

MATURATIONAL CONSTRAINTS ON LANGUAGE DEVELOPMENT

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Despite several decades of research and writing on the topic, serious differences of opinion persist as to the scope and source of maturational constraints on language development. While many accept the weak version of the critical period hypothesis for first language acquisition, there are those who deny any subsequent age-related decline in adult language learning abilities and/or reject the existence of sensitive periods for non-primary language acquisition. Further, even among those who acknowledge the existence of subsequent maturational constraints, there is considerable disagreement as to the linguistic domains to which they apply and as to their explanations.

The issue is important since it bears fundamentally on second language acquisition theory building and because it has implications for practice in language teaching and other areas. This paper reviews findings from studies of first and second language development, concluding that they are consistent with the hypothesis that both are controlled by language specific biology, and that both are subject to maturational constraints, specifically sensitive periods during which learning is successful, and after which it is irregular and incomplete. Four potential explanations for the constraints are discussed: affective, cognitive, input and neurological factors. All are problematic, but only three seem wrong.

1. The importance of maturational constraints

The question as to whether or not there exist maturational constraints on language development has importance for both theory and practice. If there are one or more neurologically based sensitive periods for second language acquisition (SLA), for example, theorists may need to posit alternate learning mechanisms or processes for older learners - such as use of general inductive problem-solving instead of universal grammar in some theories; alternatively, if no sensitive periods exist, theories which claim that first and second language acquisition are essentially similar processes, e.g. because universal grammar is available to learners of any age, have at least *prima facie* validity. It is difficult to evaluate theories which say nothing about the issue.

Similarly, just about any position taken on maturational constraints has potential implications for practice. A belief that post-pubertal language learning will inevitably be incomplete, at least where phonology is concerned,

for instance, might lead to recommendations for an early start for foreign and second language programs and to the replacement of a native-like accent as a goal for adult classroom learners with something more realistic. Rejection of the critical period idea, on the other hand, might influence the choice of methodology in first language intervention programs for mentally retarded adult populations or for normal adult SL learners and lead to greater flexibility in the timing of FL/SL programs.

Despite the apparent need to resolve the issue, however, few ideas in first or second language learning have created more controversy. Differences in interpretation are nothing new in any research area, of course. Here, however, disagreements as to the facts, their interpretation and their explanation are all very pronounced.

2. An interactionist view of maturational constraints

Part of the reason for the disagreement may be the perception that a decision on this issue entails commitment to one side or the other of the larger so-called "nature-nurture" debate, despite the fact that this has long been recognised as a false dichotomy where much human development is concerned (Hinde, 1974; Oyama, 1985). Proponents of maturational constraints often imply that failure (by "environmentalists") to recognise what they see as the clear biological underpinnings of language development is tantamount to denying the uniquely human creative language-learning ability of the child. Opponents, on the other hand, sometimes appear to be reacting to the "nativist" stance they perceive as entailed by acceptance of the existence of constraints, seeing it as a "black box" pseudo-explanation, and where language is concerned, one that is genetically implausible as well.

Why this is an understandable, if misguided, view is detailed by Oyama (1979) in her seminal article on the history and status of the concept of the sensitive period in developmental studies. As is well known, the critical/sensitive period notion had its origins in embryological development (loss of plasticity in body tissues as they become functionally differentiated, for example) and, in ethology, in the work of Lorenz, Tinbergen and others on imprinting in birds. The definition, Oyama shows (p.87 *et passim*), was initially strict and narrow: the behavior had to appear in infancy, be short and abrupt, have permanent consequences, and show developmental fixity, i.e. because genetically determined, be impervious to environmental influences.

Because of this, the sensitive period concept is often still associated with 'innate', 'unlearned', 'instinctive', or otherwise 'genetically determined' phenomena.

Saying something is 'biological' or 'maturational' does indeed often imply reliably scheduled sequences, changes in anatomical structure and size, and apparent independence of specific environmental contingencies. The terms need not be so narrowly construed, however, Oyama notes, especially when applied to human behavior. Even where animal behavior is concerned, subsequent research in ethology has relaxed the definition. Imprinting is now recognized as often being quite gradual, variable and open to environmental influences, and as not necessarily irreversible or instantaneous. Variability, Oyama reminds us (p.91), is as much an inherent part of biological processes as regularity, so that a sensitive period need not necessarily be universal or uniform to be interesting.

In sum, while maturational constraints are certainly compatible with nativist accounts of learning, they do not entail such views. Oyama (p.88) suggests that a sensitive period is more usefully thought of in an interactionist framework as a time of heightened responsiveness to certain kinds of environmental stimuli, bounded on both sides by states of lesser responsiveness.

And where the identification of sensitive periods is concerned, she notes (p.99), no specific degree of abruptness is required in the changes in sensitivity - gradual increases or declines may be expected in some cases - provided the differences are marked enough to allow identification of the period from the periods preceding and following it.

Indeed, while the terms 'sensitive period' and 'critical period' are used interchangeably throughout most of the ethological and psychological literature, a growing preference for 'sensitive period' even among ethologists (and by Lenneberg in his later writings) reflects the recognition that many of the changes will tend to be both less absolute and less than abrupt because often *not* genetically determined, or developmentally fixed. One proponent of this view is Bronson (1965, 1974). From his work on visual development and the central nervous system, Oyama reports, Bronson has concluded that

"sensitive periods in the development of more primitive, peripheral, earlier-maturing systems would tend to resemble the traditional 'critical period', with a brief interval of plasticity, abrupt termination and rather permanent, well-defined effects.

Later developing, more complex and central neural structures would involve less sharply circumscribed periods of sensitivity and variable consequences." (Oyama, 1979, p.99)

Human language is obviously a complex and central neural structure. Age-related declines in language learning ability, therefore, may be expected to be correspondingly variable in onset and effect. One would no longer predict, for example, that all areas of language will be affected during the same period (say, puberty) in all individuals. Nor would one need to show such a catastrophic one-time loss in ability in order to claim that sensitive periods exist for first or second language learning.

3. Starting hypotheses

While some critics of the notion apparently find the idea of maturational constraints counter-intuitive, not to mention empirically unfounded, a case can be made for just the opposite view, that positing maturational constraints, including one or more sensitive periods for human language development, is the *unmarked* hypothesis. One would expect there to be such constraints, among other reasons, because they are so well attested in the development of other animal species, in other types of human learning, and in other human neurological abilities.

Sensitive periods are pervasive in the animal world, from rhesus monkeys through finches and snails to dewinged walking flies (Mimura, 1986). Hinde (1970, p.566) has noted that:

"(I)n general it is a useful working assumption that no particular case of learning would occur with equal facility at all stages of the life cycle . . . the problem of sensitive periods for learning is the problem of the ontogeny of behavior itself."

Some of the animal work suggests tempting analogies with language development. Consider, for example, the findings of Marler (1970) for song-learning in white-crowned sparrows whose initial exposure to the song of the adult male, the model in that species, was manipulated by the researcher (Figure 1).

Time of first exposure to adult male song	Level of song learned by bird
(1) 3 - 7 days	- song indistinguishable from that of birds with no training at all
(2) 7 - 60 days	- total song, with all the special (Critical period) trills and grace notes
(3) 60 - 100 days	- limited basics of the song, (Marginal period) without full elaborations of normal adults (the "fragile" features?)
(4) 100+ days	- song indistinguishable from that of birds with no training at all

Marler (1970): Critical period in white-crowned sparrows

Figure 1: A tempting birdsong analogy

Marler's work provides clear evidence of the need for readiness in the organism before external stimuli have an effect, and of the existence of a critical period in these birds. The results the animals achieve when first exposed during what he calls their 'marginal period', furthermore, remind one of adult learners who achieve basic communicative ability in a SL but whose speech is marked by numerous errors, particularly of phonology and morphology, or in other words, is 'without the full elaborations of normal (native speaking) adults.'

It is obviously unjustified to extrapolate from findings like these to human behavior. While tempting, the analogy is incomplete. Many songbirds, for example, will only learn the songs of their own species, a kind of hardwiring not found in language learning. Nevertheless, writing of human development, specifically children's ability to recover from disease in the central nervous system, Lenneberg (1968, pp.168- 9) suggests it is natural to expect maturation to play a role: "if we look at behavior from a biological point of view, we should be surprised if we did *not* find critical periods,"

noting that development consists of "one long chain of phases in which one or another set of factors is of critical importance."

Oyama (1979, p.92), too, argues for the reasonableness of the expectation of maturational constraints on language learning. She observes that psychologists and educators generally accept that maturation constrains the onset of many other human developmental sequences, as seen, for example, in the ineffectiveness of training and practice in accelerating skills as diverse as toilet training and reading. In medicine, similarly, she notes, it is common to speak of periods within which remedial treatment must be administered if satisfactory results are to be obtained, and of age limitations to recovery from certain kinds of trauma (e.g. brain lesions). The same is true of resulting impediments, such as aphasia. Contrary to early opinion, recovery from these may never be perfect, even when the patient is a young child (for review, see Snow, *in press*). The prognosis does differ substantially, nevertheless, depending on the age at which the injury was suffered.

Other examples are to be found in work on child language, where researchers have found, for example, that overt error correction is futile until the child is developmentally ready to progress, at which time an error spontaneously disappears. The same lack of developmental readiness probably accounts for the null findings for teacher error correction in so many SL studies (for review, see Chaudron, *in press*). Similarly, SLA research on the effect of instruction on interlanguage development (see Long, 1987, for review) has lent credence to the notion that psycholinguistic readiness to learn constrains teachability, i.e. is a prerequisite for instructional effectiveness (Pienemann, 1984). What is not so popular, Oyama suggests, is the idea that such states of readiness may not last forever.

Yet, again, the initial evidence favors such an idea. Sensitive periods appear to exist for infant attachment (H. Gleitman, 1986), and possibly for chess and music, e.g. the acquisition of relative pitch, studied by Litke and Olsen (1979). Impressionistically, it seems that they may also operate in sport.

