

Language Acquisition after the Critical Period: Genie as of
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The case of 'Genie' has been presented to a number of meetings of linguists and psychologists in the last year. Genie is an adolescent girl, who for 11 1/2 years underwent a degree of social isolation and experiential deprivation unparalleled in the reports of scientific investigation. It is the purpose of this paper to present the most recent picture of her linguistic progress, and to report on the linguistic and neurolinguistic research now being conducted.

A brief summary of the earlier reports is necessary to provide the background for the new information to be presented. At the time of her emergence from isolation, at the age of thirteen years eight months, Genie had little, if any linguistic competence; she was faced with the task of primary language acquisition with a post-pubescent brain. Because Genie had already passed the hypothesized critical age for language learning, and because of trauma involved in speaking -- the result of her having been beaten for making any noise whatsoever -- there was great pessimism regarding her chances of acquiring language. But despite the prognosis, within a few months Genie began on her road of slow but steady linguistic development: from single CV words to two word sentences; from two word sentences to three and four word sentences which expressed negation, locative relationships, subject-verb-object relations, possessives, and modifications. Like normal children her first syllable structure was CV, expanding into a C $\left\{ \begin{array}{l} L \\ G \end{array} \right\} V$ (C) structure, and her early monosyllabic word inventory began to include words of two and three syllables, with correct stress marked by intensity and duration of the vowel, and also vowel quality. In her phonological system, in addition to consonant substitutions, and optional final-consonant deletions, her grammar included a vowel nasal assimilation rule, an initial consonant-cluster simplification rule, and a [ə] epenthesis rule which broke up consonant clusters across word boundaries. She quickly learned to articulate most of the basic phonetic segments of English. Her comprehension showed even a greater development, and although it is difficult to determine the overall extent of her linguistic comprehension of syntactic structures, it is clear that she understood in a linguistic sense the following structures and concepts: negation, plural/singular distinctions, possessives, conjunction with 'and', modification, the comparative and superlative forms of 'big', 'small', 'long' and 'short', the relational terms 'more' and 'less', prepositions 'over', 'under', 'beside', 'next to', 'in back of', 'on' and 'in' (with possible overlap) and all WH questions.

This updated report includes Genie's development in all areas of her grammar. At the time of the last report, she had just begun to use inflections, specifically ing, and the preposition on. Up until November of 1972, 18 months after Genie had started to acquire

language, she used word order, exclusively, to express semantic and syntactic relationships. In November the first grammatical markers emerged. It is of interest to note that the first grammatical formatives to appear in Genie's speech -- ing and on -- are the first to appear in normal children's language. (Cf. Brown, 1972) Since that time, Genie has begun to use the prepositions in, at, behind, front, and after and a few sporadic plurals (bears, noses, swings), the possessive morpheme ('Joel's room', 'Mark's room', 'I like Dave's car') and a few irregular past tense forms (gave, took off, fell). All of these markers are used appropriately, being affixed only to the 'correct' word category, and are used in an appropriate semantic context.

Besides the emergence of individual prepositions, Genie now uses prepositions in adverbial phrases: ('In hospital, shot hurt arm.' 'After dinner have cookie.') She still speaks in shorter strings than she is capable of constructing, and so, often deletes these items, but the syntactic markers are appearing more frequently in her spontaneous speech.

In addition, Genie has begun to use the vocative, and to produce imperative sentences. The vocative (or 'nominative of address') is present very early in normal child language, and it is of interest that it remained absent from Genie's speech for so long. Its appearance is probably more the result of emotional development than of syntactic acquisition. Or, one may suggest that the syntactic structures can only emerge given necessary psychological factors. Directing language at specific individuals to request or demand something of them involves having enough of a self-concept to feel one has the power and right to address people and make direct demands. In any case, sentences like 'Go way, Joel, finish story!' and 'Get out baby buggy!' are now part of Genie's everyday speech.

Verb particles are now being used, as is shown by regularly occurring utterances like 'Get out' 'Take off' 'put down' and 'put back.' Indirect objects also appear in recent sentences: 'Curtiss give me valentine.', 'Give valentine Mr. James.', 'Grandma gave me cereal', and 'Grandpa give me cookie chew.'

Another addition to Genie's grammar is a determiner category. Genie often imitates the definite article as in 'In the hospital,' 'in the backyard,' and makes frequent use of the determiner 'another.' ('Another house have dog,' 'Another house blue car'.) No definite-indefinite distinction has appeared.

