

1 Just in time: is there a critical period for language acquisition?

1.0 Introduction

David Sedaris (2000, 160–161), in describing his initial experiences in French language immersion in a Normandy village, points out an age disadvantage for adults learning language: “I’d hoped that language might come on its own, the way it comes to babies, but people don’t talk to foreigners the way they talk to babies. They don’t hypnotize you with bright objects and repeat the same words over and over, handing out little treats when you finally say ‘potty’ or ‘wawa.’ . . . I wanted to lie in a French crib and start from scratch, learning the language from the ground floor up. I wanted to be a baby, but instead, I was an adult who talked like one, a spooky man-child demanding more than his fair share of attention.” Sedaris presents an anecdotal view of language acquisition reflecting the folk wisdom that infants learn language with apparent ease, no instruction and in very little time. Adults, on the other hand, find learning a new language to be cognitively challenging, labor-intensive and time-consuming. While Sedaris ostensibly puts forth the view of infant language acquisition as a result of positive reinforcement, he makes the reader wonder why Burgundy wine, camembert cheese and Limoges dessert plates do not constitute the “little treats” that might entice *him* to learn French. He also admits the social dimension of adult language learning in pointing out that the learner feels reduced to child-like behavior, while the interlocutor finds him overly demanding. Sedaris implies that there is a limited time span, a critical or sensitive period, for language acquisition – it’s something that infants do with ease and adults with difficulty.

On the one hand, it seems obvious that there is a difference between children and adults with respect to language learning since the former do accomplish the task much more efficiently than the latter. But on the other hand, there is abundant evidence that adults can learn foreign languages to a sophisticated degree of fluency, as for example Joseph Conrad learned English or Samuel Beckett, French. Certainly, the difference between learning a first language as a child and a second language as an adult is

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dramatic enough to warrant the idea that there is a crucial chronological threshold which, when crossed, marks an irreversible deterioration of language learning ability. The familiar example of immigrant families dealing with a new language seems to suggest that children can learn a second language to the same extent as their first, whereas their parents speak the new tongue with foreign accents and grammatical mistakes. It appears that our brains are designed to learn our native idiom effortlessly, but that subsequently our neural aptitude fades with increasing age, a reduction in ability that seems to indicate age sensitivity for second language learning. For native language there is little empirical evidence to disprove a critical cutoff, since nearly all infants are exposed to language and acquire it normally.

A definitive view of maturational restriction to acquisition has been questioned in recent research, as cognitive scientists examine the finer points of adult/child similarities and differences in acquisition (Bailey et al. 2001; Birdsong 1999a; Doughty and Long 2003). Proponents of a critical period for language acquisition have proposed several ages as the threshold of the sensitive age for second language learning: six years (Long 1990) or younger, puberty (Lenneberg 1967; Scovel 1988), fifteen years (Patkowski 1990) and beyond. The diagnostics of foreign accent and grammatical deficit do not, however, apply unproblematically, for “no study has as yet provided convincing evidence for the claim that second language speech will automatically be accent-free if it is learned before the age of about six years and that it will definitely be foreign-accented if learned after puberty” (Piske et al. 2001). There is likewise no agreed-upon threshold for grammatical deficits in second language learning (Birdsong 1999b, 2005a, b; Birdsong and Molis 2001). Recent research has elucidated the importance of early exposure to first language, but has not definitively indicated a cutoff point after which acquisition of some language skills is totally impossible. In addition to the variety of age limits that scholars have proposed for a critical period, they have also put forward an equally diverse range of reasons for such a temporal limit, from biological necessity to sociocultural bias.

The notion of a critical period for acquisition of first and subsequent languages raises the following questions to be addressed in subsequent chapters:

- What is the evidence for a critical period for language acquisition?
- Is there a critical period for first language acquisition?
- Is there a critical period for subsequent language acquisition?

These central questions raise corollary issues about the nature of language acquisition, variables that drive and constrain it, and the role of biological maturation. The book will demonstrate that first language (L1) is

susceptible to age constraints for complete acquisition, whereas second language (L2, a term conventionally referring to any language learned after the first) is only indirectly so affected. For first language, evidence shows a clear effect of age on acquisition, for L1 phonology (sound system), grammar and stylistic mastery are not thoroughly acquired if age of onset passes five to seven years, and L1 is acquired with major deficits if age of onset passes twelve years (Newport 1994). L2 evidence also shows effects of age of onset, even for very early L2 learners of three or four years. But for L2A, the range of variation related to individual and socio-motivational differences is so wide that it prohibits a strict definition of a sensitive period for L2 (Hyltenstam and Abrahamsson 2003; Moyer 2004). Indeed, the L2 competence of expert adult learners, the unequal achievements of child L2 learners, variation of L2 endstate for learners from different native languages, and the lack of consistent empirical evidence for a maturational cutoff all cast doubt on a critical period for second language acquisition.