The starting hypothesis must be that first and second language development is subject to maturational constraints, including one or more sensitive periods. Specifically, it is predictable that first or second language development begun after the close of the sensitive period for language learning will be incomplete, i.e. identifiably different from normal monolingual native models of that language. Should this turn out to be the

case, differences might also be discernable in such areas as acquisition processes or mechanisms.

In addition, as Studdert-Kennedy (1985, p.549) has pointed out, to substantiate the idea that there are sensitive periods for language learning, two other requirements must be met. First, unique sensitive periods must be shown, distinct from any general age-related increase or decline in cognitive abilities. Second, the biologically regulated receptivity of the learner must be demonstrated to be specific to linguistic, not any, stimuli.

With these goals and requirements in mind, what, then, are the facts? Is there evidence of maturational constraints in either first or second language development? Is there anything to explain?

4. First language development

4.1. Evidence of a maturational schedule for normal L1 development

There is now a considerable amount of evidence consistent with the hypothesis that first language development follows a maturational schedule, and one, furthermore, that is specific to language, as opposed to general cognitive abilities. This is important because showing that language learning in general follows a biological time-table makes the idea of biological *constraints*, a particular aspect of the general schedule, *prima facie* more reasonable. Conversely, it would be illogical to expect to find maturational constraints in the absence of any other evidence of biological scheduling. The following are some of the more salient findings.

4.1.1. Common time of onset of production, rate and age of completion of language development across languages, cultures and linguistic environments

Children show common starting and finishing ages (and so, average rates) of development across languages and cultures (Slobin, 1982). Most strikingly, the same time of onset of production is even seen in the absence of linguistic stimuli, which argues strongly for maturational scheduling. Feldman, Goldin-Meadow and L.Gleitman (1978) studied six deaf children whose hearing parents did not know or use any sign language. Despite the consequent lack of input, it was found that the children started creating their

own informal system of communicative gestures - "home sign" - producing single gestures and two and three sign sequences at the same time and encoding the same meanings as hearing children start producing one, two and three word utterances. (The interdependence of internal and environmental factors is shown even in this case, however, by the fact that the deaf children failed to develop "closed class" items during this period - the same items shown by Newport, Gleitman and Gleitman, 1977, to be somewhat responsive to variation in caretaker speech in normal L1 development at this time.)

4.1.2. Common errors, sequences and levels of attainment, regardless of cognitive abilities

The errors made by children learning the same language are remarkably similar, and often involve constructions never heard or rarely heard in the input, such as uninverted Wh questions and uncontracted auxiliaries (Bellugi, 1967). Observed developmental sequences are also very similar, suggesting common underlying processes (James and Khan, 1982). Finally, as is often remarked, first language development is almost uniformly successful, regardless of children's other abilities, whereas adult (but not child) SLA is more typically a failure, and ultimate attainment extremely variable.

It might be argued that all these data could be interpreted as simply reflecting children's use of the same general cognitive endowment. However, language-specific maturational control is suggested by the fact that much of what children know about their mother tongue could not be derived using general inductive cognitive reasoning, as shown by the by now well-known arguments concerning language learnability and stimulus poverty (e.g. Chomsky, 1975; Pinker, 1979), as well as by the errors children would be expected to make if they were learning solely by general inductive procedures, but do not (Maratsos and Chalkley, 1980).

Furthermore, if the common errors and sequences were merely due to the same cognitive abilities being applied, we would expect to see variation in the rate of development and also in the level of attainment achieved comparable to that observed among children on other cognitive learning tasks. In fact, average rate of acquisition is fairly uniform, as noted previously (section 4.1.1.), and the level of proficiency attained, while clearly *not* uniform (Fillmore, Kempler and Wang, 1979), is remarkably homogeneous. There is relatively little effect, for example, for learner variation as great as an

IQ range of 70-140, which would affect other learning tasks.

A final counter-argument to a general cognitive interpretation consists of cases which have been documented of the developmental *dissociation* of language and cognition. The best known of these, "Genie" (Curtiss, 1977), the victim of severe child abuse, began first language development at 13-and-a-half after little or no previous exposure to language. Genie's semantic abilities far exceeded her syntactic ones after over 10 years of normal contact with adults, and Curtiss reports that this could not have been due to intellectual deficits, for Genie's abilities were more advanced than those of a normal learner, facts pointing in Curtiss' opinion (1977, p.292) to "language-specific learning mechanisms", perhaps even specialized for syntax. Another (reverse) case, one of two similar ones, is that of Anthony (Curtiss, 1982), whose language and short-term memory were those of a six-year-old (his true age), but all of whose other skills and behaviors placed him at about 24 months. Anthony's vocabulary and syntax, that is, had not been impeded by severe cognitive deficits, and so, Curtiss points out (1982, p.297-8), had presumably not been acquired using general learning mechanisms.

Such cases satisfy the requirements proposed by Studdert-Kennedy (section 3), strongly suggesting the existence of maturationally scheduled *language-specific* learning abilities. The case of Genie additionally suggests that such abilities atrophy (are subject to an off-set time) independent of any decline in general cognitive abilities, i.e. are only fully usable during a biologically timed sensitive period for first language development.

4.1.3. Relative lack of effect of environmental variation

In general, as L.Gleitman (1986) has pointed out, less effect than might be expected is seen for environmental variation, such as cultural or social class differences in child-rearing patterns or in caretaker speech, in normal L1 settings. And a striking lack of effect for such variation in an abnormal setting was that noted previously, reported by Feldman *et al* (1978), of deaf children of hearing adults with no ASL.

Some environmental influence is apparent, however. On the basis of the Feldman *et al* study and on the kinds of items Curtiss (1977) reports that "Genie" did and did not learn, respectively, Goldin-Meadow (1982) has suggested that there are "resilient" features of language (e.g. word-order production rules, constituent structure and recursion) which seem to be

resistent to learner or environmental variation, and which humans may therefore be "prepared" to learn, and "fragile" features (e.g. pro-forms, movement rules, auxiliaries and other "closed class" items), for which they may be less "prepared".

Goldin-Meadow showed, for example, that the onset of recursion, the ability to express two (or more) propositions in a single sentence, at roughly two-and-a-half in the deaf children, was comparable to that reported for hearing children learning other languages (Russian and English), and so was unaffected by impoverished input. Recursion, she noted, was also one of the properties reported as unrelated to normal variation in speech to hearing children by Newport, Gleitman and Gleitman (1977), whereas auxiliary, a "fragile" feature, was one of the few items that study did report to be related (specifically, to the input frequency of inverted yes/no questions, which front and stress auxiliary). Another such item was plural endings, which Curtiss (1977) reports Genie, too, did not learn to produce, and only understood when given formal training.

Goldin-Meadow suggests (1982, p.74) that, unlike resilient features, such as recursion, fragile features will not develop "without a linguistic model or beyond the critical period," and that even with a model, small variations affect rate of acquisition of fragile features. Hence, she speculates that there may be different principles of learning involved in the acquisition of resilient and fragile properties of language.

4.2. A sensitive period for L1—test cases

The original "strong" version of the critical period hypothesis for human language (Lenneberg, 1967; Penfield and Roberts, 1959) predicted (wrongly) that no first language learning was possible if the child was not exposed to language before a certain age, usually given as puberty, around 13. The so-called "weak" version of the hypothesis holds that some learning is possible beginning after that age, but that native-like abilities are unattainable, and that the course of development becomes more irregular and falls further short of native levels of achievement the later the age of onset.

The existence of one or more sensitive periods for first language development might be expected to be seen in abnormal or incomplete learning in cases of late starters. Given that exposure begins at birth in normal

children, relevant test cases will by definition be from the abnormal L1 literature. As can be seen from the following review, the literature supports the weak version of the critical period hypothesis for first language learning.

4.2.1. Feral children and child abuse cases

The data on children kept linguistically isolated from birth for varying periods of time are generally consistent with the "weak" version of Lenneberg's hypothesis. Learning is possible, but it becomes more irregular and falls further short of native levels of achievement the later it begins.

The case of "Isabelle" (Mason, 1942), shows that the off-set time, for most language abilities at least¹, is later than six. Imprisoned with her mute, uneducated mother and the possessor of only a few primitive gestures until she was six-and-a-half, Isabelle showed *accelerated* development to normal levels of language and intelligence within 18 months following her release. Other cases of feral children (unfortunately, often poorly documented by the original chroniclers) are reviewed by Curtiss (1980), who finds them to show that those children only achieved native-like abilities if they were recovered before age 10.

The tragic case of "Genie" (Curtiss, 1977) is by far the best documented test of Lenneberg's original claim. Starting at about 20 months, Genie spent the early years of her life confined in a small room, often strapped to a potty, fed infant food, with little human contact apart from feeding, with little or no language directed at her, and punished for making noise. Aged 13,7 on discovery, with the appearance of a child half her age, unable to stand erect, and without language, Genie nevertheless succeeded in *accelerated*, somewhat irregular passage through normal language learning sequences, but stopped well short of native-like attainment, especially in morphology and syntax, only understanding 'fragile' plural after training, for example. She was always better at vocabulary and semantics than syntax, and at comprehension than production. To the extent that the findings of a single case of a young woman, no doubt traumatized by her childhood experiences, can be generalized to normal populations, Genie shows, as Curtiss, claims, that first language acquisition is possible starting after puberty, but that learning will be irregular and incomplete. Her case is consistent, that is, with the hypothesized

¹ Recent work by Werker and Tees (1983) suggests that certain phonetic discrimination abilities are lost during the first year of life.

existence of a sensitive period for first language development.

4.2.2. Hearing children of deaf adults

"Jim", aged three and a half when first studied by Sachs, Bard and Johnson (1981), had been brought up in a fairly isolated rural area, the son of non-signing deaf parents. Otherwise denied normal input, Jim had succeeded in learning some 50 words and routines (allowing him to express simple semantic notions) but minimal syntax from watching television. The provision of normal conversational experience thereafter was followed by rapid catch-up (attainment of age norms or better by age 6). Similar findings for a total of some 20 other children are reported by Goldin-Meadow (1982), Jones and Quigley (1979) and Schiff (1979).

