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The Development of Language in Genie: a Case of Language Acquisition beyond the "Critical Period" [1,2]

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The present paper reports on a case of a now-16-year-old girl who for most of her life suffered an extreme degree of social isolation and experiential deprivation. It summarizes her language acquisition which is occurring past the hypothesized "critical period" and the implications of this language development as related to hemispheric maturation and the development of lateralization. The results of a series of dichotic listening tests administered to her are included.

When Descartes observed that " . . . there are none so depraved and stupid, without even excepting idiots, that they cannot arrange different

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[2] This is a combined and expanded version of a number of papers presented before the American Psychological Association, the Linguistic Society of America, the Acoustical Society of America, and the American Speech and Hearing Association, including S. Curtiss (1972); Curtiss *et al.* (1972, 1973); Krashen *et al.* (1972a, 1972b); Fromkin (1972); D. Rigler (1972).

words together, forming of them a statement by which they make known their thoughts" he did not consider children who are denied, for a multiplicity of reasons, language input in their formative years. Despite the wide range of views on the subject of language acquisition there is unanimity on one aspect. Neither the empiricist who believes with Locke that we are born with a mental "tabula rasa" with all language the result of "experience," nor the rationalist who supports the Descartian position of a complex, highly specific, innate language mechanism denies that certain environmental conditions are necessary for the acquisition of language. One need not attempt to replicate the apochryphal experiments conducted by Psammeticus or that of the Scottish King John to know that children will not learn any language when deprived of all linguistic input.[3] The cases of children reared in environments of extreme social isolation attest to this.

Ten such children are mentioned by Carl Linneaus in his *System of Nature* published in 1735, and are included by Linnaeus under his subdivision of Homo Sapiens which he called Homo Ferus (Wild Man). One of the defining characteristics of Homo Ferus, according to Linnaeus, was his inability to speak. All the cases of isolated children reported in the literature since his time show this to be a correct observation.

In the 18th century, the interest in such cases was stimulated by the struggle between the "geneticists" and the "environmentalists," and figured sharply in the debate over the theory of innate ideas. The different views continue to be debated today in somewhat different (perhaps more sophisticated) forms. [See, for example, Skinner (1957), Chomsky (1962), Katz and Bever, (1973), Bever (1970), Lenneberg, (1967); see also the *Synthese* Symposium on Innate Ideas, Vol. 17, No. 1, March 1967, pp. 1–28].

Despite the continuing interest, the study of children reared under conditions of social isolation and sensory deprivation represents a relatively inaccessible area of scientific research. Such children include those who are reported to have undergone a significant period of their development alone in the wilderness or to have been reared with wild animals (Itard, 1962; Singh and Zingg, 1966). The most celebrated of

[3] In the 5th century B. C. the Greek historian Herodotus reported that the Egyptian Pharaoh Psammetichus (664–610 B. C.) sought to determine the most primitive "natural" language by placing two infants in an isolated mountain hut to be cared for by a servant who was cautioned not to speak in their presence on pain of death. According to the story, the first word uttered was "bekos" the Phrygian word for "bread" convincing the Pharaoh that this was the original language. James IV (1473–1513) of Scotland is reported to have attempted the same "experiment." The Scottish children however were said by John to "spak very guid Ebrew." Two hundred years before James, the Holy Roman Emperor Frederick II of Hohenstaufen was said to have carried out a similar test but the children died before they spoke at all.

such cases is that of Victor, the "Wild Boy of Aveyron" (Itard, 1962). In addition, there have been studies of children reared within the confines of institutional life (e.g. Spitz, 1949; Dennis and Najarian, 1957; Clarke and Clarke, 1960), and of children whose isolation has been associated with congenital or acquired sensory loss (e.g., Howe and Hall, 1903; Dahl, 1965; Fraiberg and Freedman, 1964). Yet another category is that of children whose isolation resulted from deliberate effort to keep them from normal social intercourse (Von Feuerbach, 1833; Mason, 1942; Davis, 1940, 1947; Freedman and Brown 1968; Koluchova, 1972).

The case discussed in this paper is that of a child who falls into the last category. Genie, the subject of this study, is an adolescent girl who for most of her life underwent a degree of social isolation and experiential deprivation not previously reported in contemporary scientific history. It is a unique case because the other children reported on in contemporary literature were isolated for much shorter periods and emerged from their isolation at much younger ages than did Genie. The only studies of children isolated for periods of time somewhat comparable to that of this case are those of Victor (Itard, 1962) and Kaspar Hauser (Singh and Zingg, 1966).

All cases of such children reveal that experiential deprivation results in a retarded state of development. An important question for scientists of many disciplines is whether a child so deprived can "catch up" wholly or in part. The answer to this question depends on many factors including the developmental state achieved prior to deprivation, the duration, quality, and intensity of the deprivation, and the early biological adequacy of the isolated child. In addition, the ability of such "recuperation" is closely tied to whether there is a "critical period" beyond which learning cannot take place. The concept of a "critical period" during which certain innately determined faculties can develop derived from experimental embryology. It is hypothesized that should the necessary internal or external conditions be absent during this period, certain developmental abilities will be impossible.

Lenneberg (1967) presents the most specific statement about critical periods in man as it concerns the acquisition of language. He starts with the assumption that language is innately determined, that its acquisition is dependent upon both necessary neurological events and some unspecified minimal exposure to language. He suggests that this critical period lasts from about age two to puberty: language acquisition is impossible before two due to maturational factors, and after puberty because of the loss of "cerebral plasticity" caused by the completion of the development of cerebral dominance, or lateralized specialization of the language function.

The case of Genie is directly related to this question, since Genie was already pubescent at the time of her discovery, and it is to this question

that the discussion is primarily directed. The case also has relevance for other linguistic questions such as those concerning distinctions between the comprehension and production of language, between linguistic competence and performance, and between cognition and language.

There are many questions for which we still have no answers. Some we may never have. Others must await the future developments of this remarkable child. The case history as presented is therefore an interim report.