1.1 Central themes

1.1.1 *Age and language acquisition*

First language and subsequent or second language acquisition (L2A) are two distinct processes that share a number of patterns, but which also differ in crucial respects. L1A is, except in unusual circumstances, broadly successful, while L2A shows wide variations because of motivational, cultural and social influences that lead to marked dissimilarities among individuals in their proficiency. Age at onset of acquisition (AoA) is irrelevant for normal L1A since it is universally the moment of birth (or before); for L2A, however, age at onset seems to make a difference, as Sedaris suggests. In considering age of onset though, one must tease apart the influence of maturation – the physiological changes induced by growth of an organism – as compared to experience with the native language. Is it age of onset that is the crucial factor or the amount of exposure to the first language that the L2 learner has already experienced? While L1 learners thoroughly acquire all aspects of the native language, for L2A there are differential age effects in different domains – for example L2 learners notoriously have more difficulty getting correct pronunciation than they do fluent syntax.

In the case of first language acquisition, it is virtually impossible to create an empirical test of a critical period with a normal population since all hearing infants are exposed to language and acquire the ambient language as a developmental milestone. Dispossessing a child of language

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would be the “forbidden experiment” (Shattuck 1980), and the rare instances of children who mature without human contact, and whose asocial environment deprived them of most human attributes, are questionable as test cases. What can provide insight for L1A is evidence from children whose deprivation is mainly restricted to language, deaf children of speaking parents whose exposure to signed language is delayed, and from children with language pathologies resulting from brain damage or genetic characteristics. These atypical cases can be compared to normal language development to afford investigation of the sensitive period question for L1A (Mayberry 1993).

Acquisition of a single language is the norm in monolingual areas, but the ability to speak more than one language is the standard in most of the world (Cook 1993; Saville-Troike 2006). *Bilingualism* (often used to stand for multilingualism) can be defined generally as the practice of alternately using two languages (Weinreich 1953), although a stricter definition considers bilingualism to be native-like control of two languages. Such truly balanced bilingualism (resulting from “double” first language acquisition) is rare, since knowledge of the languages is usually unequal (Cook 1995). A more realistic view of bilingualism is that it includes the ability to produce complete meaningful utterances in two languages, a definition to be adopted in this book. *Early bilinguals* are individuals who learn a second language during childhood, whereas *late bilinguals* do so as adults. Two other bilingual factors relating to age and acquisition are the intermingling of languages in bilinguals and the possibility of L1 attrition. Bilinguals often mix their languages in conversational *code switching* (Myers-Scotton 1993) or adapt the phonology of one language to another (Singleton and Ryan 2004). Bilinguals for whom the second language becomes dominant lose ability in their first language to varying degrees (Isurin 2000; Schmid 2002), in a process of *attrition*.

In contrast to monolingual L1A, the case of second language acquisition provides perhaps too many means of testing the sensitive period question – longitudinal investigations, cross-sectional studies, controlled experiments on various aspects of the L2, native-like behavior as evaluated by native speakers, and even neurolinguistic testing. Nevertheless, the confounding factors of individual variation and socio-motivational differences interfere with an examination of the age factor for L2A. For example, identical twins raised in the same environment may have nearly indistinguishable native language performance in L1, yet differ substantially in L2 behavior. This book investigates the notion of a critical period for language acquisition by examining the evidence from first language acquisition, second language acquisition and studies of early and late bilingualism.

1.1.2 *Summary of chapters*

This first chapter introduces the central issues and summarizes the book by first examining the notion of sensitive periods in other species and definitions of a critical period for language acquisition. Chapter 1 introduces the neurological basis of human language to discuss the theoretical foundation of the Critical Period Hypothesis (CPH) attributed to Lenneberg (1967) for first language acquisition and extensions of the Hypothesis for subsequent language acquisition. Chapter 1 also presents the dialogue in cognitive science between domain-general associationism and domain-specific nativism to elucidate the theoretical frameworks in which current research is grounded.