Genitive constructions were one of the two earliest relations expressed, and they exemplify Genie's continuing syntactic development. As mentioned, she has begun to use the possessive marker. She has also recently begun to use the possessive pronoun 'my'. ('Willie slap my face,' 'my house,' 'my pennies') Thus, she has advanced from using word order alone, in expressing possessive to the use of explicit and appropriate grammatical formatives. Possession is also expressed more recently by the verb 'have.' The sentences, 'Bears have sharp claw,' 'Bus have big mirror,' 'Bathroom have big mirror,' 'Curtain have flower,' and 'Father have flower curtain' are examples of this more highly developed and

complex realization of possessive relationships.

Negation, too, has undergone some changes. Until very recently her one negative element was 'no more': 'No more have,' 'no more ear hurt.' For about one week 'no' appeared in sentences: 'No like hospital,' 'No stay hospital.' Now, 'not' is used as in 'Not have orange record' and 'not good fish tank.' There is still no movement of the NEG into the sentence unit; in fact, there are no movement transformations at all in her grammar to date.

At the Atlanta meeting of the LSA, we reported that Genie had produced what we believed should be interpreted as a complex sentence. Because Genie normally speaks infrequently as compared to a normal child, every sentence may represent her grammatical stage. We recognize however the dangers of such interpretation. On March 22nd of this year, Genie produced a similar sentence: 'Ask David see swing.' We are hopeful that such sentences do reflect the acquisition of a recursive property in her grammar.

Her syntactic system is advancing, as such sentences reveal, and appears to be becoming more like that of a normal child's early grammar, as more like the adult system as well.

Changes have occurred in her phonology as well. The substitution of /t/ for /k/, /n/ and /s/ which occurred previously in all positions now occurs only in word medial position. For a long period her only consonant clusters were consonant followed by a liquid. As stated above, all other clusters were either reduced, or separated by the insertion of a [ə]. /s/ plus nasal clusters are now emerging, and the s-deletion rule for syllable initial clusters is now optional before nasals.

As has been evident all along, in imitation, Genie can produce any English sound and many sound sequences that she never uses in spontaneous speech; thus it is clear that her output is constrained by her own phonological system rather than by any inability to articulate sounds and sequences.

A major development in the area of phonetic production is her increased ability to control fundamental frequency (pitch), i.e. to use intonation. Until recently, her speech was monotonic. She has difficulty controlling all the laryngeal mechanisms involved in speech, but her lack of intonation has been especially of interest since the appearance of intonation contours is normally present very early in speech development. (Miller and Erwin, 1964) Recently, however, Genie has begun both to imitate intonation patterns (especially in affective speech) and to produce pitch variations in her own spontaneous utterances. Stress, which had been signaled primarily by length, now involves an increase in pitch. Genie still does not use intonation to signal questions or imperatives, but with more control this too may result.

We are actively constructing new tests to better ascertain the extent of Genie's present comprehension ability. In particular, we are planning to test her comprehension of subordinate vs. matrix clause negation, WH questions of objects as well as subjects, and some of the relational terms suggested by some of Eve Clark's studies, such as 'here-there,' 'come-go,' and relative adjectives, 'narrow-wide' etc.

A recent development is very significant. It has been assumed that part of one's language competence is the ability to distinguish between a sentence and a non-sentence in one's language. Susan Curtiss, the first author of this paper, works regularly with Genie, and many of the linguistic sessions involves the use of index cards with printed words, in the attempt to teach or build up her linguistic competence. Since there are many physical and psychological problems which constrain her speech production, the use of the visual mode has proved to be very helpful. Genie was taught the singular/plural distinction and many prepositional relations in this way. In February, printed WH questions were constructed, because Genie has no WH words in her spontaneous speech and asks no questions of any kind. In the past, when it was Genie's turn to construct sentences with these cards, she frequently produced blatantly ungrammatical strings. Moreover, she seemed entirely satisfied with her efforts and expected to be praised in all cases. During the session, under discussion, the first WH question Genie constructed was 'WHAT IS UNDER?' She sat back, read it to herself, then said 'Silly!' and proceeded to add an NP object 'THE GREEN BOX' thereby changing her ill-formed string to a grammatical question. In constructing the answer to that question, she first replaced the question mark with a period, and removed the WH word, leaving IS UNDER THE GREEN BOX. She again read it to herself, again said 'SILLY!' and added an NP subject 'THE ORANGE BOX' to form the grammatical string 'THE ORANGE BOX IS UNDER THE GREEN BOX.' It is true that semantically the uncorrected sentences have no content, and her corrections may merely reflect this cognitive awareness. But the order of all the words was in keeping with her knowledge of 'well-formedness,' and in addition, we believe, perhaps too optimistically, that not only is this an example of the competence-performance distinction, but that it is also evidence that she is learning what constitutes a well formed string.