4.2.3. Deaf children of hearing adults with no ASL

As reported earlier, Feldman, Goldin-Meadow and Gleitman (1978) observed the emergence of "home sign" in six deaf children whose hearing parents did not know or use ASL. The youngsters were found to begin creating single gestures and two and three sign sequences at the same time and encoding the same meanings as hearing children start producing one, two and three word utterances. Importantly, however, the deaf children failed to develop "closed class" items by around age 4 and 5, as hearing children would have done. The study suggests, in other words, that the basics of human language survive the absence of a language model, underscoring the contribution of innate language learning abilities, but that the environment is crucial for the elaboration of closed class items and complex syntax.

4.2.4. Deaf children's acquisition of ASL

Some of the clearest evidence for a sensitive period for first language development comes from work on the acquisition of ASL as a first language, the population concerned this time being free of the traumas and mistreatments suffered by children like Genie.

In an early study, Woodward (1973) reported that some ASL rules (agent-beneficiary directionality, negative incorporation and verb reduplication) were learned more often by individuals who started ASL before age six. In research still under way, Newport (1984) and Newport and Supalla (in progress) have found clear evidence of sensitive periods for first language

development. They studied congenitally deaf individuals who had been exposed to ASL as a first language for equivalent periods of time (10 years), starting at different ages, and all of whom were fluent in the language when tested. The results are striking.

Group 1, native/early learners, first exposed to ASL between birth and six, reach native standards and show very uniform error types along the way. Especially noteworthy are their errors of omission and sequentialization (producing the component morphemes sequentially rather than simultaneously), since these suggest that they are learning ASL via morphological analysis, in some cases even when most of their exposure is to older non-native or late acquirers who give them somewhat deviant (morphologically unanalyzed) input.²

Group 2, learners first exposed after 7 make some errors in closed class items (grammatical morphology) after 10 years of use, and show progressively more evidence of holistic (unanalyzed) learning the later they start.

Group 3, late/adult learners (first exposed after 12), stop far short of native standards, and show much greater individual variation in error types, generally making few omission or sequentialization errors, but many arising from their use of frozen forms (signs holistically related to their meanings, not constructed from their component morphemes), with much of their production monomorphemic or of unanalyzed chunks containing 2+ morphemes, suggesting holistic rote learning. Newport and Supalla (forthcoming) describe this group's use of closed class items as sporadic, irregular, and often incorrect.

4.3. Summary and conclusion

First language development is maturationally scheduled, and like most scheduled services, this one is not available at all times. The cases of Genie, of feral children, of deaf children of hearing adults with no ASL, and of children starting to acquire ASL at different ages, combine to provide compelling

² Just what form the deviancy takes will be of interest. If some adult models consistently omit certain morphemes, the native-like acquisition process by a deaf youngster would be analogous (in some linguistic respects, at least) to creolization. Snow, p.c., however, reports that research in progress on ASL use in the homes of these children suggests that the deviancy is in the *consistency* of suppliance, rather than the total omission, of the morphemes.

evidence of maturational constraints on first language learning. They suggest a sensitive period or periods of wide scope, including morphology and syntax, not just phonology. Further, they show that when first exposure is late, ultimate attainment will be incomplete, and that not even lengthy exposure and use can compensate for this.

4.4. A note on rate

Note that the *rate* of development of what was learned was faster in Isabelle, Genie and Jim than in normal children, presumably because of their relatively advanced cognitive development. One would not say, however, that this rate advantage falsified the sensitive period hypothesis, given the findings with regard to course of development and non-native-like ultimate attainment in Genie's case and those of other late starters. In just the same way, one would not want to claim that the well attested short-term rate advantage for adults over children (section 5.2.) nullifies the idea of sensitive periods for SLA, given the findings with regard to non-native-like ultimate attainment there, too, yet many critics (e.g. Flege, 1987; Genesee, in press; McLaughlin, 1984; Snow, 1983, 1986) have based their challenge to the sensitive period hypothesis in SLA in large part on this very point.

5. Second language development

5.1. Introduction

As indicated earlier, there is a wide divergence of opinion among SLA researchers as to the existence, scope and source of maturational constraints in non-primary language learning. Some researchers find what to them seems clear evidence of maturational constraints, for example, data appearing to show that children but not adult starters can attain a native-like accent in the L2. Thus, Tahta, Wood and Lowenthal (1981a) report that if acquisition begins by 6, there is no transfer of accent, if after 12-13, there is invariably accent transfer, and if between 7 and 11, accent is usually very slight. They write: "Our data then suggest a very heavy effect of biological maturation; up to age 7 and after 12 this effect seems to be overwhelmingly important." (p.270)

Similarly, after reviewing over 20 child/adult comparisons, Krashen, Long and Scarcella (1979) conclude that, while older learners start faster, children soon overtake them and reach higher levels of ultimate attainment

in the long run.

A second group of researchers find the same data ambiguous. Following a survey of virtually the identical set of studies, Hatch (1983, p.196) offers the following opinion:

"The general picture that emerges is this: The research does not strongly support an optimal age hypothesis that says "the younger the better." Nor does it support a contrary hypothesis, "the older the better." We may state another hypothesis, "the older *child* the better," but even that is not clear from the data."

And McLaughlin (1984), among others, essentially agrees:

"In conclusion, it seems that the critical period hypothesis [for phonology] remains very much a hypothesis at the present time . . . how in fact one should define the critical period hypothesis . . . whether there are critical periods for other language skills, what the length of the critical period is in each case, and how this relates to the process of lateralization cannot be answered with any certainty. As Hegel said of Schelling's philosophy, "this is a night where all cows are black." (1984, p.58)

A third group claim that the same studies point to an advantage for *older* learners, and reject the "younger is better" notion altogether, even for SL pronunciation ability. Genesee (in press, p.35), for example, concludes that

"(1) all aspects of second language learning appear to be learned more efficiently and, therefore, possibly more easily, at least in the initial stages, the older the learner; and (2) native-like levels of proficiency in the phonological, syntactic and comprehension aspects of the second language can be attained in post-pubertal learners."

Taking an even stronger position, Snow (1983) called the "children are better" view an 'illusion' and a 'myth', and wondered why the conviction is held "not only by the general public which has no access to recent research results but also by professionals who read the research literature and by ESL teachers who have good first hand information about learners' skills?" (Snow, 1983, 141)

Finally, even among those who agree about the existence of a negative effect for increasing age of onset (AO), there is a wide divergence of opinion as to its scope and source. Re scope: is the decline in language learning ability limited to phonology, phonology and morphology, or to those two and collocation, for example, or does it appear in all domains? Where explanations are concerned, affective, cognitive, social-psychological, input and neurological variables, as well as various combinations thereof, have each

been proposed. Again representing the skeptics, on the other hand, Snow has expressed the view that "serious researchers waste too much time if they have to produce explanations for illusions as well as for real data." (*op. cit.*, 149.)

Ellis (1985) echoes these sentiments when he dismisses cognitive and neurological explanations for age differences on the grounds that no age differences exist and, hence, that there is nothing to explain.

Clearly, despite numerous studies and a great deal of theorizing on the topic, opinion is sharply divided. In fact, however, as the following review is intended to show, the picture is actually not as confused as it first appears. There is clear, if incomplete, evidence that maturational constraints operate in SLA, too. There is an initial short-term rate advantage for some older learners over children, but only quite young children are capable of eventual native-like SL attainment.

5.2. Rate differences

As noted by Krashen, Long and Scarcella (1979/1982), if short-term (rate) and long-term (ultimate attainment) studies are distinguished, the SLA literature supports three generalizations:

- (1) adults proceed through early stages of morphological and syntactic development faster than children (where time and exposure are held constant),
- (2) older children acquire faster than younger children (again in early stages of morphology and syntax, where time and exposure are held constant), and
- (3) child starters outperform adult starters in the long run.

(1) and (2) refer to rate, only; (3) refers to ultimate attainment, although it is neutral with regard to the absolute standards attainable by either group.

Short-term studies, ranging in duration from a few minutes to a few months, speak only to differential *rate* of acquisition, not to absolute abilities. They probably favor older learners because of their "teach and test" or laboratory interview formats, and their occasional use of tasks where superior cognitive skills and/or test-wiseness can obviously play a role. In one such study comparing adults with children, Asher and Price (1967) taught Russian to a total of 134 eight, 10 and 12-year-old and (college age) adult students for 25 minutes using Total Physical Response, and found that adults outperformed

all the child groups. Snow and Hoefnagel-Hohle (1978) studied the naturalistic (untutored) acquisition of Dutch by 96 English-speaking children (8-10 years old), adolescents (12-15 years old) and adults, assessing each group's performance on pronunciation, morphology, imitation and translation tasks after three, six and nine/ten months in Holland. In general, the adolescents and adults outperformed the children after three, six and nine/ten months in country. Differences were decreasing at the second and third times of testing, however, and the children had already caught up with the adults on pronunciation by time 2.³

Similar results favoring adults have also been found in short-term studies of phonology involving either teaching and testing phonemic contrasts in a new language (Olsen and Samuels, 1973) or simply testing subjects' ability to imitate target language sounds in nonsense words (Snow and Hoefnagel-Hohle, 1977). The advantage is limited to older learners over children, however; younger adults go faster than older adults, as shown in a study of the ESL listening comprehension skills attained by two groups of instructed French-speaking adult military personnel in Quebec (Seright, 1985).

