

# Age constraints on first versus second language acquisition: Evidence for linguistic plasticity and epigenesis<sup>☆</sup>

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## Abstract

Does age constrain the outcome of all language acquisition equally regardless of whether the language is a first or second one? To test this hypothesis, the English grammatical abilities of deaf and hearing adults who either did or did not have linguistic experience (spoken or signed) during early childhood were investigated with two tasks, timed grammatical judgement and untimed sentence to picture matching. Findings showed that adults who acquired a language in early life performed at near-native levels on a second language regardless of whether they were hearing or deaf or whether the early language was spoken or signed. By contrast, deaf adults who experienced little or no accessible language in early life performed poorly. These results indicate that the onset of language acquisition in early human development dramatically alters the capacity to learn language throughout life, independent of the sensory-motor form of the early experience.

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## 1. Introduction

An important question about the nature of language acquisition is the extent to which age constrains its outcome, otherwise known as a sensitive or critical period (CP) for language. The idea that languages must be learned in childhood to be learned successfully has been widely held by educators for over a century (Colombo, 1982). The specific neurolinguistic hypothesis that the outcome of language acquisition is tied to brain development has a more recent history. Penfield and Roberts

(1959) first proposed that language acquisition was related to brain plasticity. Lenneberg (1967) later marshaled a variety of evidence linking the trajectory of language acquisition to brain growth curves in early development. Despite this long history, however, the nature of the postulated critical period for language is not well understood. Indeed, the existence of a critical period for language acquisition remains controversial. In the present study we investigate this important question with a new approach.

Investigating a possible CP for language requires identifying situations where the developmental onset of language acquisition varies naturally. Possible effects on the outcome of language acquisition associated with learning languages at various ages can then be measured. The most common test of the CP hypothesis has been spoken, second language (L2) learning because age of L2 learning varies widely in the hearing population (Birdsong, 1999). A less common situation is the signed language acquisition of individuals who are born deaf (Mayberry, 1994, 2002). We compare the outcome of these two situations in the present study to probe the nature of the postulated CP for language. Specifically,

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we ask whether the onset of language acquisition in early life is related to the subsequent ability to learn any other language for the remainder of life, independent of the sensory and motor modalities of the first or second languages. Positive evidence of this kind would suggest that the postulated CP for language is similar to other biological phenomena whereby early experience organizes the development of a genetically specified system and its neural underpinnings in an epigenetic fashion (Changeux, 1985) as we explain below. Before describing the present study, we turn to previous research on age of acquisition effects on the grammatical outcome of language acquisition beginning with the case of signed language, followed by spoken language.

Several studies have investigated age of acquisition effects on the outcome of American sign language (ASL). ASL is the most commonly used signed language in North America but only one of the world's many signed languages (Klima & Bellugi, 1979). Signed languages are natural languages that have evolved through generations of children's acquisition and adult use by Deaf communities worldwide (Baynton, 1996; Senghas & Coppola, 2001). Because they are natural languages independent of spoken languages, signed languages are neither universal nor gesture codes for speech (Morford & Kegl, 2000). The linguistic architecture of signed language is similar to that of spoken language in that it is characterized by rule-bound form at the levels of phonology, morphology and syntax, and semantics (for a review see Emmorey, 2002). Infants exposed to ASL by their parents acquire it in a fashion and on a timetable akin to hearing children's acquisition of spoken languages (Chamberlain, Morford, & Mayberry, 2000; Lillo-Martin, 1999; Petitto & Marentette, 1991).

In the first study of age constraints on ultimate attainment in ASL, Mayberry and Fischer (1989) found significant differences in the narrative shadowing performance and lexical error patterns of native signers (who learned ASL from their deaf parents) compared to that of non-native signers (who learned ASL between the ages of 9 and 16). In a second experiment, performance accuracy on ASL sentence shadowing and recall tasks showed a linear relation to age of acquisition (between the ages of birth to 15 years), when length of ASL experience was a confounding factor. In a third experiment controlling length of experience, age of acquisition continued to show a significant linear relation to performance accuracy and morphological error patterns on a task of complex ASL sentence recall (Mayberry & Eichen, 1991). Newport (1990) also found age of acquisition (from birth to older than 13 years) to correlate with ASL ultimate attainment using a composite score derived from a battery of expressive and receptive ASL tests. Finally, Emmorey, Bellugi, Friederici, and Horn (1995) found native ASL learners to outperform non-native learners on a sign monitoring

task but not on a grammatical judgement task. Together these results indicate that age of acquisition is an important factor in the outcome of signed language acquisition. Clearly age constraints on language acquisition are not limited to spoken languages to which we now turn.

The most common method of investigating age constraints on the outcome of language acquisition has been to measure the grammatical ability of individuals who learned a second spoken language at varying ages. Some studies have investigated age constraints on the outcome of L2 phonological learning but, because the focus of the present study is grammatical ability, we do not discuss them here (see Flege, 1999). Several studies reported a negative correlation between age of spoken L2 acquisition and L2 grammatical outcome and/or significant differences in grammatical performance between native and non-native learners. These effects were found using a variety of language measures including: sentence shadowing (Oyama, 1978), assessment of written transcripts of spoken interviews (Patkowski, 1980), and assessment of tape-recorded interviews (White & Genesee, 1996). Other studies reported effects for age of acquisition on L2 grammatical outcome using judgement of grammatical and ungrammatical sentences presented in either auditory or written forms (Birdsong, 1992; Birdsong & Molis, 2001; Flege, Yeni-Komshian, & Liu, 1999; Johnson & Newport, 1991; Johnson, 1992; White & Genesee, 1996). In most studies the L2 tested was English; French was the L2 in one study (Birdsong, 1992). The first languages (L1) were Chinese, French, Italian, Korean, Spanish, or unspecified.<sup>1</sup>

Although a negative correlation between age of L2 acquisition and grammatical outcome has been replicated several times using a variety of language measures across a variety of first languages, controversy remains as to whether these findings provide positive evidence for the postulated CP for language. Most studies found L2 grammatical outcome to show a linear function in relation to age of acquisition; as age of acquisition increases, L2 grammatical outcome decreases after the age of 8 (e.g., Birdsong & Molis, 2001; Flege et al., 1999; Johnson & Newport, 1989; Oyama, 1978; Patkowski, 1980). However, some researchers have argued that the slope of the function between age of acquisition and grammatical outcome should be non-linear in nature and stop abruptly at some age coincident with the end of the CP (e.g., Bialystok & Hakuta, 1999).

A non-linear function between age of L2 acquisition and grammatical outcome was found by Johnson and Newport (1989), who tested native speakers of Chinese and Korean with an untimed, grammatical judgement

<sup>1</sup> Several studies claiming age of acquisition effects for L2 outcome are not cited here because they either did not control for practice effects or perform the necessary statistical tests.

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