CASE HISTORY

Genie was first encountered when she was 13 years, 9 months. At the time of her discovery and hospitalization she was an unsocialized, primitive human being, emotionally disturbed, unlearned, and without language. She had been taken into protective custody by the police and, on November 4, 1970, was admitted into the Childrens Hospital of Los Angeles for evaluation with a tentative diagnosis of severe malnutrition. She remained in the Rehabilitation Center of the hospital until August 13, 1971. At that time she entered a foster home where she has been living ever since as a member of the family.

When admitted to the hospital, Genie was a painfully thin child with a distended abdomen who appeared to be six or seven years younger that her age. She was 54.5 inches tall and weighed 62.25 pounds. She was unable to stand erect, could not chew solid or even semi-solid foods, had great difficulty in swallowing, was incontinent of feces and urine, and was mute.

The tragic and bizarre story which was uncovered revealed that for most of her life Genie suffered physical and social restriction, nutritional neglect, and extreme experiential deprivation. There is evidence that from about the age of 20 months until shortly before admission to the hospital Genie had been isolated in a small closed room, tied into a potty chair where she remained most or all hours of the day, sometimes overnight. A cloth harness, constructed to keep her from handling her feces was her only apparel of wear. When not strapped into the chair she was kept in a covered infant crib, also confined from the waist down. The door to the room was kept closed, and the windows were curtained. She was hurriedly fed (only cereal and baby food) and minimally cared for by her mother, who was almost blind during most of the years of Genie's isolation. There was no radio or TV in the house and the father's intolerance of noise of any kind kept any acoustic stimuli which she received behind the closed door to a minimum. (The first child born to this family died from peneumonia when three months old after being put in the garage because of noisy crying.) Genie was physically punished by the father if she made any sounds. According to the mother, the father and

older brother never spoke to Genie although they barked at her like dogs. The mother was forbidden to spend more than a few minutes with Genie during feeding.

It is not the purpose of this paper to attempt to explain the psychotic behavior of the parents which created this tragic life for Genie, nor to relate the circumstances which led to the discovery [See Hansen (1972); D. Rigler (1972)]. It is reported that Genie's father regarded her as a hopelessly retarded child who was destined to die at a young age and convinced the mother of this. His prediction was based at least in part on Genie's failure to walk at a normal age. Genie was born with a congenital dislocation of the hips which was treated in the first year by the application of a Frejka pillow splint to hold both legs in abduction, and the father placed the blame for her "retardation" on this device.

On the basis of what is known about the early history, and what has been observed so far, it appears that Genie was normal at the time of birth and that the retardation observed at the time of discovery was due principally to the extreme isolation to which she was subjected, with its accompanying social, perceptual, and sensory deprivation. Very little evidence exists to support a diagnosis of early brain damage, primary mental deficiency, or infantile autism. On the other hand, there is abundant evidence of gross environmental impoverishment and of psychopathological behavior on the part of the parents. This is revealed to some extent in Genie's history and equally by the dramatic changes that have occurred since her emergence. [See D. Rigler (1972); M. Rigler (1972).]

Genie's birth was relatively normal. She was born in April, 1957, delivered by Caesarian section. Her birth problems included an Rh negative incompatibility for which she was exchange transfused (no sequelae were noted), and the hip dislocation spoken of above. Genie's development was otherwise initially normal. At birth she weighed 7 pounds, 7.5 ounces. By three months she had gained 4.5 pounds. According to the pediatrician's report, at 6 months she was doing well and taking food well. At 11 months she was still within normal limits. At 14 months Genie developed an acute illness and was seen by another pediatrician. The only other medical visit occurred when Genie was just over 3.5 years of age.

From the meager medical records at our disposal, then, there is no indication of early retardation. After admission to the hospital, Genie underwent a number of medical diagnostic tests. Radiology reported a "moderate coxa valga deformity of both hips and a narrow rib cage" but no abnormality of the skull. The bone age was reported as approximately 11 years. Simple metabolic disorders were ruled out. The neurologist found no evidence of neurological disease. The electro-

encephalographic records reported a "normal waking record." A chromosomal analysis was summarized as being "apparently normal."

During the first few months of her hospitalization additional consultations were undertaken. The conclusion from among all of these evaluative efforts may be summarized briefly. Functionally Genie was an extremely retarded child, but her behavior was unlike that of other mentally defective children. Neither, apparently, was she autistic. Although emotionally disturbed behavior was evident there was no discernible evidence of physical or mental disease that would otherwise account for her retarded behavior. It therefore seems plausible to explain her retardation as due to the intensity and duration of her psycho-social and physical deprivation.

The dramatic changes that have occurred since Genie's emergence reinforce this conclusion. Approximately four weeks after her admission to the hospital a consultant described a contrast between her admission status and what he later observed [Shurley (personal communication)]. He wrote that on admission Genie

> was pale, thin, ghost-like, apathetic, mute and socially unresponsive. But now she had become alert, bright-eyed, engaged readily in simple social play with balloons, flashlight, and toys, with familiar and unfamiliar adults. . . . She exhibits a lively curiosity, good eye–hand coordination, adequate hearing and vision, and emotional responsivity. . . . She reveals much stimulus hunger. . . . Despite her muteness . . . Genie does not otherwise use autistic defenses, but has ample latent affect and responses. There is no obvious evidence of cerebral damage or intellectual stenosis—only severe (extreme) and prolonged experiential, social and sensory isolation and deprivation during her infancy and childhood. . . . Genie may be regarded as one of the most extreme and prolonged cases of such deprivation to come to light in this century, and as such she is an "experiment in nature."

GENIE'S LINGUISTIC DEVELOPMENT

Important elements in Genie's history are still unknown and may never be known. We have no reliable information about early linguistic developments or even the extent of language input. One version has it that Genie began to speak words prior to her isolation and then ceased. Another is that she simply never acquired language at all beyond the level observed on hospital entry. One thing is definite; when Genie was discovered she did not speak. On the day after admission to the hospital she was seen by Dr. James Kent who reports (Kent, 1972):

> Throughout this period she retained saliva and frequently spit it out into a paper towel or into her pajama top. *She made no other sounds except for a kind of throaty whimper.* . . . (Later in the session) . . . she imitated "back" several times, as well as "fall" when I said "The puppet will fall." . . . She could communicate (her) needs non-verbally, at least to a limited extent. . . . Apart from a peculiar laugh, frustration was the only other clear affective behavior we could discern. . . . When very angry she would scratch at her own face, blow her nose violently into her clothes and often

> void urine. During these tantrums *there was no vocalization.* . . . We felt that the eerie silence that accompanied these reactions was probably due to the fact that she had been whipped by her father when she made noise.