Representative studies consistent with generalization (2), favoring older over younger children in rate of acquisition of morphology and syntax, are those of Ekstrand (1976), Fathman (1975) and Morris and Gerstman (1986). Ekstrand (1976) studied 2,189 eight to 17-year-olds learning Swedish as a SL over a two-year period. He found a steady improvement with age, and that older children performed better than younger children on measures of listening comprehension, reading, free writing, pronunciation and speaking. In an analogous ESL study, Fathman (1975) looked at 200 children, aged 6-15, resident in the US from one to three years, assessing their English morphology, syntax and pronunciation using the SLOPE (a picture-cued sentence-completion test) and a picture description task. 11-15-year-olds outperformed six-10-year-olds on morphology and syntax; the younger group did better at pronunciation.

Morris and Gerstman (1986) compared the performance of 182 American public school children, ages 9 (n=61), 12/13 (n=73) and 16 (n=48), on a 20-minute lesson in Hawaiian, testing the children immediately after the

³ Due to limitations on space and the reader's patience, representative sample studies, only, will be briefly described in this and subsequent sections, with references provided to other relevant literature.

lesson and a second time one week later. Instructional materials, which were presented auditorily, pictorially and orthographically, consisted of a cartoon story (target language models), an English-Hawaiian vocabulary list (also available to students during testing to avoid a memory problem), and explicit rule statements (grammatical explanations) on the main focii of the lesson: the stative/transitive verb and locative *i* versus *ma* contrasts in Hawaiian. The test was written, and consisted of 14 multiple-choice items, seven sentence- unscrambling (word order) items and seven error-detection (semantic acceptability judgment) items. Of the total of 28 items, half were syntactic and half semantic, half easy and half difficult, half linguistic and half meta-linguistic, and half involved rule learning and half rote learning.

Using the first test scores as a covariate in the analysis of the delayed test scores to help eliminate the memory factor, the two older groups were found to do significantly better than the nine-year-olds, with the 12/13-year-olds doing best overall, but not significantly better than the 16-year-olds. Results for moderator variables (type of learning, task and sub- test) were inconsistent, but with sentence-unscrambling being easier for all students and semantic error detection easier for the youngest group than for the two older groups. Motivation to learn Hawaiian was significantly *negatively* correlated with test scores, and attitudinal measures uncorrelated. Multiple regression analyses revealed consistent predictive power across age levels for English reading ability, knowledge of a SL, and SES, among other factors, however, showing that, while powerful, age effects can sometimes be mitigated by a variety of cognitive, demographic and task factors.

Similar or related findings are reported by Snow and Hoefnagel-Hohle (1978), Ervin-Tripp (1974), Adiv (1980), Harley (1982, 1986), Ramirez and Politzer (1978), Fathman and Precup (1983), Ekstrand (1976), Asher and Price (1967), Olsen and Samuels (1973), Florander and Jansen (1979), Grinder, Otomo and Toyota (1962) and Weber-Olsen and Ruder (1980).

Walberg, Hase and Pinzur Rasher (1978) found no effect for AO on the ESL of Japanese children in US schools, but an effect for length of residence (LOR), a result apparently in conflict with generalization (2). As noted by Krashen *et al* (1982, p.163), however, at least two factors explain the contradiction. First, most of the children had been in the US from three to four years, and some for as long as 12 years, when tested, sufficient for younger children to have caught up with older ones. Second, the teacher ratings used

in the study assessed the children's progress in terms of age/grade norms for American children. Since norms for older children are higher, the fact that the Japanese children showed no effect for age really means that the older children had gone faster, consistent with generalization (2), having reached their (higher) standards in the same amount of time as the younger children had reached their lower ones.

Findings for pronunciation in these age groups are at first sight somewhat confusing. Most studies report a rate advantage for older over younger children in phonology like that in morphology and syntax, but some do not, and as usual, the waters are further muddied by a third set of long-term findings showing an advantage for younger children. In order to explain the results for *rate*, it is necessary to invoke two moderating variables, amount of exposure and task.

Studies showing an initial rate advantage in phonology for older over younger children share two properties in common. First, they tested children who had either had (through classroom instruction or residence abroad) or were given (in the laboratory) sufficient exposure to the target sounds to let their superior cognitive and test-taking skills operate, but not so much time that they could be overtaken by the younger children, who eventually outperform them in phonology, as elsewhere. Studies showing a short-term rate advantage for phonology in this way, with the approximate amount of exposure involved in each case, are Olson and Samuels (1973) - 10 hours, Ervin-Tripp (1974) - maximum of nine months, Ekstrand (1976, 1978) - less than two years, Grinder, Otomo and Toyota (1962) - one year, and Snow and Hoefnagel-Hohle (1978) - three to 10 months.

In a study which sampled children from a similar age range, but included subjects with longer periods of exposure (one to three years), Fathman (1975) found that six-to-10-year-olds starters had overtaken 11-to-15-year-olds. From one to three years had apparently been long enough for the younger immigrant children going to school in the US to catch up with older children in phonology.

The exact amount of exposure needed for younger children to catch-up is unclear at present, and catch-up *time* actually overlaps across studies somewhat; two years was not enough in Ekstrand (1976), whereas from one to three years was sufficient in Fathman (1975). More precise estimations are

impossible on existing data, however. Future research on this issue will need to use more exact measures of exposure than LOR, and should avoid pooling data on large groups of subjects with varying amounts of exposure. The literature suggests, nevertheless, that the rate advantage for phonology is especially short-lived. In their study of the naturalistic acquisition of Dutch by English speakers, Snow and Hoefnagel-Hohle (1977) report that the initial age differences favoring adolescent and adult learners for phonology disappeared after four to five months, with the younger children overtaking the two older groups on some sounds by 10/11 months.

In apparent conflict with the pattern outlined above, however, some *short-term* (laboratory) studies have found *immediate* superiority for younger over older children in phonology. In a study focusing primarily on vocabulary learning, Yamada, Takatsuka, Kotake and Kuruse (1980) had 30 Japanese children, aged seven to 11, learn one- and two-syllable concrete nouns by seeing pictures of the objects twice, accompanied by two repetitions of models each time, for a total of four models per word. The children were then asked to attempt to say the words 10 times and given feedback after each trial. Yamada *et al* found that the younger children learned the words faster, with learning scores being significantly negatively correlated with age, and, impressionistically, that they had better pronunciation.

In another study, Tahta, Wood and Lowenthal (1981a) found that the ability of a group of 231 five to 15-year-old English school children to imitate French and Armenian pronunciation of isolated words and phrases after one model declined steadily with increasing age. The same children's ability to replicate intonation in longer phrases remained steady in the five to eight-year range, and then dropped rapidly between eight and eleven, plateauing again in the 11 to 15 range. The reverse pattern was observed in the number of models and trials the children required before they could produce the intonation patterns well, the most marked increase in the number of trials needed by older children coming from eight to 11 (Tahta, Wood and Lowenthal, 1981a, b).

Contrary to first appearances, however, the findings by Yamada *et al* and Tahta *et al* may not actually conflict with those of the first set of studies at all, due to the nature of the task both groups of researchers utilized. The procedures followed in each study allowed subjects just four models and one model, respectively, of the words or phrases to be imitated. Hence, as

suggested by Krashen *et al*, the findings favoring younger over older children in these two studies may really simply be demonstrating the younger children's superiority for mimicry.

A third laboratory study exists which appears to threaten this explanation, however. In a separate study of Dutch by English speakers, Snow and Hoefnagel-Hohle (1977) used 136 subjects with no knowledge of Dutch, ages ranging from five to 31. Each subject listened to and repeated five different nonsense words using Dutch sounds on tape a total of 20 times per word, the subject's own imitations being recorded. These were later rated by one of three NS judges on a five-point scale, revealing a small linear improvement with age. The crucial difference between this study and those by Yamada *et al* and Tahta *et al* is probably the 20 different exposures to the target sounds subjects received, which were apparently enough data for the older children and adults to begin to work on, whereas one or four models in the other studies were not. In fact, the findings of all three studies agree in this respect, since Snow and Hoefnagel-Hohle report that differences favoring the older subjects only began to emerge after the first 10 presentations.

The idea that the amount of exposure needs to be sufficient for older children's early rate advantage to manifest itself is further supported by closer examination of the Snow *et al* findings. The results show that, while older subjects (in the 12-31 age range) did somewhat better than the *youngest* children (five to 7-year-olds), there was actually very little difference between the latter group and children aged nine to 15, the groups of interest for comparison with other older-younger children results. Snow and Hoefnagel-Hohle do not provide raw scores, but inspection of their graphed results (Snow and Hoefnagel-Hohle, Figure 1), show that scores for *all* subjects (five through 31) fall within a narrow range, between approximately 2.5 and 3.25 on a five-point scale, and that seven and nine-year-olds actually did better than 10 and 11-year-olds. Lastly, the statistical tests reported as demonstrating an improvement with age within the entire group of subjects in fact show only that there was at least one significant difference between one younger and one older group (probably between five-year-olds and adults), not between each group and the next oldest. The statistical testing also showed that the *overall* increase in pronunciation ability with age was linear, not that older children did significantly better than younger children. In other words, 20 models was probably really only sufficient basis for a small early rate advantage for older

learners to offset the mimicry ability of the youngest children, not for the typically more noticeable rate advantage for older children.

In summary, most of the literature to date is consistent with generalizations (1) and (2), above, supporting the idea of a rate advantage for adults over children, and for older children over younger children, but with the advantage being temporary and applying primarily to developmentally early morphology and syntax. The advantage also operates in phonology, but seems to last for a shorter period, and requires a certain minimum exposure to target language sounds before it is measurable. Such findings would seem to argue against the existence of maturational constraints on SLA were it not for the initial rate advantage for late starters noted earlier in cases of delayed first language acquisition, including, crucially, cases where the ultimate attainment of some of the subjects concerned in fact provided clear evidence of sensitive periods for primary language development.

While short-term learning efficiency data are important for many practical concerns, therefore, such as the timing of SL immersion programs (Genesee, 1983), the most important data for demonstrating maturational constraints on SLA are not those dealing with rate of development. Rather, they are, first, those concerning generalization (3) above, to the effect that children outperform adults in the long run, and second, those probing absolute potential, i.e. whether adults (or child starters, for that matter) can reach native-like levels in a SL. It is to studies addressing these issues that we now turn.