Chapter 2 examines the schedule, manner and end result of first language acquisition. It describes the infant's development of native ability in *phonology* (sound system), *lexicon* (vocabulary), *morphology* (grammatical endings and words), *syntax* (word order of sentences) and *pragmatics* (the discourse appropriateness of speech), from birth through age of fluency. Recent research has shown that newborn infants are sensitive to both phonological and lexical characteristics of the ambient language that they perceive in utero (de Boysson-Bardies 1999), and that the young learner acquires substantial vocabulary through the teen years (Bloom 2002). Nevertheless, the core of the L1A process occurs between eighteen months and four years, at which time the normal child is in command of basic vocabulary, phonology and syntax (Guasti 2002).

Chapter 3 revisits Lenneberg's hypothesis in examining the empirical substantiation for a critical period for L1A. The chapter explores the genetic predisposition for language manifested in cross-linguistic uniformity of L1A, dissociation of language and cognition (Smith and Tsimpli 1995), and spontaneous development of creoles (Bickerton 1995; Kegl, Senghas and Coppola 1999; Padden et al. 2006). While little evidence exists from the forbidden experiment of depriving a child of L1 exposure, there is documentation for a few individuals who underwent such a deprivation (Curtiss 1977; Shattuck 1980). More relevant perhaps to the question, and more prevalent in terms of available data, are the studies of deaf individuals whose first exposure to language – often in this case signed language – may vary (Mayberry 1993; Newport 1994).

Chapter 4 examines the timing, manner and end result of second language acquisition. Unlike the strictly circumscribed schedule of L1A, L2 learning varies significantly in a number of ways. The development of ability in phonology, lexicon, morphology, syntax and pragmatics does not follow the pattern of L1A and does not result in equal achievement in all areas (Robinson 2002). Phonetic accuracy in L2 may be quite elusive,

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whereas mastery of word order is gained early; acquisition of lexical items surpasses that of morphology, especially when nonnative features (e.g. gender) are characteristic of the L2, but not the native language (White 2003).

Chapter 5 examines the evidence for a sensitive period for L2A, looking at experimental studies on apparent deterioration of L2 phonology (Scovel 1988) and morphosyntax (Johnson & Newport 1989) that measure effect of age of first exposure to the L2. A critical examination of these studies does not confirm a precipitous loss of ability, but rather a fading into adulthood. A lifelong weakening in language learning ability does not support a monolithic critical period cutoff, but rather a gradual decline (Bialystok 2002a). In contrast, several studies of ultimate achievement verify that adult L2 learners can be near-native in their mastery of syntax, morphology and the lexicon (Birdsong 1992; Ioup et al. 1994; White and Genesee 1996), achievements that also argue against a critical period threshold for L2A.

Chapter 6 looks at biological and non-biological causes for linguistic deficits in recent studies of bilinguals that examine processing and memory of various language functions, complex socio-economic and educational factors (Bialystok 2001). There has been substantial new research on neurological processing, particularly of fMRI and Event Related Potentials (ERPs) measuring brain activity (Dehaene et al. 1997). Processing reactions to native language anomalies of both lexico-semantic (N400) and syntactic (P600) types have been documented for some time (Osterhout and Holcomb 1993). Processing reactions of L2 learners have demonstrated qualitatively parallel reactions, especially of near-native speakers, but some studies indicate distinct profiles of L2 learners that seem to relate to AoA (McLaughlin et al. 2004). In an area of research that is just getting underway (Schlaggar et al. 2002), use of neural imaging has produced a rich array of data on language processing of mono- and bilinguals. Finally, there are external factors such as environment, education and culture that affect the acquisition and final state achievement of second language (Bialystok 2001).

The final chapter summarizes the arguments presented throughout the book and draws conclusions concerning a critical period for L1A and L2A. Substantial evidence exists that favors Lenneberg's notion of a critical period for L1A: late L1 acquisition (Curtiss, 1977), neural development (Lenneberg 1967), signed language acquisition (Mayberry 1993; Newport 1994), creoles (Bickerton 1995). Although apparent longitudinal deterioration of L2 ability in syntax and phonology seems to suggest a biological basis to L2A as well, a number of factors render the critical period only indirectly applicable to nonnative language learning. For child L2A, it

appears that age five to ten is a period of diminishing ability in language acquisition, but not a sudden loss, and that there is, in fact, no precipitous end of acquisition capacity. Furthermore, other evidence argues against a critical period for L2A: adults learning an L2 may be capable of near-native acquisition (Sorace 2003), and deterioration of language learning ability varies substantially from individual to individual (Long 2003).