At the outset of our linguistic observations, it was not clear whether Genie's inability to talk was the result solely of physiological and/or emotional factors. We were unable to determine the extent of her language comprehension during the early periods. Within a few days she began to respond to the speech of others and also to imitate single words. Her responses did not however reveal how heavily she was dependent on nonverbal, extra-linguistic cues such as "tone of voice, gestures, hints, guidance, facial and bodily expressions" (Belugi and Klima, 1971). To determine the extent of her language comprehension it was necessary to devise tests in which all extra-linguistic cues were eliminated.[4] If the comprehension tests administered showed that Genie did comprehend what was said to her, using linguistic information alone, we could assume that she had some knowledge of English, or had acquired some linguistic "competence." In that case, the task facing Genie would not be one of language learning but of learning how to use that knowledge—adding a performance modality—to produce speech. If the tests, on the other hand, in addition to her inability to speak, showed that she had little ability to understand what was said to her when all extra-linguistic cues were eliminated, she would be faced with true first-language acquisition.

LINGUISTIC COMPREHENSION

The administration of the comprehension tests which we constructed had to wait until Genie was willing and able to cooperate. It was necessary to develop tests which would not require verbal responses since it was her comprehension not her active production of speech to be tested at this stage. The first controlled test was administered in September, 1971, almost 11 months after Genie's emergence. Prior to these tests Genie revealed a growing ability to understand and produce individual words and names. This ability was a necessary precursor to an investigation of her comprehension of grammatical structure, but did not in itself reveal how much language she knew since the ability to relate the sounds and meanings of individual lexical items, while necessary, is not a sufficient criterion for language competence.

It was quite evident that at the beginning of the testing period Genie could understand individual words which she did not utter herself, but, except for such words, she had little if any comprehension of grammatical structures. Genie was thus faced with the complex task of primary

[4] The tests were designed, administered and analyzed by S. Curtiss.

language acquisition with a post-pubescent brain. There was no way that a prediction could be made as to whether she could or would accomplish this task. Furthermore, if she did not learn language it would be impossible to determine the reasons. One cannot draw conclusions about children of this kind who fail to develop. One can, however, draw at least some conclusions from the fact that Genie has been acquiring language at this late age. The evidence for this fact is revealed in the results of the 17 different comprehension tests which have been administered almost weekly over the last two years. A slow but steady development is taking place. We are still, of course, unable to predict how much of the adult grammar she will acquire.

Among the grammatical structures that Genie now comprehends are singular-plural contrasts of nouns, negative-affirmative sentence distinctions, possessive constructions, modifications, a number of prepositions (including *under, next to, beside, over,* and probably *on* and *in*), conjunction with *and,* and the comparative and superlative forms of adjectives. [For further details on the comprehension tests, see Curtiss *et al.* (1973).]

The comprehension tests which are now regularly administered were designed by Susan Curtiss who has been most directly involved in the research of Genie's linguistic development. (New tests are constantly being added.) The nouns, verbs, and adjectives used in all of the tests are used by Genie in her own utterances (see below for discussion on Genie's spontaneous speech production). The response required was primarily a "pointing" response. Genie was familiar with this gesture prior to the onset of testing. One example can illustrate the kinds of tests and the procedures used.

To test Genie's singular/plural distinction in nouns, pairs of pictures are used—a single object on one picture, three of the identical objects on the other. The test sentences differ only by absence or presence of plural markers on the nouns. Genie is asked to point to the appropriate picture. The words used are; balloon(s), pail(s), turtle(s), nose(s), horse(s), dish(es), pot(s), boat(s). Until July, 1972, the responses were no better than chance. Since July, 1972, Genie gives 100% correct responses. It is important to note that at the time when she was not responding correctly to the linguistically marked distinction, she could appropriately use and understand utterances including numbers ("one," "two," "three," etc.) and "many," "more," and "lots of."

SPEECH PRODUCTION AND PHONOLOGICAL DEVELOPMENT

Genie's ability to comprehend spoken language is a better indication of her linguistic competence that is her production of speech because of

the physical difficulties Genie has in speaking. At the age when normal children are learning the necessary neuro-muscular controls over their vocal organs to enable them to produce the sounds of language, Genie was learning to repress any and all sounds because of the physical punishment which accompanied any sounds produced. This can explain why her earliest imitative and spontaneous utterances were often produced as silent articulations or whispered. Her inability to control the laryngeal mechanisms involved in speech resulted in monotonic speech. Her whole body tensed as she struggled to speak, revealing the difficulties she had in the control of air volume and air flow. The intensity of the acoustic signal produced was very low. The strange voice quality of her vocalized utterances is at least partially explainable in reference to these problems.

Because of her speech difficulties, one cannot assess her language competence by her productive utterances alone. But despite the problems which still remain, there has been dramatic improvement in Genie's speech production. Her supra glottal articulations have been more or less normal, and her phonological development does not deviate sharply from that observed in normal children. In addition, she is beginning, both in imitations and in spontaneous utterances to show some intonation and her speech is now being produced with greater intensity.

Like normal children, Genie's first one word utterances consisted of Consonant–Vowel (CV) monosyllables. These soon expanded into a more complex syllable structure which can be diagrammed as (C) (L/G) V (C), where L stands for liquid, G, glide, and the parenthesized elements optional.

Words of two and three syllables entered into her productive vocabulary and in these words stress was correctly marked by intensity and/or duration of the vowel as well as vowel quality (with the unstressed vowel being ə). To date, all of the consonants of Standard American English are included in her utterances (with the inter-dental fricatives occurring only in imitations, and the affricates occurring inconsistently). She still deletes final consonants more often than not. Their correct sporadic presence, however, shows them to be part of her stored representation of the words in which they occur. Consonant clusters were first simplified by the deletion of the /s/ in initial /sp/ /sk/ /st/ clusters; at the present time, in addition to this method of preserving the CV syllable structure, she sometimes adds an epenthetic schwa between the two consonants.