5.3. Ultimate attainment differences - sensitive periods for SLA

The results of long-term studies, those comparing achievement after several years of foreign language study and/or residence in the SL environment, show that younger starters consistently outperform older ones, and that only quite young children are capable of native-like attainment, even after many years of target language exposure. Learners starting later than age six often become communicatively fluent, but typically finish with measurable accents in phonology - and with progressively later starts, with "accents" in other linguistic domains, too.

5.3.1. Phonology

In one of the largest and most carefully conducted studies of this issue to date, Oyama (1976) looked at the pronunciation ability of 60 Italian immigrants with different age of arrival, or age of onset (AO), in the US (range 6-20), who had lived there for different periods (range 5-18 years). Oyama found a clear main effect for AO, and no effect for LOR or motivation once the effect for AO was partialled out. Child arrivals performed in the range of NS controls; those older than 12 on arrival did not, and accents were also evident in some who arrived earlier than 12.

Oyama's results are consistent with those of several other long-term SL and second dialect studies. Of particular interest, the finding that some children starting considerably younger than puberty retained accents in the SL is by no means unique. First, Oyama's findings were replicated by Patkowski (1980). Earlier, Asher and Garcia (1969) had found that 71 Cuban students with AO in the US of 1-6 were judged closest to native-like on a sentence-repetition task, with stronger non-native accents being heard in progressively more subjects in groups with AOs of 7-12 and 13-19. In a Canadian study, Ramsey and Wright (1974) observed a sharp drop in the intonation perception abilities of immigrant children arriving in Toronto schools after age seven. And finally, in a study of the ability to acquire the phonology of a second dialect, Payne (1980) found that predictable, regularly conditioned vowel phonemes of the variety of English spoken in King of Prussia, Philadelphia, were learned by all children moving there from parts of the USA where other dialects are spoken. Unmotivated exceptions, however, were only mastered by children who arrived by age six and had locally born parents who spoke with the King of Prussia accent in the home.

The suggestion that age six is critical for phonology also receives support from several short-term studies. The sharp drop in imitation abilities observed by Tahta, Wood and Lowenthal (1981b) can be accounted for by positing that maturational constraints begin to set in as early as six for suprasegmental phonology and soon after that for segmental phonology. Such a view would also account for the findings by Fathman (1975), for the impressionistic pronunciation assessments in Yamada *et al* (1980), and for the findings of a short-term second dialect study by David (1985).

The beginning of a decline in phonological abilities by age six is

considerably earlier than has traditionally been assumed by those believing in maturational constraints, but cannot be explained away as an artefact of insufficient SL or second dialect exposure. Some children in the six-10 age group in Oyama's study, for example, were accented despite LOR of 12-18 years, and as reported earlier, several of the long-term studies tested but found no effect for LOR. Note, also, that the results for late ASL morphology (Newport, 1984; Newport and Supalla, in progress) discussed in section 4.2.4., show the onset of a decline for those first exposed after seven.

In summary, the SL and second dialect results all suggest that SL phonological attainment is strongly conditioned by learner age; specifically, (a) ultimate attainment is inversely related to AO, and (b) a native-like accent is impossible unless first exposure is quite early, probably before six. Very high standards can be attained starting later, of course, but not, it seems, native-like standards. Some ability appears to have been irreversibly lost.

Apparent counter-evidence to the idea of a sensitive period for phonology is offered in a series of studies by Neufeld (1979). Neufeld's research requires close scrutiny since his findings, interesting in themselves, are also relied upon heavily by critics of the sensitive period notion for SLA (see, e.g. Ellis, 1985; Flege, 1987; Genesee, 1987; Snow, 1987).

Neufeld has demonstrated that high levels of pronunciation and intonation can be achieved by both foreign and second language learners (a finding not inconsistent with the notion of a sensitive period for SLA, of course). In one study (Neufeld, 1977), after receiving 18 hours of intensive instruction in Japanese and Chinese phonology, 20 adult NSs of English first practised five times and then recorded 10 phrases of four to eight syllables in length in each language, the tape later being played to three NSs of each language. Three of the 20 subjects received a NS rating in one language, one of the three doing so in both languages. In other studies (Neufeld, 1979), a small minority of tapes made by adult starters (actual AO of subjects is not reported by Neufeld) with lengthy naturalistic French SL exposure and use were good enough to lead some individuals among groups of linguistically sophisticated and naive judges to misclassify them as those of NSs when hearing a master tape of randomly ordered NNS and genuine NS "read aloud" speech samples. His findings have led Neufeld to claim that accent-free SL performance is possible and that, therefore, there is no sensitive period for SLA.

This is arguably to overstate the case, however, since the studies suffer

from some important limitations and possible methodological flaws. Most obvious among the former is the question of population validity, or the generalizability of Neufeld's findings. First, in the French studies (although not in the Chinese/Japanese study), the NNSs tested were an elite few, drawn from a true bilingual environment (the English/French-medium University of Ottawa), who, after responding to a public request for subjects who considered themselves highly proficient bilinguals, survived an initial screening interview for accentedness, and who were therefore by definition not representative even of the attenuated sample volunteering for the study, much less of the population at large. This in no way invalidates them as potential test cases for the sensitive period hypothesis, of course, but severely limits any generalizations about typical adult SL pronunciation abilities.

Second, the variability of both native English and French in Canada, plus the numerous additional varieties of each language brought by continuous immigration from around the world, make for complex ranges of heterogeneous speech communities in cosmopolitan cities like Montreal, Toronto and Ottawa, as well as for great tolerance for and expectation of within-language variation. These factors may be expected to cause raters to think twice before rejecting accented English or French as definitely non-native.

Third, the speech samples in Neufeld's studies were extremely limited, consisting of tape-recordings either of rehearsed imitations of short isolated phrases (in the Japanese/Chinese study) or of a 78-word rehearsed passage (in the French study), read aloud by the subjects, and in some cases re-recorded by them if not in their opinion as native-like as they felt capable of sounding. The judges' task was to identify these (admittedly very proficient) speakers as non-natives, based on hearing the tiny careful speech samples presented on tape, mixed in random order with renditions of the same passage read by a number of NSs. How valid a sample even of those subjects' normal spontaneous speech is such carefully rehearsed and monitored behavior? Is the test to be whether some subjects can fool some of the raters (actually, just 75% of the raters was the standard used in the French study) some of the time or, as would seem more reasonable, whether some subjects can fool all of the raters all of the time? 'All of the time' obviously has to be circumscribed for the hypothesis to be testable at all, but not nearly as circumscribed surely, as in

Neufeld's research.

Finally, Neufeld's instructions to raters in both studies leave something to be desired. In the French study, judges were asked to rate the 10 speech samples they would hear as those of 'Canadian Francophones', 'Francophones from another country' or 'Non-Francophones'. Inclusion of the second category may have reminded them of the wide variety of "accented" but still "native" French heard in Canada, in turn quite possibly making them hesitant about classifying a sample as non-native. They were told there might be as many as 10 or as few as zero NSs on the tape, possibly setting up an expectancy of a 50/50 split, when there were in fact seven non-natives and just three NSs, thereby increasing the likelihood of false identifications of non-natives as natives.

Scovel (1981, p.398) has pointed out that the wording of the instructions given to the raters in the teaching study was ambiguous, and potentially leading. Judges were told they were about to hear 20 speakers of Japanese/Chinese, "some of whom, as recent arrivals [to Canada] might not yet have learned English. Still others . . . might be fluent speakers with detectable traces of interference."(Neufeld, 1977, p.53)

These instructions, Scovel notes, would presumably lead raters to suppose that they were hearing NSs of Japanese/Chinese (when all the speakers on the tape were in fact English speakers), and so set them up to classify NNSs as NSs. They might think, for example, that the voices were those of immigrants, NSs of Chinese or Japanese, now accented in their L1 due to learning English. A preferred procedure, used by Scovel (1981) in his own research, is to use both NSs and NNSs, inform judges of this, and present them with the straightforward binary task of deciding which group each subject belongs to on the basis of his or her speech sample.

In summary, Neufeld's studies seem most valuable as demonstrations of the high standards both foreign and second language learners sometimes achieve. Ironically, they may even underestimate adult abilities, for, as Flege (1987) has noted, demonstration of the L2 pronunciation-improving effects for some subjects of limited amounts of alcohol by Guiora, Beit-Hallahmi, Brannon, Dull and Scovel (1972) suggests that adults' phonological competence in a SL exceeds their typical L2 performance. Neufeld's findings do not, however, constitute counter-evidence to the idea that there is a sensitive period for SL (and second dialect) acquisition.

The need not just for unambiguous instructions but also for an adequate speech sample in research of this kind is shown by a cleverly designed series of studies by Scovel (1981) of the ontogeny of the ability to recognize a spoken or written foreign accent. Scovel had four groups of judges (31 adult NSs, 146 child NSs of different ages, 92 adult NNSs and 23 adult aphasics), rate 20 eight-second "read aloud" taped 31-word speech samples (recorded by the subjects after as many trials as they wished, as in Neufeld's research), as those of NSs or NNSs of American English. The adult judges were also asked to try to distinguish the same 20 natives and non-natives on the basis of short written pieces, unspeeded free paragraphs on 'The importance of sleep'. There were 10 NSs and 10 NNSs of American English in the sample, and Scovel took several steps to make sure the NNSs were very good. First, he selected only extremely proficient speakers, all of whom used English professionally on a daily basis, had a LOR of at least five years and had done graduate studies at US universities. Second, two of the "NNSs" (of American English) were actually NSs of Irish and South African English. Third, Scovel had three experienced ESL teachers screen the group for any whose pronunciation was not excellent.

