

**Georgetown University Round Table
on Languages and Linguistics 1975**

**Developmental Psycholinguistics:
Theory and Applications**

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Editor



Georgetown University Press, Washington, D.C. 20057

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AN UPDATE ON THE LINGUISTIC DEVELOPMENT OF GENIE

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The case of Genie has by now been widely discussed among linguists. Papers have been published on her linguistic development (Fromkin et al. 1974; Curtiss et al. 1974; Curtiss et al. 1973a) and presented before countless scholarly meetings (Fromkin 1972; Curtiss et al. 1972a, 1972b; Krashen et al. 1972a, 1972c, 1972d; Curtiss et al. 1973b). It is not the purpose today to repeat what is in these papers, but some background may be helpful for those hearing of Genie for the first time.

The case history of Genie is of interest to all concerned with the effects of sensory deprivation. While certain experiments concerned with sensory deprivation have been conducted using consenting adults as subjects, it is obvious why no experimental studies have used children. If we could ignore the cruelty and inhumanity of such a study we might wish to replicate the apocryphal experiments of Psammeticus or King John. One could then start by separating the child from social input, e.g. put her into a room away from others, keep the doors closed to muffle the passage of sounds, limit the intensity and variety of visual experiences, keep all social contact to a bare minimum, and immobilize the child to reduce opportunity for kinesthetic feedback. One might reduce stimulation further by bathing the child infrequently, by making interruptions for toileting unnecessary, and by feeding the child only infant food. In addition, one might beat the child if she produced any sounds.

The experiment described is unfortunately the one experienced by Genie for most of her first 14 years. Genie is now almost 18 years old. Yet, one might say that her life really began on November 4, 1970, when at 13 years 7 months she was hospitalized on orders from the Los Angeles Superior Court. It is surprising that she survived at all. It is not surprising that she was malnourished, unable to stand erect, unable to speak or comprehend spoken language--a primitive and unsocialized victim of unprecedented deprivation and social isolation. Many things have taken place during these 4-1/2 years. She now expresses love, pleasure, and anger; she laughs and cries. She has learned many social skills: she can eat with utensils, chew her food, dress herself, brush her teeth, wash her hair, and tie her shoelaces. She rides a bus to school and sews on a sewing machine. She runs and jumps and throws basketballs. And she speaks and understands--imperfectly, to be sure.

This real life experiment is not finished. We do not yet know the extent of the damage which her isolation and sensory deprivation has wrought. She is still learning, still developing. Many aspects of her development provide information on a number of key issues of interest to linguists. We will try to discuss some of these today.

This report is based on the eight months Genie stayed at the Children's Hospital Rehabilitation Center and the subsequent years in a foster home. During the entire period she has been observed, tested, recorded, and videotaped. Standardized tests have been administered (psychological, linguistic, cognitive development, and perceptual tests), as well as various linguistic comprehension tests developed particularly for her. In addition, dichotic listening and T-scope tests have been used to determine her cerebral dominance for language and certain other abilities. She may be the most tested subject in history.

Language acquisition

All the evidence at our disposal revealed that at the time of her emergence Genie had not acquired language. The big question, then, was: could she? Was she too old? She was already pubescent and according to Lenneberg's hypothesis already past the age when one can acquire a first language through normal (or even non-normal) means.

An example of the extent to which Genie is acquiring language is shown by the following dialogue, part of a larger interchange of February, 1975:

Marilyn and Genie: 2-19-75

- G: Marsha give me square (referring to a piece of fabric that she held).
 M: When?
 G: In the class.
 Marsha give me in the class.
 Marsha in the class.
 M: Which class?
 G: 1 class, 2 class, 3 class.
 M: What does Marsha do in class?
 G: Draw.
 M: What does Marsha draw?
 G: Sun.
 M: Did Marsha come to your class, or did you go to Marsha's class?
 G: Go {in } Marsha class.
 ling
 M: Oh! You're changing classes. That's something new.
 Do you have a new teacher?
 G: Jill. Marsha have Jill.
 M: Marsha has Jill, too. Is Marsha in your class, or are you in Marsha's class?
 G: Marsha class. Go in Marsha class.
 M: You went in Marsha's class.
 G: Marsha's class.

A further example of the extent to which Genie is acquiring language is shown by the complex negation test, first administered to Genie on October 17, 1973. In this test Genie is presented with sentences such as the following: (a) Point to: The book that is not blue is on the table. (b) Point to: The book that is blue is not on the table. In this test she had before her four pictures: (a) a red book on a chair, (b) a red book on a table, (c) a blue book on a chair, (d) a blue book on a table. Her score was 83 correct and 1 incorrect, demonstrating that even under controlled conditions of presentation she understands the notion of 'scope'.

It is interesting to compare these results with her processing of complex sentences with embedded relatives not involving negation. She has no difficulty with sentences such as The boy is looking at the girl who is frowning, where the relative is on the object, or The boy who is frowning is looking at the girl, with a relative on the subject, when the relative clause does not end in an NP. But in a sentence such as The boy who is looking at the girl is frowning, where the relative clause ends in an NP followed directly by the main verb, she always interprets the noun closest to the verb as the subject. This

conforms to Bever's and Mehler's findings and suggestion regarding the NVN processing strategy (Bever 1970, 1971; Mehler 1971).