Other changes in Genie's phonological system continue to be observed. At an earlier stage a regular substitution of /t/ for /k/, /n/, and /s/ occurred in all word positions: this now occurs only word medially. /s/ plus nasal clusters are now being produced.

What is of particular interest is that in imitation Genie can produce any English sound and many sound sequences not found in her spontaneous speech. It has been noted by many researchers on child language that children have greater phonetic abilities than are revealed in their utterances. This is also true of Genie; her output reflects phonological constraints rather than her inability to articulate sounds and sound sequences.

Neither Genie nor a normal child learns the sound system of a language totally independent from the syntactic and semantic systems. In fact, the analysis of the syntactic and semantic development of Genie's spontaneous utterances reveals that her performance on the expressive side is parallelling (although lagging behind) her comprehension.

As stated above, within a few weeks after admission to the hospital Genie began to imitate words used to her, and her comprehension of individual words and names increased dramatically. She began to produce single words spontaneously after about five months.

SENTENCE STRUCTURE

For normal children perception or comprehension of syntactic structures exceeds production; this is even more true in Genie's case possibly for the reasons given above. But even in production it is clear that Genie is acquiring language. Eight months after her emergence Genie began to produce utterances, two words (or morphemes) in length. The structures of her earliest two-word "sentences" were Modifier + Noun and Noun + Noun genitive constructions. These included sentences like "more soup," "yellow car," "Genie purse" and "Mark mouth." After about two months she began to produce strings with verbs – both Noun (subject) + Verb, and Verb + Noun (object), e.g., "Mark paint" (N + V), "Curtiss cough" (N + V), "want milk" (V + N) and "wash car" (V + N). Sentences with a noun followed by a predicate adjective soon followed, e.g., "Dave sick."

In November, 1971, Genie began to produce three and four word strings, including Subject + Verb + Object strings, like "Tori chew glove," modified noun phrases like "little white clear box," subject–object strings, like "big elephant long trunk," and four word predications like "Marilyn car red car." Some of these longer strings are of interest because the syntactic relations which were only assumed to be present in her two-word utterances were now overtly expressed. For example, many of Genie's two-word strings did not contain any expressed subject, but the three-word sentences included both the subject and object: "Love Marilyn" became "Genie love Marilyn." In addition, Modifier–noun Noun Phrases and possessive phrases which were complete utterances at the two-word sentence stage are now used as constituents of

her longer strings, e.g., "more soup" occurred in "want more soup" and "Mark mouth" became a constituent in "Mark mouth hurt."

In February, 1972, Genie began to produce negative sentences. The comprehension test involving negative/affirmative distinctions showed that such a distinction was understood many months earlier. (In the tests she had no difficulty in pointing to the correct picture when asked to "show me 'The girl is wearing shoes'" or "Show me the bunny that has a carrot" vs. "Show me the bunny that does not/doesn't have a carrot.") The first negative morpheme used by Genie was "no more." Later she began to use "no" and "not." To date, Genie continues to negate a sentence by attaching the negative morpheme to the beginning of the string. She has not yet acquired the 'Negative movement transformation' which inserts the Negative morpheme inside the sentence in English.

About the same time that the negative sentences were produced, Genie began to produce strings with locative-nouns, such as "Cereal kitchen" and "play gym." In recent months prepositions are occurring in her utterances. In answer to the question "Where is your toy radio?" she answered "On chair." She has also produced sentences such as "Like horse behind fence," "Like good Harry at hospital."

In July, 1972, Verb plus Verb-phrase strings were produced: "Want go shopping," "Like chew meat." Such complex VP's began to emerge in sentences that included both a complex Noun-phrase and a complex Verb-phrase, e.g., "Want buy toy refrigerator" and "Want go walk (to) Ralph." Genie has also begun to add the progressive aspect marker "ing" to verbs, always appropriately to denote ongoing action: "Genie laughing," "Tori eating bone."

Grammatical morphemes that are phonologically marked are now used, e.g., plurals as in "bears," "noses," "swings," and possessives such as "Joel's room," "I like Dave's car."

While no definite–indefinite distinction has appeared, Genie now produces the definite article in imitation, and uses the determiner "another" spontaneously, as in "Another house have dog."

At an earlier stage, possession was marked solely by word order; Genie now also expresses possession by the verb "have," as in "Bears have sharp claw," "bathroom have big mirror."

A most important syntactic development is revealed by Genie's use of compound NP's. Prior to December, 1971, she would only name one thing at a time, and would produce two sentences such as: "Cat hurt" followed by "dog hurt." More recently she produced these two strings, and then said "Cat dog hurt." This use of a "recursive" element is also shown by the sentence "Curtiss, Genie, swimming pool" in describing a snapshot.

Genie's ability to combine a finite set of linguistic elements to form

new combinations, and the ability to produce sentences consisting of conjoined sentences shows that she has acquired two essential elements of language that permit the generation of an infinite set of sentences.

This is of course an overly sketchy view of the syntactic development evidenced in Genie's utterances. [For further details see Curtiss *et al.* (1973).] It is clear even from this summary that Genie is learning language. Her speech is rule-governed—she has fixed word-order of basic sentence elements and constituents, and systematic ways of expressing syntactic and semantic relations.

LINGUISTIC DEVELOPMENT IN RELATION TO NORMALS

Furthermore it is obvious that her development in many ways parallels that of normal first-language acquisition. There are, however, interesting differences between Genie's emerging language and that of normal children. Her vocabulary is much larger than that of normal children whose language exhibits syntactic complexity parallel to Genie's. She has less difficulty in storing lists than she does learning the rules of the grammar. This illustrates very sharply that language acquisition is not simply the ability to store a large number of items in memory.