The child judges' ability to make correct identifications increased steadily from 73% accuracy at age five (the youngest children Scovel could get to understand the task) to near perfect classification (97% accuracy) by age 9/10. The adult NSs also had no problem with the oral samples (95% accuracy), but performed at chance level (47%) on the written samples, presumably because, again, the writing represented the subjects' best, monitored production, and also allowed subjects to avoid problem areas that might have revealed them to be highly proficient but non-native.⁴ Adult NNSs improved in their detection ability with increasing ESL proficiency, but even the advanced group achieved an accuracy rate of only 77%, similar to the five-year-old children's performance and poorer than the 85% average of the group of aphasic patients. In addition to offering several methodological lessons for this type of research, Scovel's findings supplement those of a sensitive period for *production* of a SL or second dialect phonology by providing evidence of the

⁴ This interpretation is strengthened by findings by Ioup (1984) that linguistically sophisticated NSs could correctly classify interlanguage samples as belonging to one of two native language groups when phonological clues were available, but not when the only evidence was syntactic.

age-related evolution of accent *recognition* in NSs and of a sensitive period for accent recognition in non- natives.

5.3.2. Morphology, syntax and semantics

Evidence of age-related barriers to SLA is not limited to phonology, as some have claimed. Morphology and syntax are affected, too. This is not to say, of course, that syntactic development cannot continue late in life; it clearly can, as Wald (1986) has demonstrated in his analysis of late emerging complex syntax in the speech of Spanish-English bilinguals in East Los Angeles. It is apparent, however, that native-like attainment of an entire second dialect or SL syntax is beyond the late starter.

In another large-scale study, Patkowski (1980, 1982) obtained global syntactic proficiency ratings of transcribed five-minute excerpts from the spontaneous speech of 67 NNSs of English, immigrants to the US, and 15 NS controls during interviews with NSs. Use of written transcripts removed any phonological clues as to the speakers' backgrounds or proficiency. Two trained raters employed something like the old US Foreign Service Institute scale (with 0 indicating no ability and 5 meaning native-like performance) to rate the ESL speakers. Unknown to them, the subjects had varying AO, LOR (minimum of five years) and amount of formal ESL instruction. Patkowski found a strong main effect for AO (negatively correlated with proficiency), no main effect for any other variables (LOR, informal exposure or formal instruction), and no interaction effects. Most striking, as shown in the histogram (Figure 2), was the clear bimodal distribution among the NNS subjects, indicating that they represented two populations, identified by Patkowski as those who had arrived in the US before and after the age of 15. The younger group did statistically significantly better than those arriving after 15, and were themselves outperformed by the NS controls, who received perfect ('five') ratings (Patkowski, 1982, p. 111).

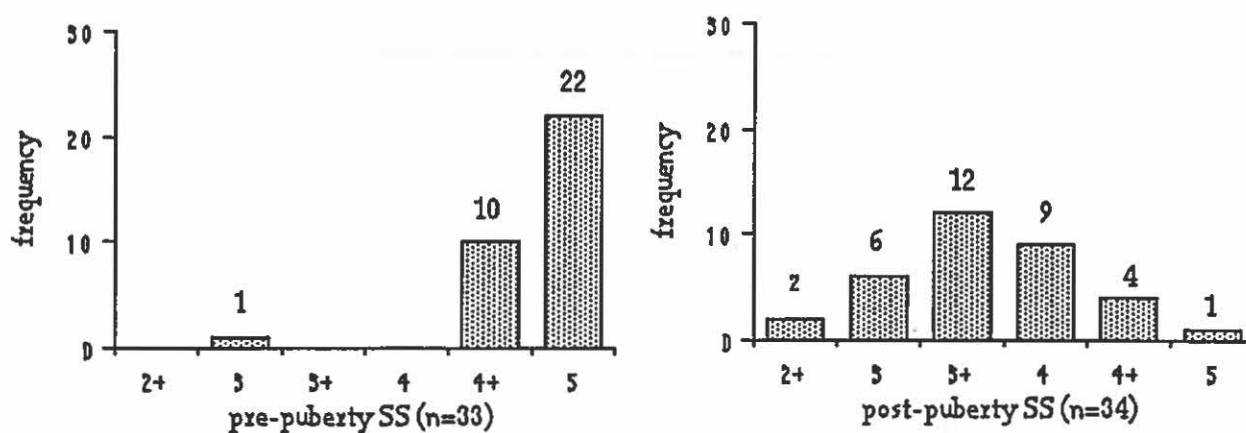


Figure 2: Syntax ratings for pre- and post-puberty learners
(from Patkowski, 1982, p.56)

While age effects clearly exist for morphology and syntax, it is also clear that more SL learners reach higher levels of proficiency in these domains than in phonology. This presents certain methodological problems for those doing research in these areas, principally the low frequency and relative ease of avoidance of the constructions of interest where ultimate attainment in very advanced learners is concerned, as seen in the written samples in the study by Scovel (1981) and the same finding by Ioup (1984). Since a great deal of production data may reveal nothing of interest, comprehension tasks which probe a learner's competence are called for. One solution is to use elicitation measures of some kind. In another part of his study, Patkowski (1980) had his subjects complete a grammaticality judgment test, and found the same pattern of results as for the syntactic ratings.

Coppieters (1986) elicited grammaticality and semantic judgments via a written questionnaire in a study of highly proficient, highly educated NNSs of French (mostly university faculty) from a variety of first language backgrounds, all of whom had learned French as adults. He then followed up with lengthy taped interviews (an average of 50 minutes) with each of his 21 NNS subjects, and with 20 French NSs. In the interviews, Coppieters obtained detailed explanations and glosses on the judgments. Items covered included semantic distinctions between pairs of French sentences contrasting *il/elle*

with *ce*, preposed and postposed adjectives, *imparfait* and *passé composé* tense choices, and article use, and grammaticality judgments in such areas as causatives and clitic pronouns, object plus predicate constructions and the A over A constraint.

Coppieters' subjects were all very advanced, six sufficiently so as to be reported by the researcher as having no "clearly detectable" accent in French after his conversation with them. Each, nonetheless, showed unmistakable evidence of being a NNS on the syntactic/semantic judgment tasks. While NS controls exhibited some variability on some items, the greatest NS variability on any item was easily exceeded by the least amount of variability shown by the NNSs on any item. The NNS *closest* to the prototypical NS norm on the quantifiable items (chiefly those concerning grammaticality judgments) was about three standard deviations away from the NS mean, showing, once again, that two distinct populations were being sampled, and leading Coppieters to report his findings as clearly consistent with a hypothesized age-related decline in SLA syntactic abilities. Qualitative analysis of semantic judgments obtained in the interviews revealed even greater divergence from NS norms in the semantic domain, and Coppieters concluded (1986, p.40):

"(T)he extent of the gap between native and non-native speakers, particularly as far as the interpretation of grammatical forms are concerned, points to truly qualitative, not simply quantitative, differences between the two groups."

5.3.3. Aural abilities

In a second study with the same group of 60 Italian immigrants, Oyama (1978) found a strong negative effect for subjects' AO in the US and their ability to comprehend masked speech. Children arriving before 11 performed similarly to NS controls, with later arrivals showing a progressive (linear) decline with age. Once again, there was no LOR effect. In the only other relevant study, as indicated earlier, Scovel (1981) found that NS ability to recognize foreign accents reaches native levels at age 10, and was not achieved by his NNS subjects. A replication with more advanced learners would be useful, however.

5.3.4. Lexis/collocation

There appears to be no published work on ultimate attainment in the area of lexis and collocation. Some unpublished information is available,

however. Patkowski (1980, pp.116-121) provides examples of lexical/collocation errors involving violations of selectional restrictions taken from the transcripts of the six most proficient NNSs in his sample of 67, as judged by their syntax ratings. Summarizing, Patkowski concludes that with NNSs of this ability level, very close to native norms, it is not so much qualitative differences in the errors that advanced NNSs and some NSs make, but rather, the frequency of such errors in the interlanguage samples and the degree of deviance that distinguishes the NNSs (1980, p.121).

In an unpublished small-scale study, Matsunobu (1981) found NS judges easily able to distinguish writing samples obtained under the same conditions from NS freshman composition students and non-native speakers in the same remedial writing classes at a US college. In solicited written comments and underlinings, judges indicated the basis of their classifications had been both the collocation errors in the NNSs' writing, which were absent in the NS samples, and conversely, idiomatic phrasing in the NS samples which the NNS writing did not exhibit. (Matsunobu used three groups of raters, incidentally, finding ESL teachers best at classifying the samples as NS or NNS, followed by freshman composition teachers, with college-level content teachers bringing up the rear.) Matsunobu's findings were later confirmed in a small-scale replication using NNSs, "standard" English NSs, and NSs of Hawaii Creole English (Toutaiolepo, 1984).

More research in this area is clearly needed, but findings to date suggest that age-related learning effects will be discernable here, as elsewhere. While NNS writing samples have passed as native in two studies (Ioup, 1984; Scovel, 1981), as reported earlier, it seems that lexical voids and collocation errors will be less easy to conceal in longer, spontaneous speech samples, or even in writing samples, especially under speeded conditions, when the NNS is less adept at planned discourse and avoidance strategies.

5.3.5. Discourse/pragmatics

Very little empirical work has been done in the areas of discourse and pragmatics, either, but the data so far again suggest the existence of maturational constraints. While not primarily addressing the age factor, a study by Scarcella (1983) produced results consistent with the idea that late starters will not be able to achieve true native competence in such subtle (but as Scarcella shows, measurable) areas as culturally appropriate topic choice and

sequencing, back-channel cues, and other conversational strategies. The 10 NNSs in her study had all arrived in the US by age seven, in fact, and yet were still deficient in these areas after from 12 to 17 years' residence. They had what Scarcella describes as a 'discourse accent'.