1.2 Background research on critical periods

1.2.1 *Biology, maturation and behavior*

The idea of a *critical or sensitive period* in biological development first emerged in the late nineteenth and early twentieth centuries through the study of experimental embryology (Scott 1978), and was developed substantially in the twentieth century, especially with respect to language (Bailey et al. 2001; Birdsong 1999a, b; Bornstein 1987a; Bruer 2001; Krashen et al. 1982; Rauschecker and Marler 1987; Scott 1978; Scovel 1988; Singleton 1989; Strozer 1994). Stockard (1978 [1921], 25) demonstrated a “critical moment” of embryonic development of minnow eggs by interrupting growth (with temperature change) during a sensitive period of rapid cell proliferation, an intervention that inhibited normal development and resulted in “a great variety of monsters.” His original hypothesis had been that the cause of abnormality was the interfering agent (e.g. a noxious chemical), but he later realized that the abnormality was a function of the timing of the interference. His experiments demonstrated that timing is crucial to the development of an organism, and that intervention at different moments in the sequence results in predictable abnormalities. The notion was extended throughout the twentieth century to apply to animal imprinting (Lorenz 1978 [1937]), human behavior (Gray 1978 [1958]), neurological development (Hubel and Wiesel 1962), birdsong learning (Nottebohm 1978 [1969]) and human language (Lenneberg 1967).

Scott (1978, 82) notes that bonding in domestic chicks had been observed even in the nineteenth century, but that it was Lorenz (1978 [1937]) who first recognized its importance for animal behavior and established the term “*imprinting*.” Lorenz, who was aware of the attachment pattern of birds (which bond to the first moving object they perceive, usually the mother or another member of the species), demonstrated this connection in an experiment with a greylag gosling. He kept the gosling isolated from other birds for a week after hatching so that it attached to humans, and then he transferred it to a turkey hen. The baby goose followed the turkey and used it for warmth, but would abandon the hen whenever a human came into the environment, the hen being a poor

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substitute for the original imprint-target of the gosling, the human. Lorenz (ibid., 87) compares this imprinting to embryological development, laying out two significant points relating to the notion of critical periods. “(1) The process is confined to a very definite period of individual life, a period which in many cases is of extremely short duration . . . (2) The process, once accomplished, is totally irreversible, so that from then on, the reaction behaves exactly like an ‘unconditioned’ or purely instinctive response.” The extrapolation of the notion of critical period to behavior led to the observation of sensitive periods for bonding in a wide range of animals and humans as, for example, Gray’s (1978 [1958]) discussion of critical periods for human socialization parallel to those of animal attachments. However, the wide range and unpredictability of human behavior, including language, render the critical period question much more complex, as subsequent discussion will show.

Timing is a clearly critical element in the physiological development of vision, a phenomenon first observed by Hubel and Wiesel (1962). These scientists induced irreversible loss of *binocularity* by depriving kittens of input to one eye during a critical moment of their infancy. Numerous experiments of this type – in which kittens were deprived of input to one eye that was sewn shut – followed, to confirm the importance of adequate input to both eyes during the critical period to insure binocular mature eyesight. The onset and termination of the critical period were determined by systematically varying the onset moment and duration of the deprivation with different subjects. Timney (1987), in discussing monocular deprivation, points out that there is not a single sensitive period, but rather that different physiological functions develop during different sensitive periods; furthermore, the intervention does not result in irreversible damage if corrective measures are taken to restore adequate input during the sensitive period. Deprived kittens whose previously sewn eye is reopened may reverse the loss of binocularity if the opening is done within a certain time frame.