Genie's performance on the active/passive comprehension test also appears to deviate from that of normal children. Bever (1970) reports on experiments aimed at testing the capacity in young children "to recognize explicitly the concept of predication as exemplified in the appreciation of the difference between subject–action and action–object relations." The children in these experiments were requested to act out using toys both simple active sentences and reversible passive sentences, such as "The cow kisses the horse" and simple passives such as "The horse is kissed by the cow." He reports that "children from 2.0 to 3.0 act out simple active sentences 95 percent correctly, (and) . . . do far better than 5 percent on simple passives." He concludes that "since they perform almost randomly on passives . . . they can at least distinguish sentences they can understand from sentences they cannot understand. Thus, the basic linguistic capacity evidenced by the two-year-old child includes the notion of reference for objects and actions, the notion of basic functional internal relations, and at least a primitive notion of different sentence structures." Genie was similarly tested but with the "point to" response rather than the "acting out" response. That is she was asked to point to "The boy pulls/is pulling the girl" or "The girl is pulled by the boy." For each such test sentence she was presented with two pictures, one depicting the boy as agent, the other with the girl as agent. Unlike the children tested by Bever, Genie's responses to both active and passive sentences have been random, with no better than a chance level of correct responses for either the active or the passive sen-

tences. This is particularly strange when compared with Genie's own utterances which show a consistent word order to indicate Subject Verb Object relations. While she never produces passive constructions, her active sentences always place the object after the verb and the subject before the verb (when they are expressed).

Another difference between Genie and normal children is in the area of linguistic performance. Genie's linguistic competence (her grammar, if we can speak of a grammar at such an early stage of development) is in many ways on a par with a two or two and a half year old child. Her performance—particularly as related to expressive speech—is much poorer than normal children at this level. Because of her particular difficulties in producing speech, however, a number of relatively successful efforts have been directed to teaching her written language. At this point she recognizes, names, and can print the letters of the alphabet, can read a large number of printed words, can assemble printed words into grammatically correct sentences, and can understand sentences (and questions) constructed of these printed words. On this level of performance, then, she seems to exceed normal children, at a similar stage of language development.

Genie's progress is much slower than that of normals. Few syntactic markers occur in her utterances; there are no question words, no demonstratives, no particles, no rejoinders. In addition, no movement transformations are revealed. Such rules exist in the adult grammar and in normal children's grammars as early as two years. Transformational rules are those which, for example, would move a negative element from the beginning of the sentence to the position after an auxiliary verb. Such a transformational rule would change *I can go* in its negative form from *Neg* + *I* + *can* + *go* to *I* + *can* + *neg* (can't) + *go*. As stated above, Genie continues to produce negative sentences only by the addition of the negative element to the beginning of the sentence, e.g., *No more ear hurt, No stay hospital, No can go.*

Cognitively, however, she seems to be in advance of what would be expected at this syntactic stage. Her earliest productive vocabulary included words cognitively more sophisticated than one usually finds in the descriptions of first vocabulary words. Color words and numbers, for example, were used which usually enter a child's vocabulary at a much later grammatical stage (Castner, 1940; Denckla, 1972).

At the time that Genie began to produce utterances of two-words (June, 1971) she had an active vocabulary of over 200 words, which far exceeds the size of the normal children's lexicon at this stage (about 50 words). This development seems to parallel that found in aphasic children (Eisenson and Ingram, 1972). She comprehends all the WH questions; normal children ordinarily learn HOW, WHY and WHEN ques-

tions later than WHO, WHAT, and WHERE (Brown, 1968), although syntactically such questions are similar. Her comprehension of the comparative and superlative, and the differences between "more" and "less" also indicate cognitive sophistication not revealed by her syntax, suggesting at least a partial independence of cognition and language.

COGNITIVE DEVELOPMENT

The attempt to assess Genie's cognitive development is extremely difficult. All tests purported to measure cognitive abilities, in fact, measure knowledge that has been acquired through experience. In addition, many tests are substantially dependent on verbal response and comprehension. The distinction between cognition and language development is therefore not always possible. A number of tests have however been utilized.

Genie could not easily be psychologically tested by standard instruments at the time of her admission. It is still difficult to administer many of the standard tests. On the Vineland Social Maturity Scale, however, she averaged about 15 months at the time of admission, and on a Gesell Developmental Evaluation, a month and a half later, scores ranged from about one to about three years of age. There was a very high degree of scatter when compared to normal developmental patterns. Consistently, language-related behavior was observed to occur at the lower end of the range of her performance and was judged (by the psychologists at the hospital) to be at about the 15 months level.

Her cognitive growth however seemed to be quite rapid. In a seven month span her score had increased from 15 to 42 months, and six months after admission, on the Leiter International Performance Scale (which depends relatively little on culturally based, specific knowledge, and requires no speech) she passed all the items at the four year level, two at the five year level, and two out of four at the seven year level. In May 1973 her score on this test was on the 6–8 year level. At the same time, the Stanford Binet Intelligence Scale elicited a mental age of 5–8. In all the tests, the subsets which involved language were considerably lower than those assessing other abilities.

From this brief summary of Genie's linguistic development we can conclude the following: (1) When she first emerged from isolation, Genie, a child of 13 years, 9 months had not acquired language; (2) Since there is no evidence of any biological deficiencies, one may assume this was due to the social and linguistic isolation which occurred during 11 years of her life; (3) Since her emergence she has been acquiring her first language primarily by "exposure" alone. This is revealed both by her own speech and by her comprehension of spoken language. (4) Her cognitive development has exceeded her linguistic development.

THE "CRITICAL AGE" HYPOTHESIS AND LANGUAGE LATERALIZATION

As mentioned above, Genie's on-going language acquisition is the most direct test of Lenneberg's critical age hypothesis seen thus far. Lenneberg (1967) has presented the view that the ability to acquire primary language (and the acquisition of second languages "by mere exposure") terminates with the completion of the development of cerebral dominance, or lateralization, an event which he argues occurs at around puberty. As we have demonstrated above, however, while Genie's language acquisition differs to some extent from that of normal children, she is in fact in the process of learning language, as shown by the results of tests and by the observations of her spontaneous and elicited speech. Thus, at least some degree of first language acquisition seems to be possible beyond the critical period.

Genie also affords us the opportunity to study the relationship of the development of lateralization and language acquisition.