In a small-scale pilot study, Devenney (1986) administered a written test of cultural competence ('intertextuality') to NSs and NNSs of English. Subjects were asked to respond to 25 items probing their recognition of such things as literary reference and allusion in lines from advertisements, song titles, etc., e.g. 'To run or not to run', 'The Emperor's New Coins' and 'An orange is an orange is an orange'. While several of the NNSs had achieved fairly high proficiency in ESL (over 590 on the TOEFL), the highest NNS score on Devenney's test among subjects who had first received ESL instruction after age 12 (n=7) was lower than the lowest NS score, even though each NNS had lived in the US for at least four years. NNSs whose first ESL instruction had been before age 12 (n=4), on the other hand, all scored as high as the lowest scoring NS. There was no relationship between NNS scores and either LOR in the US or amount of classroom ESL study.

5.4. Summary

Contrary to recent assertions in the literature, there is clear evidence that maturational constraints are at work in SL learning, and that they are not confined to phonology. Studies showing an initial rate advantage for adults over children, and for older over younger children, in early syntax and morphology should be interpreted as just that - a short-lived rate advantage. They do not show that older children or adults are better learners. On the contrary, long-term studies reveal that ultimate attainment is inversely related to AO. Starting after the first five or six years of life, it is impossible to achieve native-like competence in phonology; starting later than the early teens, the same is true of morphology, syntax and semantics. Preliminary results suggest that the same will eventually be found to hold for collocation, discourse and pragmatics once more of the relevant research is undertaken.

Because some learners do reach very high levels in these domains, however, even starting in the teenage years in some cases, and because many problem areas (e.g. in syntax) occur infrequently and (unlike phonological difficulties) are often relatively easy to avoid, it is necessary to employ carefully designed elicitation tasks in order to reveal gaps in NNS competence.

Anecdotal reports of individuals who have achieved NS abilities in morphology, syntax, etc. are typically based on impressionistic judgments of inadequate samples of inappropriate (production) data.

5.5. A note on pidgins and creoles

Bickerton (1983) defines pidginization as SLA with restricted input, and creolization as first language acquisition with restricted input. Curtiss (1980) makes the interesting observation that the kinds of features (adult created) pidgins lack, but (child created) creoles have are very similar to the features that mark cases of severely delayed and post-sensitive period first language development as non-native-like, e.g. poor morphology. (Similar results appear to be emerging in cases of late sign language learning, too, one notes.) Given the data presented from numerous studies in this section on adult SLA documenting the failure of normal adults to attain native-like standards in a SL to which they have unrestricted access, it seems that Bickerton's definition of pidginization is in need of revision. Restricted input obviously plays a role in shaping pidgins. The crucial characteristic, however, appears to be the age of the learner trying to develop a SL with restricted input. Pidginization should be redefined as *post sensitive period* SLA with restricted input.

6. Explanations and problems

The sensitive period does not explain the phenomena to which it is applied, but is itself to be explained (Bateson, 1973; Hinde, 1970, p.564). Even among those scholars who agree that age-related differences in SLA do exist, there is serious disagreement as to their causes. At least four major clusters of variables have been implicated.

6.1. Social/psychological/affective factors

A number of writers have claimed that success and failure in SLA is largely the result of social, psychological or affective factors (e.g. Brown, 1979; Schumann, 1975; Taylor, 1974), with learner age being either irrelevant or only indirectly relevant in that children and adults often differ in these areas.

Variables such as attitude, motivation, empathy, self-esteem, ego-permeability and perceived social distance, enter into varied combinations to impede SLA in different ways in these writers' views, e.g. by acting as a 'filter'

which stops input from reaching brain areas responsible for language acquisition (Krashen, 1982, p.31).

Problems with this explanation include the following. (1) Children vary in these areas, but their language development does not (Gregg, 1984). (2) The claim offers no explanation as to why different linguistic domains are affected at different ages, e.g. phonology before syntax, or as to why particular linguistic features are "filtered out" of the input while other features seem to be acquired by learners with, e.g. very different attitudes towards speakers of the target language. (3) The precise claim is unclear. Just which of these variables, in what combinations, to what degree, are supposed to affect learning, and why? For example, does it matter that a highly motivated learner with a positive attitude, etc. has just one supposedly harmful affective state (say, low self-esteem), or is the claim that an "average" value for the variables (however that might be calculated) needs only to be positive to ensure success? (See, Schmidt, 1981, for discussion of this problem.) The claims made for these variables are not strictly testable or falsifiable until these and other issues are clarified. (4) If both the lack of precision of the claims and the serious instrumentation problems with valid measurement of affect variables cross- culturally in SL populations are temporarily ignored, they would in any case appear to have been empirically falsified (see, e.g. d'Anglejan and Renaud, 1985; Oyama, 1976; Purcell and Suter, 1980; Schmidt, 1981; Strong, 1984).

6.2. Cognitive factors

Increasing cognitive development has been claimed to underlie *decreasing* adult language-learning ability by Felix (1981, 1985), Krashen (1982) and Rosansky (1975), although the precise nature of their positions differs. One claim is that attainment of Piaget's formal operations stage around puberty involves (among other things) access to meta-linguistic skills and the (for adult SLA) counter-productive ability to perceive differences between the L1 and L2, not just their underlying similarities. Child L1/SLA and adult SLA are different processes, it is held, the former utilizing something like a LAD, the latter using general problem-solving abilities (hypothetico-deductive logic) instead of the LAD (Rosansky) or in competition with the LAD (Felix).

The rapid "catch-up" effect in "normalized" L1 acquisition (e.g. Curtiss, 1977; Lenneberg, 1967; Mason, 1942; Shatz and Gelman, 1980) by older learners,

and the rate advantage for older over younger L2 learners argues for some cognitive role. However, problems with this position include the following. (1) Doubts exist as to the age at which the formal operations stage is attained, Piaget specifying 14/15 or older, Ausubel (1968) claiming 10-12, with some individuals never doing so, and some critics (e.g. Brainerd, 1978) disputing Piaget's whole model. (2) Even if Piaget is correct, a one-time, qualitative change like the onset of formal operations could not account either for incremental loss in ability (if it exists) or for gradual/continuous age-related decline, which is well documented. This is at the very least an argument for the involvement of factors in addition to cognitive ones.

There are additional problems with the cognitive explanation. (3) If cognitive development was heavily implicated in language development, we would expect to see cognitive/IQ related variability in L1 success, but do not (section 4.1.2.), and similar variability in adult SLA, and only do so on tests of reading, grammar and vocabulary, not where oral production skills are concerned (Genesee, 1976). (4) If children and adults were learning in fundamentally different ways (children with the LAD, adults with general problem-solving abilities), we would expect to see evidence of different acquisition processes and sequences (e.g. different errors or stages), but there is little evidence of this to date, at least where child/adult SLA comparisons are involved (Fathman, 1975; Ritchie, 1978; but cf. Newport, 1984). There is also little research on this as yet, however. (5) There are many attested errors in the SLA literature which are hard to explain as the product of general problem-solving abilities. One example is Turkish learners' observed production of *No V* negation in early Swedish SL, given that both languages have post-verbal negation (Hyltenstam, 1977). (6) The evidence of the long-term superiority in ultimate attainment for young children over late starters in both first and second language development argues against any claim of a permanent advantage for cognitive maturity in the language learner.

6.3. Input factors

6.3.1. Type of input

In an article in which she rejected the idea that there was an optimal age for SLA, Hatch (1977) nevertheless speculated interestingly on the role of differences in the type of SL input child and adult learners receive as a

potential explanation of age-related differences in rate and ultimate attainment, should such differences eventually be shown to exist. Younger learners, especially young children, Hatch suggested, receive better tuned, less complex input, providing them with more and clearer samples from which to learn the target language.

There seem to be two problems with this explanation. (1) Younger learners receive "simpler" input, but older learners may in fact obtain better (more comprehensible) input because they are better able to negotiate it, as shown in a study by Scarcella and Higa (1982). (2) As noted earlier (section 4.1.3.), there is a relative lack of effect even for quite major input differences in (abnormal) first language development.

6.3.2. Amount of input

Snow (1983) has used the claim that younger learners have usually received more input when tested, because earlier AO often means greater LOR, as an argument that adults (who she thinks do as well or better at SLA on less input) are better learners.

As should be clear from the previous literature review, it is not in fact the case that adults are better learners. Two additional problems with this explanation, however, are as follows. (1) Adult learners (and many children) with unlimited input do not attain target levels (e.g. Pavesi, 1984; Schmidt, 1981). (2) LOR has been found to be unrelated to SLA in several studies (e.g. Oyama, 1976, 1978; Patkowski, 1980; Tahta, Wood and Lowenthal, 1981a, 1981b), or at most only briefly related (Fathman, 1976).

6.4. Neurological/neurophysiological factors

6.4.1. Plasticity loss with lateralization

With some minor differences among them, Penfield and Roberts (1959), Lenneberg (1967), and Scovel (1969, 1981), among others, have claimed that cerebral dominance is established with the end of lateralization, at around puberty, and that this marks loss of plasticity, which, during a critical period (0/2-13), allows recovery from aphasia, transfer of language function to an undamaged hemisphere, first language development in the mentally retarded, automatic accent-free SLA from mere exposure, and other good

things.

Problems with this position are well known by now. (1) The most serious, as Krashen (1973) first pointed out, is that lateralization starts prenatally and is complete in most individuals at around age 5, not puberty, yet most sensitive period effects appear much later than this. (2) Because plasticity loss is not a sudden, one-time effect, but gradual, it would be difficult to argue that it causes a sudden, one-time loss in SLA abilities, even if the latter were empirically attested.

6.4.2. Plasticity loss due to other cerebral changes

Seliger (1978), with a "multiple critical periods hypothesis", and Long (1978), among others, have claimed, that the ability to acquire SL skills in general declines (abruptly or incrementally) with a loss of plasticity due to aspects of cerebral maturation unrelated to lateralization. These may include myelination, thickening of the corpus callosum and intrahemispheric specialization (localization of function). Evidence of greater plasticity in children comes, e.g. from the near normal language learning observed in hemidecorticated infants, but not adults (Mehler, Morton and Jusczyk, 1984). Localization phenomena, of which lateralization is just one, albeit major, stage, last into the teens, as does the incremental loss of plasticity associated with them.

