & M. Long (Eds.), *Sensitive periods, language aptitude and ultimate attainment* (pp. 3–41). John Benjamins.
- Marinova-Todd, S. (2003). *Comprehensive analysis of ultimate attainment in adult second language acquisition*. Unpublished Ph.D. thesis, Harvard University.
- Marinova-Todd, S.H., Marshall, D.B., & Snow, C.E. (2000). Three misconceptions about age and L2 learning. *TESOL Quarterly*, 34(1), 9–34. <https://doi.org/10.2307/3588095>
- Muñoz, C. (2003). Variation in oral skills development and age of onset. In M.P. García Mayo & M.L. García Lecumberri (Eds.), *Age and the acquisition of English as a second language* (pp. 161–181). Multilingual Matters.
- Muñoz, C. & Singleton, D. (2011). A critical review of age-related research on L2 ultimate attainment: State of the art article. *Language Teaching* 44 (1), 1-35. <https://doi.org/10.1017/S0261444810000327>
- Murphy, V. A. (2014). *Second language learning in the early school years: Trends and contexts*. Oxford University Press.
- Nenert, R., Allendorfer, J.B., Martin, A.M., Banks, C. Vannest, J., Holland, S.K. & Szaflarski, J.P. (2017). Age-related language lateralisation assessed by fMRI: The effects of sex and handedness. *Brain Research*, 1674, 20-35. <https://doi.org/10.1016/j.brainres.2017.08.021>
- Penfield, W.G. & Roberts, L. (1959). *Speech and brain mechanisms*. Atheneum.
- Piske, T., Flege, J.E., MacKay, I.R.A., & Meador, D. (2002). The production of English vowels by fluent early and late Italian-English bilinguals. *Phonetica*, 59(1), 49–71. <https://doi.org/10.1159/000056205>
- Pfenninger, S. E. & Singleton, D. (2017). *Beyond age effects in instructional L2 learning: Revisiting the age factor*. Multilingual Matters.

- Pfenninger, S. E. & Singleton, D. (2019). Starting age overshadowed: The primacy of differential environmental and family support effects on L2 attainment in an instructional context. *Language Learning*, 69(S1), 207–234. <https://doi.org/10.1111/lang.12318>
- Pfenninger, S., Festman, J., & Singleton, D. (2023). *Second language acquisition and lifelong learning*. Routledge.
- Pliatsikas, C., Moschopoulou, E., & Saddy, J. D. (2015). The effects of bilingualism on the white matter structure of the brain. *Proceedings of the National Academy of Sciences of the United States of America*, 112(5), 1334–1337. <https://doi.org/10.1073/pnas.1414183112>
- Ramírez Gómez, D. (2017). *Language teaching and the older adult: The significance of experience*. Multilingual Matters.
- Rossi, E., Díaz, M., Kroll, J. F., & Dussias, P. E. (2017). Late bilinguals are sensitive to unique aspects of second language processing: Evidence from clitic pronouns and word order. *Frontiers in Psychology*, 8, 342. <https://doi.org/10.3389/fpsyg.2017.00342>
- Sebastián-Gallés, N., Echeverría, S., & Bosch, L. (2005). The influence of initial exposure on lexical representation: Comparing early and simultaneous bilinguals. *Journal of Memory and Language*, 52(2), 240–255. <https://doi.org/10.1016/j.jml.2004.11.001>
- Singleton, D. (2005). The critical period hypothesis: A coat of many colours. *International Review of Applied Linguistics*, 43(4), 269–285. <https://doi.org/10.1515/iral.2005.43.4.269>
- Singleton, D. & Leśniewska, J. (2021). The critical period hypothesis in second language acquisition: An unfalsifiable embarrassment? *Languages*, 6(3), <https://doi.org/10.3390/languages6030149>
- Singleton, D. & Zaborska, D. (2021). Adults learning additional languages in their later years: The pain, the profit and the pleasure. *Journal of Multilingual Theories and Practices*, 1 (1), 112–124. <https://doi.org/10.1558/jmtp.15361>
- Steinhauer, K., & Kasparian, K. (2020). Brain plasticity in adulthood: ERP evidence for L1 attrition in lexicon and morphosyntax after predominant L2 use. *Language Learning*, 70(S2), 171–193. <https://doi.org/10.1111/lang.12391>