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Critical Periods, Time, and Practice¹

Eve V. Clark

1 Critical Periods, Sensitive Periods, and Lateralization

In 1967, Eric Lenneberg made a compelling case for there being a critical period for first language acquisition, with a rough cut-off at around puberty. He drew on evidence from childhood aphasia, hemispherectomies, brain trauma, and recovery of speech, all linked to the localization of speech in the left hemisphere. From the general observations on recovery of language after trauma, Lenneberg concluded that there was a critical period for first language acquisition analogous to the critical period for imprinting in chicks, say, or for learning species-specific bird-songs.

Today, many biologists prefer to use the term 'sensitive period' rather than 'critical period' because development in many species appears rather more labile, and it has become clear that a great deal of learning can still occur after any so-called critical period. It has also become clear that in language, especially in second language learning, other factors also play a critical role—namely, the amount of time expended in initial learning and practice, the degree of immersion, motivation for learning, and attitudes towards the language itself.

In this paper, I revisit the question of whether we are well-served by appealing to a critical period for language acquisition and from then on simply assuming that children can't learn a language fully after that period has passed. I begin with a brief consideration of some recent findings on brain lateralization for language, and the absence of specifiable cut-offs in neurological specialization of different parts of the brain. This suggests that there may not after all be a well-defined critical period or even sensitive period for language acquisition. I then take up some preliminary estimates of the amount of time children expend on their initial language learning, and compare these amounts to the average time adults spend on second language learning in the typical classroom. I also visit the issue of whether children receive feedback when they make errors, what form this can take, and the

¹ This research was supported in part by a grant from the Center for the Study of Language and Information, Stanford. I am grateful to K. Anders Ericsson for helpful discussion of expertise, and to Penelope Eckert for prompting me to consider the role (or non-role) of critical periods for language, compared to the roles of exposure, correction, and practice.

pragmatic basis for its construal as negative evidence. A further question here is whether adult language learners receive comparable feedback in any form to the same extent as young children. I end by turning to some research on the acquisition of expertise—expertise in chess, in music, and in athletics—and consider some of the implications of this work for the idea that language acquisition and language use also involve expertise—expertise in language.

2 Localization with Lateralization

Localization of different centers in the brain occurs gradually over time as infants experience more and more of the world around them. For language, lateralization in the left hemisphere takes place only gradually, beginning at around 12-16 months of age. At this stage, one finds equal activation in both hemispheres for words, for example. But by age two, for familiar words, children show activation only in the left hemisphere. Unfamiliar words continue to produce activation in both hemispheres (Mills et al. 1993, 1997). That is, once children become familiar with certain words (learn their sounds and some part of their meaning), these words appear to be stored primarily in the left hemisphere and so show activation in that hemisphere when children hear them. Presumably the same gradual lateralization takes place for the sounds and constructions of a language. Until recently, the apparent difficulties adults have in learning second languages have been attributed to their being past the critical period for language learning, that is, past the point at which their first language has been lateralized in the left hemisphere. But if lateralization has no particular cut-off point, this may offer a less than satisfactory explanation.

Localization for other domains like sight, touch, and hearing, also takes time. In effect, the lateralization of abilities in either the left or the right hemisphere is now known to occur over the course of many years, with no particular cut-off or change of pace at puberty. Such lability in hemispheric specialization suggests that we should look at other factors as well in trying to make sense of the apparent course of acquisition in language, and of apparent failures of acquisition after a certain age or stage in life.

3 Time and Exposure

The first factor I'd like to take up is the amount of time young children under 3 or 4 spend on language, simply in terms of the amount of exposure they receive (child-directed speech), and how this compares with the amount of exposure typical for second language learners. Let's take young children

first, and start from the assumption that they are awake for at least 10 hours a day, and in their waking hours are normally in the company of an adult. This would allow for potential exposure to language for 70 hours a week, and 3,650 hours a year. In their first four years, then, children may be exposed to some 14,610 ($3 \times 3,650 + 3,660$) hours of language. How do these numbers compare to the second language case?