Neurolinguistic research with Genie has thus far revealed two related findings; dichotic listening tests have shown that Genie is processing language in her minor, right hemisphere, and psychological testing has shown that she performs surprisingly well in tests that involve "appositional" skills (skills that in normals are dependent on right hemisphere mechanisms).

Dichotic listening has been used since 1961 (Kimura, 1961) to determine hemisphere specialization for auditory stimuli and has proven to be a safe and reliable procedure. In dichotic listening, subjects are presented with simultaneous competing stimuli, one to each ear. In right handed subjects, the right ear generally excels for verbal stimuli, reflecting left hemisphere specialization, or dominance. The left ear excels for certain non-verbal stimuli (environmental sounds, Curry, 1967, and musical chords, Gordon, 1971) indicating right hemisphere dominance. With the assistance of Lloyd Rice and Sarah Spitz of the UCLA Phonetics Laboratory, special dichotic tapes were prepared for Genie, one consisting of words familiar to her and the other consisting of familiar environmental sounds.

Genie was first tested monaurally and scored 100% in each ear. As we have reported elsewhere (Krashen, Fromkin, Curtiss, Rigler, and Spitz, 1972, and Krashen, Fromkin, and Curtiss, 1972) Genie manifested an extreme left ear advantage for verbal material. Both the direction and degree of ear difference are unusual; right handed subjects (Genie is right handed) generally give a small but statistically significant right ear advantage on such tests (as did our controls, twenty right handed college students). Ear differences as extreme as we found with Genie have thus far been found only in split-brain and hemispherectomized subjects. For environmental sounds, Genie showed a more moderate left ear advantage, essentially a normal finding and one that points to right hemisphere processing of environmental sounds. In our other reports (see above) we have argued that Genie may have begun language acquisition (before her confinement) with her left hemisphere. Through disease, the left hemisphere is now no longer able to fulfill its original linguistic function and Genie may be using her right hemisphere to learn language. The "atrophied" left hemisphere language areas may be preventing the flow of right ear impulses from reaching the right hemisphere and thus may be the cause of Genie's huge left ear advantage in dichotic listening.

The environmental sounds results indicate that Genie is not merely one of those infrequent cases of reversed laterality (language in the right and nonlanguage in the left hemisphere). Rather, both linguistic and nonlinguistic processing is taking place in the right hemisphere.

Recently we have observed that Genie's behavior on psychological tests can be comprehended more meaningfully when performance on two kinds of tests can be distinguished: those that require analytic or sequential use of symbols, such as language and number; and those that involve perception of spatial configurations or Gestalts. On the first group of tasks Genie's performance is consistently in the low range, presently approximating an age of two and a half to three years. Compared with her behavior on admission, this represents a growth of about one and a half to two years over a two year period. On configurational tests her performance ranges upwards, lying somewhere between eight years and the adult level, depending on the test. The rate of growth on these tests has been very rapid.

Some specific results are as follows: One year after admission to the hospital Genie's mental age scores on the French Pictorial Test of Intelligence spanned the range from four and one half to nine years. About three months later, her performance on the Raven Matrices corresponded to the 50th percentile of children age eight and one half to nine years. In June 1972, two performance subtests of the WISC corresponded to mental ages of about eight and a half to nine and a half. On the Street Gestalt test, she recently scored above the mean for American adults. In contrast to these results, in April, 1972, she achieved an extrapolated IQ of 36 on the Peabody Picture Vocabulary test, and in September an IQ of 38 on the Columbia Mental Maturity Scale.

Both the dichotic listening and psychological testing results are consistent with the hypothesis that Genie is using her healthy right hemisphere for both verbal and nonverbal functions; what are generally considered right hemisphere or appositional functions (perception of the environment) thrive quite well, while Genie's right hemisphere is not as successful with what are considered left hemisphere appositional functions. We are attempting to confirm this hypothesis by further testing for both level of performance and cerebral localization of what are considered in normals right and left lateralized abilities.

We see at the moment two points of interest of this research to linguists. First, we may be directly witnessing the linguistic potentialities of the minor hemisphere. Second, this study may help to clarify the relationship of the language faculty to other mental abilities; in line with the predictions made in Krashen (1972) Genie's performance in mental abilities underlying the language function (e.g. temporal processing) may prove to be correlated with her linguistic progress.

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