What is very strange is that one would certainly expect Genie also to interpret all simple active NVN sentences as actor-action-object sentences; yet this is not so. At first (1971, 1972) her responses were random on a word order test, when asked to point to the picture showing The girl pulls (or is pulling) the boy vs. The boy pulls the girl. She did no better with active sentences than with passive. More recently she responds either 100% correct or 100% wrong. She seems to be attempting to figure out the word order strategy but so far without success.

In addition to the anomalous responses to actor-action-object active sentences, she is still not using word order to distinguish between such sentences as What is on the blue box ? vs. What is the blue box on ? Yet in contrast to this, along with the complex sentences, she appears to be using the NVN strategy to process simple sentences on a pronoun test frequently given to her. The test consists of a set of pictures and test sentences, each of which describes only one of the pictures. Although until recently Genie did not appear to comprehend any of the third person pronouns, and made many errors on the pronoun test, it is interesting that with the sentences where all NP's are nouns, her errors are not reversals of subject and object. For example, Genie is presented with sentences such as The girl is feeding the boy, as well as She is feeding him. On the sentences where subject and object are both nouns, she has made only one error which was a subject-object reversal, and in that instance she immediately corrected herself. All other instances of noun subject-verb-noun object on this test have been interpreted correctly.

These data seem to be contradictory; she does use the word order strategy in the case of the pronoun test and the relative clauses. In addition, her own spontaneous utterances show great constraints on word order including agent-action-object order and have done so from the beginning. On the other hand, she does not use the word order strategy on any of the word order tests.

Bever suggests that with children 'there is a steady improvement in interpreting reversible passives until about the age of four; at this age, there is a temporary increase in the tendency to interpret the first noun as the actor and the last noun as the object.' Bever points to a

general relation between cerebral dominance and the utilization of perceptual strategies . . . (in) that those children with a preference for stimuli presented to the right ear have a greater dependence on the linguistic perceptual strategy than children without such an ear preference.

Since, as I will discuss subsequently, it appears that Genie is using her right hemisphere for language as well as other processes, it may be the case that this has an influence on her variable use of this perceptual strategy.

The importance of temporal ordering relations is revealed in Genie's responses to sentences involving before and after. When the sentence order follows the temporal order of events, she has no difficulty. Thus she never errs on commands such as Touch your nose before your ear or After you touch your nose, touch your ear. Long after she could process these sentences correctly, she was still having difficulty with sentences which do not follow temporal order of events, such as Touch X after you touch Y, or Before you touch X, touch Y. There seems to be increasing understanding, however, and interestingly enough, in the last six months, her responses to the after sentences in which the temporal order is reversed are for the most part wholly correct, while she still frequently errs on the before sentences. This does not support the hypothesis that before [the feature [+prior] on adverbials] is learned earlier than after (Clarke 1971).

It is interesting to see the kinds of shifts she makes in her understanding and knowledge. Until recently, in tests involving the distinction between some, one, and all, the sentences with some were interpreted as all. Thus, when asked to put some of the beads in the dish, she would put all of them in. She has now made a shift and some is interpreted as one, which in some sense is more correct than her earlier interpretation.

Her confusions on prepositions are also revealing. She has no problems with in, on, next to, in front of, and in back of. Earlier she had no difficulty with over and under. But now she errs on under, as disjunct items with no relationship between them, and when the relationship was understood, a confusion between them set in. This is supported by the fact that she often confused in front of and in back of--again only with each other. The errors may then show increased understanding rather than retrogression.

Syntactic understanding of tense and aspect still seems to be missing. We use tests with pictures with which normal children have no difficulty. Genie in discussion about the pictures seems to understand conceptually what they stand for, but is unable to point to the correct picture distinguishing between, for example, The girl will open (is opening/opened) the umbrella.

Yet she usually responds correctly to The girl is going to/is gonna open the umbrella and always correctly to The girl finished opening the umbrella. Her ability to interpret the 'finished' sentences correctly, and her inability to respond to the morphologically marked past tense parallels her relative sophistication for the concepts underlying sentences as compared to their syntactic reflection.

She seems to be beginning to learn the pronoun system of English--but just beginning. At first, responses on this test were random, and mostly incorrect. Most of her responses to sentences using third person subject and object pronouns are now correct, e.g. The girl is feeding him or her or She/he is feeding the girl, and even She is feeding him vs. He is feeding her, but she is still making errors. Interestingly though, she comprehends the reflexive and reciprocal markers (self, each other). Her errors on the sentences containing reflexives are only where the subject NP is a pronoun and she misinterprets that pronoun--i.e. where He is feeding himself is misunderstood as She is feeding herself. Since she does not err when the subject is a noun, this shows that she knows the meaning of self but ignores the pronoun marker on the reflexive altogether and relies on her comprehension of the subject NP to determine her response.