For adults learning a second language in the classroom, the typical amount of exposure amounts to 1 hour a day, and to 5 hours a week. (One might add 1 additional hour in the language lab, for an adjusted total of 6 hours a week). This, then, in an academic year of 30 weeks would amount to between 165–180 hours a year, or over four years (for comparison with the first language child), to between 660 and 720 hours of exposure. This amounts to just 5% of the exposure in time of the young child. The amount of time expended in exposure to a language then favors the young child by 20:1.

What difference might this asymmetry in exposure make? First of all, it offers children the possibility of much more experience with the language during the earlier stages of learning; it also implies that children will have many more opportunities for practice, again in the earlier stages of learning. Adult learners of a second language, by comparison, get very little exposure, perhaps even less than the ratio suggests, since languages are typically taught in classrooms with many participants, and the teacher often addresses only one at a time. In addition, because of the social setting of adult learning, they are also less likely to have opportunities for intensive practice.

4 Information About Errors

When adults talk to young children, they spend a lot of time checking on what their children intended. They frequently reformulate their children's erroneous utterances in conventional form, either within a side sequence or as an embedded correction (Jefferson 1972, 1982). In fact, adults reformulate in response to child errors between 50% and 70% of the time, to children under 3;6. These reformulations are significantly more frequent than replays of conventional child utterances, where the adult simply repeats what the child said with no changes, as shown in Figure 1 for Abe, a child acquiring English, and in Figure 2 for Philippe, a child acquiring French. The data from these two children are representative of the five studied by Chouinard and Clark (2003).

Reformulations, where adult speakers take up the child's intention and present it in conventional form (i.e., with errors corrected) as they check up on whether this was indeed what the child meant to say, present children

with extensive negative evidence about their errors. Adults reformulate in response to all kinds of errors: errors of phonology (the adult pronunciation of words) and morphology (inflections and word-formation), errors in syntactic constructions and word choices. The amount of reformulation appears very similar across error-types.

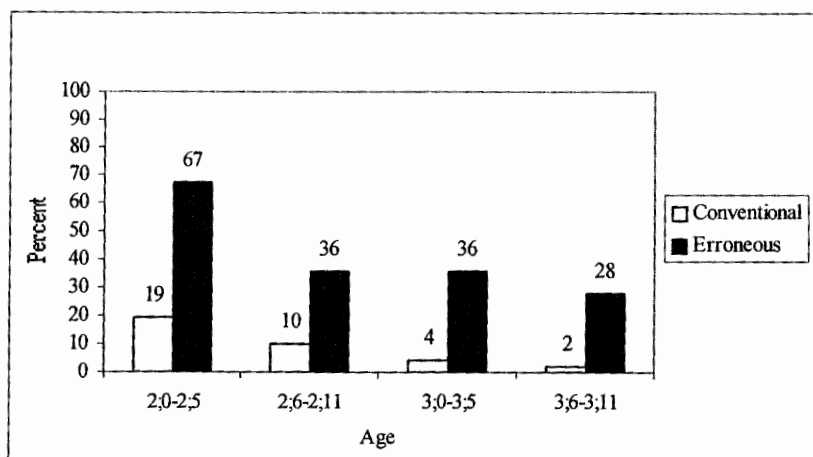


Figure 1. Percentage of Abe's conventional utterances replayed and erroneous utterances reformulated

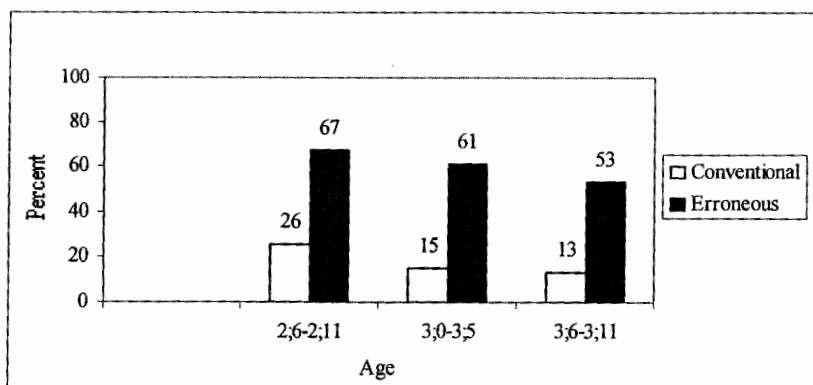


Figure 2. Percentage of Philippe's conventional utterances replayed and erroneous utterances reformulated

At the same time, adults appear to use more reformulations to younger children, to children who are making the most errors. But once past 3 – 3;6, children's utterances become both more conventional in form, with fewer errors, and, as a result, more intelligible, and adults then produce many fewer reformulations (see further Chouinard and Clark 2003). What appears to be most important here is that children receive extensive information about how they should have said what they are trying to say at a stage where they are making a lot of errors. Such negative feedback dwindles as they produce more utterances that observe the adult conventions for the language.