Problems with this explanation include the following. (1) The position is inevitably largely speculative, given the current state of knowledge and instrumentation problems in neurophysiology. (But see Jacobs, 1987, for a review of recent developments in this area.) (2) The position is based mostly on pathological evidence, with attendant dangers of generalizing to normal populations. (3) Little is currently known about neurological changes coinciding specifically with the onset of puberty (Whitaker, Bub and Leventer, 1981) or with any other ages associated with declines in language learning ability, (although, again, see Jacobs for promising recent developments in this area). Note, however, that the human brain both reaches adult size and completes lateralization at about 5/6, the age that the first maturational constraints (for SL and second dialect phonology) seem to set in. (4) There is obviously a danger in extrapolating from the abnormal to the normal brain, as in, e.g. use of the recovery from hemispherectomy results. In other words, is the plasticity usable in *non-insult* situations?

6.5. Summary and conclusion

Four popular sources of explanations of age-related declines in SLA abilities are affective, cognitive, input and neurological variables. The first three clearly suffer from a variety of logical and empirical flaws, and seem unlikely candidates for a successful theory. Positing a role for neurological factors, particularly incremental losses of plasticity with increasing brain maturation, seems the only defensible position. It is not without problems of its own, however, notably its lack of much empirical content or precisely synchronized relationships with claimed losses in SLA abilities, themselves only roughly tied to precise ages. This state of affairs, one must assume, is due to the state of knowledge in neurophysiology rather than to the non-existence of such relationships.

Several methodological implications are also clear from the SLA literature reviewed. Data in some crucial areas, notably lexis, collocation, discourse and pragmatics, are sparse. The research needed in these areas should focus on very advanced learners, like those studied by Coppieters (1986). In order to probe subtle areas, researchers will need to use elicitation instruments, especially grammaticality and appropriacy judgment measures, not just global proficiency ratings. The goal is to determine whether even the very best SL learners actually have native-like competence, or whether, as is claimed here, they can pass as NSs only when limited samples of their performance are sampled, using production rather than comprehension data, with the attendant opportunities for avoidance that allows. The fine detail sought in many of the judgment tasks will also make it preferable to conduct at least some of the work in relatively homogeneous speech communities.

7. The status of maturational constraints on language development

Contrary to the opinions of some respected theoreticians in the field, there is compelling evidence for the existence of maturational constraints on language development.

1. First language development appears to run on a maturationally controlled schedule, as suggested by (a) the common time of onset of production, rate and age of completion of development across languages, cultures and linguistic environments, (b) the common errors, sequences and levels of attainment observed, regardless of cognitive abilities, and (c) the

relative lack of effect of environmental variation, at least on basic properties of languages, although not on "fragile" ones.

2. The existence of this degree of maturational control makes the existence of maturational constraints, in the form of a sensitive period for first language development, *prima facie* a reasonable hypothesis, at least.

3. The evidence from various kinds of abnormal first language development is all consistent with the existence of a such a sensitive period. Most important in this regard are (a) various feral children, (b) Genie, (c) deaf children of hearing adults producing "home sign", and (d) deaf individuals learning ASL, all of whom show that language learning is typically somewhat irregular and incomplete if begun late (around age 6 - 8), and that the irregularities and shortfalls from native-like levels of ultimate attainment become more severe with increasing AO and are very severe in cases of post-pubertal learning. These late starters often exhibit an accelerated *rate* of development compared to younger learners, a fact which is not taken as disproving the existence of a sensitive period for first language development in light of the ultimate attainment data.

4. The existence of maturational scheduling and of a sensitive period for first language development makes the existence of such constraints on SLA *prima facie* a reasonable hypothesis, at least.

5. The evidence from numerous studies of SLA in various domains (of which only a small, representative sample have been reviewed here) is broadly consistent with the existence of one or more sensitive periods for SLA, although the data are not as clear or as uncontroversial as they are for first language development. The most pertinent facts are as follows.

6. Adults and older children do early SL morphology and syntax, *faster* than younger children. This is presumably at least in part due to the cognitive advantages they have over younger learners. The rate advantage is generally only temporary, however, and, as in first language development, 'faster' does not equal 'better', as shown (below, 7) by the markedly lower ultimate levels of attainment older starters achieve. As in the case of first language development, a rate advantage for older SL learners does not disprove the existence of sensitive periods for SLA in the face of the crucial ultimate attainment data. Findings are mixed as to whether there is a rate advantage in phonology for older children.

7. Child starters outperform adults in the long run. Specifically, and consistent with the hypothesized existence of one or more sensitive periods for SLA, only child starters seem capable of achieving native-like levels of SL attainment in segmental and suprasegmental phonology, accent recognition, aural comprehension, morphology and syntax, and probably (although the data here are sparse) in lexis/collocation, discourse and pragmatics, too. The first sensitive period seems to be for phonology, with abilities declining quite sharply from about age six. Others seem to close later, with native-like syntax probably impossible starting after the mid-teens.

8. Explanations offered for maturational constraints are as diverse as views on the existence of the constraints themselves. Biological accounts seem reasonable in the first language cases, since (presumably) no-one is inclined to argue that, say, the deaf youngsters are less motivated to learn than their hearing age peers, since input is no problem in most cases (e.g. normal L1 acquisition of ASL), and since cognitive factors, as shown by the rate advantage data, if anything favor these older first language learners.

9. If this explanation is acceptable for the first language cases, it is presumably feasible for the SL data, too. In addition, where SLA is concerned, a variety of logical, conceptual and empirical arguments exist with which to rebut the social/psychological/affective, cognitive and input explanations, as well as a neurological/neurophysiological explanation based on lateralization at puberty.

10. While itself admittedly open to charges of vagueness and lack of supporting data, the default, and currently only tenable, position must be an explanation based on gradual loss of cerebral plasticity. This may first become apparent with the close of lateralization at around 5/6 (note the evidence for initial declines in first and second language achievement starting at this age), followed by progressive localization of function within the dominant hemisphere over the next decade or so.

8. The mental endowment for SLA

If the neurophysiological basis of the sensitive periods claim is vague (necessarily so because of the state of knowledge in neurophysiology), the nature of the concomitant change (if any) in mental endowment for language learning is even more speculative.

Contrary to some recent proposals (e.g. Clahsen, 1985; Newport, 1984),

whatever changes occur presumably *cannot* involve loss of access to whatever language-specific endowment facilitates normal first language development. If access were lost, it would be difficult to explain (a) the occurrence of so many of the same errors in child and adult L2, including many not easily arrived at by general problem-solving alone (e.g. the data on SL negation), or (b) the obviously successful learning by many (if a minority) of adults of very advanced L2 features (syntax, etc.) for whose acquisition language-specific abilities are claimed to be necessary in first language and child second language development (the learnability/stimulus poverty argument). In any case, (c) grammaticality judgment studies by Bley-Vroman, Felix and Ioup (1987) and Ritchie (1978) suggest that universals are still intact in the adult, even when not taken up in the L1, as in the case of the so-called right-branch constraint in adult Japanese learners of ESL (Ritchie, 1978).

If some language-specific endowment (e.g. UG) is intact, and nothing else has changed, however, some writers have claimed that it is impossible to explain the extreme variability of L2 achievement data, especially among adults. As one solution to this perceived problem, Felix (1985) has proposed a "competition model", in which the adult learner's developed inductive problem-solving abilities mature at Piaget's formal operations stage. These abilities are not powerful enough to handle the abstract linguistic properties of natural languages. They are also not restrictive enough, in that their lack of syntactic constraints allows them to consider a wider range of possible grammars than UG allows the infant, leading to inefficient, slower, and incomplete learning. Reliance on them is why adults fail to achieve native-like SL competence.

There are several problems with this position, however, as noted by Bley-Vroman (1986). First, why should adult learners rely on these less efficient means when they have tried and true, perfectly adequate ones intact? Felix offers no explanation for this, or of why adult learners utilize UG for some structures (and succeed) and GPS abilities for others (and fail), or (b) what (other than *post hoc* classification, 1985, p.58) distinguishes the two classes of items. Felix's model, then, is both intuitively unappealing and unfalsifiable.

Another idea, proposed here, is that the language-specific endowment remains intact throughout adult life, but that access to it is impeded to varying degrees and progressively with age, unless the faculty is used, and so kept

plastic - the "use it or lose it" position. With dis-use, progressive quantitative losses in ability eventually become qualitative, or sufficiently catastrophic (Woodcock and Davis, 1978) to be interpretable as sensitive periods. An analogy would be the way human muscles remain available, until old age, at least, unless allowed to atrophy through dis-use. The more frequent their flexing, the easier it is to bring them back up to standard when needed.

A "mental muscle" model of this sort would predict greater achievement in adult language learning by individuals who have learned other languages throughout their life, compared with monolinguals who suddenly attempt SLA for the first time at, say, 30. This is not an obvious prediction, since one might expect increasing difficulty in SLA by multilinguals due to the greater number of potential sources of interference they bring to subsequent language learning tasks. Data on third and subsequent language learning is sparse, but suggestive findings consistent with the hypothesis have been reported (e.g. Nation and McLaughlin, 1986; Ramsay, 1980).

What is missing in this and other models, however, are clear linguistically motivated predictions as to just which classes of items will become impossible or difficult to access, and in what order. Without such predictions, this model, like Felix's, is at least partly unfalsifiable. Whatever the explanation, there is clearly a need for longitudinal studies of child versus adult interlanguage development, designed to determine what if any are the similarities and differences in errors, stages, and ultimate attainment. Meanwhile, although very unsatisfactory, the absence of an explanation with much intuitive appeal or empirical support is not a reason for denying either the existence of maturational constraints on language development or the need for serious theory construction and testing to explain them.

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