Lateralization refers to the fact that each hemisphere appears to be specialized for different cognitive functions; that is, some functions seem to be "localized" primarily on one side of the brain. This assumption is based on operational criteria. The discovery, more than a century ago by Broca (1861, and Bonin 1960) that lesions to the left hemisphere produce language problems whereas lesions to the right do not, and that therefore the left hemisphere is dominant for language has been supported by other aphasia studies (Russell and Espir, 1961), by experiments with split-brains (Gazzaniga and Sperry, 1967) and by a variety of other experimental techniques. For example, temporary aphasia is more often the result of left hemisphere anesthetization (Wada, 1949). It has also been shown that the right visual field excels for verbal stimuli (Bryden, 1965). Evoked potential and EEG techniques have confirmed these findings (Wood, Goff, and Day, 1971; McAdam and Whitaker, 1971; Buchsbaum and Fedio, 1970). In addition, dichotic listening tests have consistently shown a right-ear preference when verbal stimuli are presented, which preference is not shown with non-verbal stimuli (Broadbent, 1954; Kimura, 1961; Curry, 1967; Borkowsky, Spreen and Stutz, 1965; Pettit and Noll, 1972; Studdert-Kennedy and Shankweiler, 1970; Berlin *et al.*, 1972; Kimura and Folb, 1968; Zurif and Sait, 1969; Van Lancker and Fromkin, 1973).

There is ample evidence, in addition, to show that certain other cognitive functions are similarly lateralized. In addition to language, the left hemisphere is specialized for temporal order judgments (Carmon and Nachson, 1971) while the right hemisphere is dominant for spatial relations (Bogen, 1969), part to whole judgments (Nebes, 1971), 'gestalt' perception (Kimura, 1966), the perception of musical chords (Gordon,

1970), and the perception of environmental sounds (Curry, 1967). Finally, for certain stimuli, no hemispheric specialization has been found, and hence it is concluded, no lateralization of function (Schulhoff and Goodglass, 1970; Milner, 1962).

That the two sides of the brain appear to show differential abilities seems clear. It is still a matter of debate as to what, if any, the role of the "minor" hemisphere is in carrying out functions associated with the "major" hemisphere. While Lenneberg has maintained that lateralization is complete by puberty and corresponds to the critical period, Krashen and Harshman (1972; see also Krashen, 1972 and 1973a) have argued that lateralization is complete at about five and that this process is not associated with a critical period limiting language acquisition. Instead, they argue that the lateralization and simultaneous maturation of certain mental abilities (e.g. temporal order judgments) underlying the language faculty must precede or at least be simultaneous with language acquisition (argued in greater detail in Krashen, 1972 and 1973b). Whether lateralization has already taken place in Genie is thus of interest. Was her left hemisphere "prepared" for language or would left hemisphere specialization occur along with language acquisition?

Dichotic listening procedures are simple and easy to administer and for this reason such tests were used in our attempt to investigate lateralization development in Genie. In all these tests, a subject is presented with competing simultaneous stimulus pairs. For example, in the right ear he may hear /da/ or "big" and in the left ear /ga/ or "pig." When the stimuli are verbal, items presented to the right ear are generally reported more accurately by normal right handed subjects. This is assumed to be due to left hemisphere "dominance" for language. When the stimuli are non-verbal (musical chords, Gordon, 1970; environmental sounds, Curry, 1968) a left ear preference is revealed indicating right hemisphere dominance.

The dichotic listening tests administered to Genie were designed, administered and analyzed by Stephen Krashen. The stimuli were prepared at the UCLA Phonetics laboratory using computer programs developed by Lloyd Rice. Two sets of stimuli were prepared; the "verbal" tape consisted of 15 pairs of "point to" words. Each pair of words was preceded by the binaural instructions "point to the ____." Genie pointed to toys or pictures representing the words. [Knox and Kimura (1970) used a similar procedure and found a right ear advantage.] The words were familiar to Genie: baby, boy, car, picture, table, mirror.

The non-verbal tape, prepared by Sarah Spitz, consisted of pairs of environmental sounds recorded from Genie's actual environment (piano chords, car horn, water running, telephone ringing, squeal of toy chimp). She responded by pointing to snapshots of the sound source.

TABLE 1
GENIE'S DICHOTIC LISTENING RESULTS—SINGLE PAIRS OF WORDS PRESENTED DICHOTICALLY

Date	No. of pairs	No. correct right ear	No. correct left ear
3/27/72	29	6	29
5/10/72	15	1	15
8/16/72	30	5	30
overall %		16%	100%

Genie was first tested monaurally; that is, the stimuli were presented to her one ear at a time. She had no difficulty whatsoever in either ear in responding appropriately. Monaural presentation was used as a "warm up" in subsequent sessions and in every case Genie scored 100%. This finding is consistent with her audiometry results of no obvious unilateral hearing loss.

Tables 1 and 2 present the results of the dichotic tests using verbal stimuli. The results show an extreme left ear advantage, suggesting right hemisphere dominance for language. This is an unusual finding since it is very rare to find a right handed subject who is right dominant, and Genie is right handed. [EEG data that was obtained during studies of Genie's sleep is described as "typical of a left hemispheric dominance." (Shurley and Natani, 1972)]. Approximately 1/3 of left handers are also right dominant for language. It is clear that the hypothesis that lateralization had not yet been complete because of the language acquisition taking place is not supported by these results.

The degree as well as the direction of lateralization is also unusual. Dichotic listening in normals nearly always produces a slight, but statistically significant, right ear advantage for verbal stimuli. Genie's left ear was perfect while her right ear performed at a chance level.