The data from Abe and Philippe are representative of the five children we studied longitudinally (Chouinard and Clark 2003). Our analyses also showed that the findings from English and French were highly comparable, so this is a first step in showing how general reformulations are within middle-class populations. At the same time, reformulations *per se* likely represent just one of many possible forms of negative feedback adults make available to young children.

5 Feedback About Errors

When adults reformulate children's errors, they offer a conventional version of what the child appeared to want to say as they check up on whether this was the case. As a result, they consistently offer direct evidence to children about errors they have made. This evidence comes in two major forms. About two-thirds of adult reformulations appear in side sequences, illustrated in (1a) for English and (1b) for French. Most of the remainder occur as embedded corrections, illustrated in (2).

1 (a) English [Kuczaj, Abe 12:6]

Abe (2;6.4): milk. milk.

|| Father: you want milk?

|| Abe: uh-huh.

Father: ok. just a second and I'll get you some.

1 (b) French [Léveillé, Philippe 1:1007]

Philippe (2;1.19): l'est fermé, l'est fermé le disque.

|| Mère: il est fermé le disque? Le disque il est fermé?

|| Philippe: le disque est fermé.

2 (a) English [Kuczaj, Abe 4:66]

Abe (2;5.10): I want butter mine.

Father: ok. give it here and I'll put butter on it.

- 2 (b) French [Léveillé, Phil 2:116]
 Philippe (2;1.26): une petit de lait.
 Mère: une petite boîte de lait.

Overall, children who hear reformulations like these may receive negative feedback on up to 70% of their errors. They also give quite extensive evidence that they notice and attend overtly to such reformulations: they may repeat the adult's version, thereby correcting an error directly; or they may reject the adult version where the adult has misunderstood—this, too, is good evidence that children are attending; they may acknowledge the adult's reformulation before going on; and they may repeat some piece of new information that had been included in the reformulation (Chouinard and Clark 2003). These are all evidence that children are paying overt attention to the reformulations they hear. And they may well be paying covert attention and taking in what they hear, even when they may be unwilling or unable to produce it yet themselves. That is, they store information about conventional forms in memory long before they necessarily produce those forms themselves.

Adult reformulations offer explicit negative evidence because they offer an immediate and direct contrast in form to the child's erroneous utterance. That is, a reformulation expresses the same intention as the child (the same meaning) but provides a different form when the child has made some error. The fact of the reformulation signals that there is an error, and it simultaneously identifies the locus in the child's utterance and offers a correct conventional form for that same meaning. So the principle of contrast plays a critical pragmatic role here, along with conventionality, in providing negative feedback through reformulations when children make errors (Clark 1987, 1993).

6 Adult Learners vs. Children

Adults don't appear to get as much feedback about errors as children do. Why? What's the difference between adults and children when it comes to learning a language? At least two factors may be important here: use of a first language, and matters of face.

First of all, adults learning a second language already know a first language. It's important to stress this because it could help that they already know what kinds of things are likely to be encoded in language, and they know a good deal about possible structures in language. But this may be less of an advantage if adults are living a life where they use their first language most of the time—in their jobs, in everyday social contacts, and with their

families. This leaves very little place for use of the second language outside the classroom. While children learning a first language are motivated to come to belong to the speech community, adults already belong to a speech community and are trying to join a second one, one that is typically not as accessible as their current one because it is distant in space.

The second factor I mentioned is the question of face. Adults are well aware that repetitions in conversation often implicate some kind of error in the original speaker's utterance (Walker 1996), so extensive use of side sequences and embedded corrections in conversations with adults might be less effective as a source of information about the conventional way to say something than with young children. For adults these conversational devices, if used very frequently, would intrude too much on the conversation itself. Moreover, frequent signaling of errors in this way might well result in some loss of face for the second-language speaker. While this is probably not a consideration for very young children, it matters for adults who are highly effective in their first language but still novices in the second one.