The area of critical period research that is perhaps most informative on the question of human language is the learning of *birdsong*, a phenomenon that displays several complexities of timing, triggering models and adaptability. Research substantiates the restriction of song learning to a specific period of life for many species (e.g. the white crowned sparrow) labeled *closed-ended*, although there are other species that continue to be able to learn new song later in their lives (e.g. canaries), known as *open-ended*. Young birds (usually male) learn their song through exposure to the melodies of adult members of their kind, most often as a result of hormonal stimulation, and they “subsequently convert this memory to a motor pattern of song production in the sensorimotor phase of development”

(Brenowitz 2004, 561). Sex hormones are essential at the learning phase, but also for production and for continued availability of song throughout life, particularly during the reproductive cycle when song is deployed to protect territory and attract females. Thus, the elements that enter into play for development of song during a sensitive period – sex hormones, relevant areas of the brain, species-specific song, seasonal changes – are also crucial to the adult bird's annual cycle. In both open and closed-class species, areas of the brain related to song increase up to 200 percent during breeding season, as, for example, in song sparrows whose neuron number increases from 150,000 in the fall to 250,000 during the breeding season (*ibid.*, 564). The annual metabolic changes are influenced by day length, social cues from females and seasonal hormonal variations. "Rather than representing two distinct adaptations, juvenile and adult song learning may represent a continuum of [brain] plasticity," Brenowitz (2004, 578) concludes.

In a classic experiment demonstrating a sensitive period for a closed-ended species, Nottebohm (1978 [1969]) performed an experiment with a chaffinch to tease out the elements of the learning process. Male chaffinches (the singers) learn their repertoire when exposed to the spring song at around nine months of age (the onset of "puberty" when testosterone turns their beaks blue). By one year they have established stereotyped song themes that they cannot alter for the rest of their lives, and they cannot learn new songs after this point. In Nottebohm's experiment, he deferred puberty by castrating a male chaffinch and depriving him of song during the age of nine to twelve months. A year later the bird was given testosterone and exposed to two songs, A and B, both of which the chaffinch learned. This same experiment was conducted the following year with the same bird, but at that point the chaffinch had established his inalterable repertoire, demonstrating that the critical period could be deferred, but that it was inalterable once completed.

Marler (1987), who has used both live models and taped models to train sparrows, finds that the birds trained with taped models are subsequently able to learn new songs presented by live models even after they have solidified their knowledge of the tape-induced songs. He also observes that the input required for learning is distinct for different stages of development, especially in the species that could have extended periods of song acquisition. He concludes that the sensitive period for birdsong learning is flexible since sparrows are able to extend their learning period when exposed to live models, but that this period is susceptible to several variables.

Orca whales also develop communication systems during maturation, with specific dialects and unique name calls. "Each dialect is an acoustic badge of identity; youngsters learn their pod's dialect from their mothers and older siblings. They also learn to recognize the dialects of other pods"

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(Chadwick 2005, 94), since they need to pick mates among distantly related pods. Gould and Marler (2004 [1987], 207) – after discussing the preprogramming and time-sensitive nature of instinctive learning in a variety of species, including language learning in humans – conclude “that human learning evolved from a few processes, which are well illustrated in other animals, to fit species-specific human needs.” Indeed, Doupe and Kuhl (1997) elaborate similarities between human language and birdsong: innate predisposition, production after perception, specialized forebrain, sensitive period learning, necessity of modeling and feedback, and sustained plasticity.

1.2.2 *Definitions of critical period*

What are the defining characteristics of a critical period? Scott (1978, 11) points out the biological basis of a sensitive period, “the idea that critical stages occur at times when rapid cell proliferation and rapid developmental changes are occurring.” He also observes the irreversibility of the developmental change. In principle, a critical period “implies a sharply defined phase of susceptibility preceded and followed by lack of susceptibility” (Bateson 1987, 153). In fact, though, there are many variables for behavioral phenomena found in animals: nature of the input (e.g. taped or live models), schedule of onset (e.g. delayed start of input), length of time (e.g. shortened or lengthened exposure), and traits of the individual subject. The studies of birdsong learning have shown a good deal of flexibility in the many variables and indicate an adaptability that enables the songbird to stretch the sensitive period in different ways.

Looking more specifically at language, Eubank and Gregg (1999, 67) define critical period as “a physiological phenomenon that implicates some aspect of the central nervous system,” interacting with input from the environment during the course of development. Bruer (1999, 110) postulates that critical periods make evolutionary sense “because they rely on stimuli that are ubiquitous within normal human environments – patterned visual input, the ability to move and manipulate objects, the presence of speech sounds. These kinds of stimuli are available in any child’s environment, unless that child is abused to the point of being raised in a sensory deprivation chamber.” Bornstein (1987b, 5) identifies five parameters for describing sensitive periods:

- onset
- terminus
- intrinsic maturation event
- extrinsic trigger
- organismic system affected