TABLE 2
GENIE'S DICHOTIC LISTENING RESULTS—TWO PAIRS OF WORDS, PRESENTED DICHOTICALLY, SEPARATED BY ½ SECOND

Date	No. of pairs	No. correct right ear	No. correct left ear
6/3/73	28	0	28
Controls ($N = 21$, right handed adults with normal hearing): (p .025, one tail)			
	28	23.5	21.4

TABLE 3
GENIE'S DICHOTIC LISTENING RESULTS—SINGLE PAIRS OF ENVIRONMENTAL SOUNDS PRESENTED DICHOTICALLY

Date	No. of pairs	No. correct right ear	No. correct left ear
8/2/72	20	12	18
8/16/72	20	14	19
6/3/73	20	14	20
		67%	95%

TABLE 4
GENIE'S DICHOTIC LISTENING RESULTS—TWO PAIRS OF ENVIRONMENTAL SOUNDS, PRESENTED DICHOTICALLY, SEPARATED BY ½ SECOND

Date	No. of pairs	No. correct right ear	No. correct left ear
6/3/73	28	15	27

The results of the tests using dichotically presented environmental sounds, given in Tables 3 and 4 show that Genie is not simply one of the rare but attested individuals with reversed dominance, with language on the right and certain non-verbal faculties on the left. These show a moderate left ear advantage with her overall accuracy only slightly lower than that of the controls run thus far. This indicates right hemisphere processing of environmental sounds and is a normal finding for right handed subjects (Curry, 1968). It appears that Genie's right hemisphere is doing all the work.

A comparison with other subjects who show similar extreme ear differences, namely split-brain and (right) hemispherectomized patients, may provide some insight into these unusual results. This is presented in Table 5.

TABLE 5
COMPARISON OF GENIE'S VERBAL DICHOTIC LISTENING RESULTS WITH NORMAL, SPLIT-BRAIN, AND HEMISPHERECTOMIZED SUBJECTS

	% Correct better ear	% Correct weaker ear
Normal subjects	60.3	51.9 (Curry, 1968)
Genie	100	16
Right hemispherectomized	99	24.3 (Berlin *et al.*, 1972)
Split-brain	90.7	22.2 (Milner *et al.*, 1968)

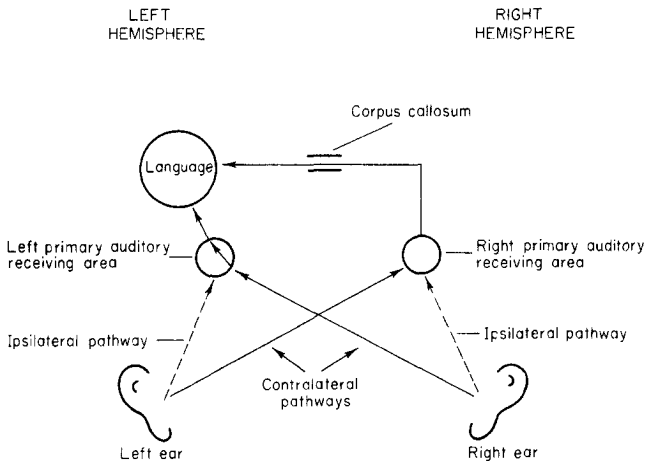

FIG. 1. A model of auditory processing in "normal" dichotic listening.

A brief examination of the mechanisms thought to underlie dichotic listening may be helpful in attempting to understand the parallel between Genie's verbal results and those of the split-brain and hemispherectomized subjects.

Figure 1 is a model of dichotic listening for normal subjects.[5] It has been suggested (Kimura, 1961) that when stimuli are presented dichotically, the contralateral, or crossed auditory pathways suppress the ipsilateral pathways. Thus, in dichotic listening, the uncrossed pathways can be regarded as relatively non-functional. The left primary auditory receiving area then receives only stimuli presented to the right ear while the right primary auditory receiving area receives stimuli presented to the left ear. Since the left primary auditory receiving area is "closer" to the language areas in the left hemisphere, stimuli presented to the right ear have a perceptual advantage. In other words, left ear stimuli must first be routed to the right hemisphere and this gives them a slight disadvantage in competition with the right ear stimuli in the language processing areas. In both split-brain and (right) hemispherectomy, as shown in Fig. 2, there is no input to the language areas from the right hemisphere; thus, any contribution from the left ear is due to the weak (suppressed) ipsilateral pathway.

In monotic listening, both split brains and hemispherectomies perform quite well, at or near 100%. For dichotic listening suppression occurs and the ipsilateral pathway is occluded; because of suppression, the right ear does about four times as well as the left ear. The typical scores

[5] Figures 1 and 2 are taken from Krashen (1972), and Krashen *et al.* (1972a, 1972b).

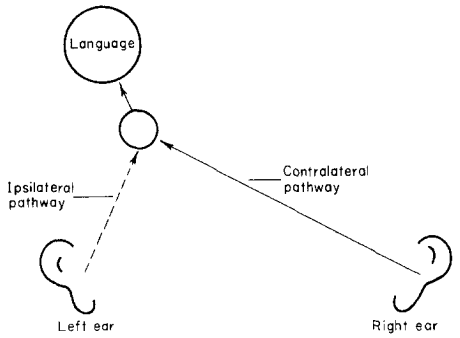

FIG. 2. Dichotic listening for the split-brain and (right) hemispherectomized subject—supression only.

presented in Table 5 have been replicated in other studies (Sparks and Geschwind, 1968; Curry, 1968).

Genie similarly scores 100% in each ear when stimuli are presented monaurally; dichotically she shows the extreme ear difference only parallelled by split brains and hemispherectomies. In a recent study, however, Netley (1972) found that extreme ear differences were found only in hemispherectomized subjects who incurred lesions late (around 17 months), as opposed to those who were injured at birth. It is interesting to note that Genie's case history corresponds more closely to the late lesioned group both with respect to ear difference and onset of lesion.

Genie's results indicate that she in utilizing only her contralateral left ear and ipsilateral right ear pathways in language processing. This does not seem to be true for her non-verbal auditory perception.