When these factors are combined with the small number of hours when adults are exposed to a second language, and the rare opportunities for practice, it becomes very clear that they receive much less exposure, get much less correction of errors, and get much less practice than they did in learning their first language or languages.

7 Gaining Expertise

So what does it take to become an expert—a chess master, a concert pianist, or a tennis champion? Studies of expertise and what it takes to achieve it show some consistent parallels across domains. One needs a certain amount of time; a good amount of exposure on top of the basic time investment; corrections of errors in the early stages, and ongoing practice to sustain the skill involved. In music, for instance, reaching a professional level of expertise appears to take 10,000 hours, with a further 25,000 hours of added exposure to music-related activities (listening to pieces, reading scores, taking relevant classes, etc.), plus ongoing practice (see Ericsson 1996). Similar times hold for gaining expertise in complex games like chess and in many sports such as tennis. In every case, the experts sustain their levels of skill with ongoing practice (e.g., Ericsson, Krampe, and Tesch-Roemer 1993, Krampe and Ericsson 1996). Another ingredient in all these domains appears to be consistent correction of errors during the early stages of learning. How do these estimates for time, exposure, and practice compare in the case of language?

When we apply these measures to first language acquisition, we see the following: Children would need three to four years of producing language to

attain their first 10,000 hours of learning, practice, and use. But they don't start to produce anything until age one at the earliest and may not start producing any recognizable words until age two—this is within the normal range. So four years would take them to about age five for many of the basics in language production. This would still leave a huge amount of vocabulary and a good bit of syntax to be mastered, not to mention many subtleties of language use. Children must not only learn how to produce the structures of their language, but also just how to use them to the best effect, for instance in making puns, telling jokes, persuading someone of a particular view, or persuading them to undertake some action, describing games and rules, telling stories (whether fictional or autobiographical), and mastering the details of everyday social interactions where the details all matter within each language community (Clark 2003). (Comprehension is a somewhat different matter and harder to assess here, in terms of how much initial exposure may be required, either to get started, or to add to one's storage in memory. But comprehension clearly plays a major role in learning to deal with the full range of structures and uses in a language.)

But 10,000 hours covers just the basics. To become experts, skilled users, children need a further 25,000 hours of exposure, along with extensive, ongoing practice. With language, of course, we can say that we practice every time we say something. Children also need practice in how to adjust the language they are using to different addressees, to different topics, and to different situations. They need to be sensitive to the appropriate register to choose, as well as the appropriate genre in each setting they encounter. So learning to use language with skill depends on both cognitive skills—how best to present the specific perspective the speaker wishes to convey—and social skills—how best to affect achieve the goals of the conversation given a particular addressee.

All of this takes time and the outcomes reveal an extended range of individual differences in language skill: differences in knowledge of the structures, in size of vocabulary, in making appropriate choices of perspective and genre to fit the goals at issue; differences in skill at telling stories, remembering and telling jokes, in persuading others of one's views, in taking account of each and every participant in a conversation. Language learners do *not* all end up with the same knowledge or skill. They display at least the same range visible for other domains such as chess, music, or athletics. And much of the variance in this range, I would suggest, can be attributed to differences in the kinds of exposure children (or adults) receive, the amount of correction for mistakes early on (adults are at a disadvantage for this), and the sheer amount of both practice and exposure they accrue not just during the first five or six years of learning a language, but also thereafter—how

they continue to use language—the range of addressees, of topics, of settings—and the range of uses they continue to be exposed to.

8 Conclusion

We need to take another look at what's required in learning a language, whether a first language in early childhood, or a second, third, or fourth being learnt in adulthood. While there may be a period that is socially and cognitively ideal for first language learning—a time when children have few social obligations or preoccupations, when they are unconcerned with 'presentation of self' and unselfconscious about the impressions they make on others—it may well be that the general bar to learning another language well is less a matter of age-of-acquisition than a matter of willingness-to-invest-enough-time, where enough time means a minimum of 10,000 hours plus a further 25,000 hours of exposure to a language in its many forms and uses—a large investment indeed, but one that appears to be essential for the acquisition of such a complex skill.

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