In trying to assess this unusual situation it is important to note that Genie seems very proficient in what are considered right hemisphere functions. It was pointed out above that in psychological tests her development can be comprehended more meaningfully when performance on two kinds of test tasks are 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, approximately the age level of her linguistic performance using comparative linguistic criteria. On configurational tests, however, her performance ranges upwards, lying somewhere between eight years and the adult level, depending on the test (see above for Leiter results). The rate of growth on these tests has been very rapid. One year after admission to the hospital, and about two and a half months after she entered the foster

home Genie made mental age scores on the French Pictorial Test of intelligence that spanned the range from 4.5 to 9 years. About 3 months later, her performance on the Raven Matrices could not be scored in the usual manner but corresponded to the 50th percentile of children aged 8.5 to 9 years. Her performance on the Street Gestalt Test, administered by Dr. Joseph Bogen, also attests to the fact that her right hemisphere is mature. This test is known to be dependent on the ability to make part to whole judgments; patients with right hemisphere lesions perform worse on this test than other brain damaged or normal subjects (De Renzi and Spinnler, 1966). Genie scored 7 and 9 out of 12 on two occasions, an unusual performance in view of the fact that the mean for adults is about 7 and the test is somewhat culture-bound. (For example, one of the items to be recognized on the test is a pot-bellied stove, an object never seen by Genie.) In addition, Genie is quite proficient at finding her way around, a skill that is impaired in cases of right lesions.

It would appear then that Genie is lateralized to the right for both language and non-language functions. This assumes that these non-linguistic abilities, which have been shown to be right-hemisphere lateralized, are indeed functions of Genie's right hemisphere. We are now in the process of designing tests involving other modalities which will hopefully provide more conclusive evidence on this question.

If this proves to be the case, one tentative hypothesis to explain how this developed is as follows: At the time of her isolation, Genie was a 'normal' right handed child with potential left hemisphere dominance. The inadequate language stimulation during her early life inhibited or interfered with language aspects of left hemisphere development. This would be tantamount to a kind of functional atrophy of the usual language centers, brought about by disuse or suppression. Apparently, what meager stimulation she did receive was sufficient for normal right hemisphere development. (One can imagine her sitting, day after day, week after week, year after year, absorbing every visual stimulus, every crack in the paint, every nuance of color and form.) This is consistent with the suggestion (Carmon *et al.*, 1972) that the right hemisphere is the first to develop since it is more involved with the perception of the environment. Genie's current achievements in language acquisition, according to this reasoning, is occurring in that hemisphere which somehow did mature more normally.

The hypothesis that Genie is using a developed right hemisphere for language also predicts the dichotic listening results. The undeveloped language areas in the left hemisphere prevent the flow of (just language) impulses from the left primary auditory receiving areas to the right hemisphere. This explains why Genie's scores are so similar to split-brain

and hemispherectomized subjects; the only auditory pathways that are functional for *verbal* stimuli are the right ipsilateral and left contralateral. The low right score is due to the suppression that occurs under the dichotic condition. Her perfect monotic scores are predicted, since suppression only takes place dichotically.

If this hypothesis is true it modifies the theory of the critical period: while the normal development of lateralization may not play a role in the critical period, lateralization may be involved in a different way; the left hemisphere must perhaps be linguistically stimulated during a specific period of time for it to participate in normal language acquisition. If such stimulation does not take place during this time, normal language acquisition must depend on other cortical areas and will proceed less efficiently due to the previous specialization of these areas for other functions.

A comparison of Genie's case with other instances of right (minor) hemisphere speech in adults implies that Genie's capacity for language acquisition is limited and will cease at some time in the near future. Such cases are rare and not well described from a linguistic point of view. A. Smith's (1966) description of a left hemispherectomized man is the best of these. This man could not speak at all after his left hemisphere was removed but did begin to communicate in 'propositional language' ten weeks later. The patient continued to make linguistic progress but remained severely aphasic 8 months after surgery (see also Bogen, 1969). Similarly, Hillier (1954) reported a left hemispherectomy performed on a 14 year old boy for a tumor whose onset was one year previous to surgery. Again, there was early progress in language learning but after 19 months progress ceased and the deficit became stable.

It is unfortunate that there is no information concerning cerebral dominance for other cases of isolated children—those that acquired language as well as those that didn't. Itard suggests that Victor was about 12 years of age when he was found in the woods of Aveyron, and that "It is . . . almost proved that he had been abandoned at the age of four or five years" (Itard, 1962). If, in those first years he was not genetically deficient, lateralization should have been complete and language should have been acquired. Itard states further that "if, at this time, he already owed some ideas and some words to the beginning of an education, this would all have been effaced from his memory in consequence of his isolation." How, why, and if such "memory effacement" occurs, are questions open to speculation. Despite this "effacement," Victor "did acquire a very considerable reading vocabulary, learning, by means of printed phrases to execute such simple commands as to pick up a key." (Itard, 1962, p. xii) but he never learned to speak. The scar "which (was) visible on his throat" may have damaged his larynx. It is impos-

sible to tell from Itard's reports the exact extent of Victor's comprehension of spoken language.

Another case, similar to some extent to that of Genie, is that of a child who was not exposed to language until she was six and a half years old because of her imprisonment with a mute and totally uneducated aphasic mother. (Mason, 1942). Within twenty-two months, she progressed from her first spoken words ("ball," "car," "bye," "baby") to asking such questions as "Why does the paste come out if one upsets the jar?" The rapidity with which she acquired the complex grammar of English provides some support for the hypothesis that the language learning mechanism is more specific than general.

This case is also consistent with a two-to-puberty critical period theory. The language learning capacity of the right hemisphere, then, may be limited either in time or amount of learning. Because we have no grammatical descriptions of right hemisphere speech, we cannot predict how far Genie will progress from comparisons with such cases. On the other hand, Genie's progress in language acquisition impressionistically seems to have far exceeded that of the other reported cases. We intend to continue administering dichotic listening tests to see if the left hemisphere begins to show increasing language function. If this occurs, one plausible conclusion would be that language acquisition and use is a precondition for such lateralizatiion to occur. We note, of course, that this would be contrary to the Krashen and Harshman position that lateralization *precedes* language acquisition. There is also some evidence of laterality differences in neonates (Wada, quoted in Geschwind, 1970; Molfese, 1972).

It is clear from this report that we have more questions than answers. We are hopeful that Genie's development will provide some of these answers.

As humanists we are hopeful that our tentative prognosis of a slowing down of language and permanent dysphasia will prove to be wrong. For despite the predictions of our hypothesis, Genie continues to make modest but steady progress in language acquisition and is providing us with data in an unexplored area, first language acquisition beyond the "critical period." After all, a discarded hypothesis is a small price to pay for confirmation of the astonishing capabilies and adaptability of the human mind.

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