While third person subject and object pronouns are receiving increasingly more correct responses, this is not so with possessive pronouns; his, her, my, your, our, their are all undifferentiated at this point. [Test: 'Point to his arm', 'Point to her shoe', etc. . . .]

Despite the huge gaps in Genie's knowledge of syntax, it is clear that she has learned a great deal. Acquisition is painfully slow but it continues.

Comprehension vs. production

It is also clear that like most normal children, for the most part Genie's comprehension exceeds her production. First it should be said that she still speaks very little, or comparatively little. Her articulation remains very faulty, despite the fact that in imitation she does very well. Her phonological system is far simpler than her phonetic ability. She still simplifies consonant clusters, deletes final consonants, centralizes and laxes vowels, etc. It is still an effort for her to speak. The amplitude of her speech has improved greatly, however, and her pitch has decreased somewhat. Furthermore, there is greater pitch variation beginning to approach what one could call sentence intonation. One hears one primary stressed syllable in each utterance, with the stress realized by both pitch and amplitude. Nonetheless, it is still very difficult to understand her if you have not been with her for a period of time.

There is great contrast between her knowledge of the phonological and phonetic representation of words and her production of them. The fact that Genie is able to distinguish between singular and plural nouns in a comprehension test shows her ability to distinguish between final simple consonants and clusters, although for the most part in speaking she still deletes or simplifies final clusters in her speech.

This contrast between her knowledge of the phonological and phonetic representation of words and her production of them is further evidenced by her ability to understand and produce rhyming words. In one test she was presented with a picture and then with three other pictures and asked to point to the picture that 'rhymes'. Prior to the test in game playing she had shown she could rhyme or at least we so concluded and wished to make sure. For example, she might be shown a picture of a pear and then pictures of a peach, a pie, and a bear. She has no difficulty with pointing to the rhyming bear.

Her simplified phonological system is perhaps the source of a number of items that mark the great disparity between Genie's comprehension and production of syntax as well. For example, as stated previously, there is no doubt that she comprehends pluralization on nouns, but since she deletes (or simplifies) final consonants and consonant clusters, plural markers do not appear in her spontaneous production of nouns. It is the same with possessive markers. She comprehends the possessive, but it does not appear in her own production. Past tense and third person singular marking also involve final clusters; so here, too, Genie's phonological system may mask what grammatical features of language she intends to mark on the surface.

Despite absence of such forms, her spontaneous utterances are becoming increasingly more complex. Prepositions are now used at times as is the copula, and many utterances include what one may call 'serial verb constructions', or complex sentence types. Examples of such sentences are:

Eat lunch on plate.
Genie have a tantrum at school.
Genie angry at teacher.
I am going see dentist on Friday.
Is buttoning coat.
I want go school.
I want think about Mama riding bus.
Think about going dentist on Friday.
Mama said don't spit.
Mr. Vaughan say put face in swimming pool.

The disparity between comprehension and production runs two ways. As we described above, there are elements of language which she comprehends but does not produce, e.g. plural and possessive. Perhaps the most striking example of this difference is with questions, however. She comprehends all question types--yes/no questions or who, what, when, which, where, why, and how questions. Yet she does not ask any questions, except those she has been trained

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perception of spatial relationships is substantially determined by activities in the right hemisphere. While this is undoubtedly an oversimplified formulation, it has been reflected in empirical findings and in neurological theory for over a century.

There are further speculations and hypotheses concerning the relationship between language acquisition and lateralization. This is further related to the 'critical age hypothesis'. It is interesting that Alajouanine and Lhermitte (1965) have been unable to demonstrate any critical period in their study of 37 children who sustained brain injury ranging from about 18 months to about 11 years. Krashen (1972b) has shown that the data reported in the literature support a completion of lateralization by the age of 5. If language learning continues after this, then the relationship between lateralization and language acquisition is not simple.

Bever (1971) suggests that 'the fact that functional dominance appears to develop simultaneously with the perceptual strategies (noted earlier) raises the possibility that cerebral lateralization is itself critically dependent on certain kinds of experience.'

The study of Genie may support this proposal. Genie appears to do very poorly on tasks that reflect normally left hemisphere activity, whereas on right hemisphere tasks she performs quite well. Since there is no gross neurological deficit we have speculated on a relationship between her years of isolation and lack of exposure to language stimulation, and on the other hand, her physical immobilization and sensory deprivation in an unchanging, monotonous environment during the usual period in which language is acquired and lateralization develops.

As has been reported in detail in the literature (Krashen 1973; Fromkin et al. 1974; Curtiss et al. 1974), the dichotic listening tests administered to Genie by Krashen showed an overwhelming left ear advantage for verbal stimuli but not for environmental sounds. What was even more surprising was the relative magnitude of her left ear advantage for verbal stimuli, far beyond that of other normal subjects and comparable only to patients with hemispherectomy or with split-brains.

One possible interpretation of these results is that Genie is indeed lateralized but not in the ordinary sense--in which there is a division of functions between the two hemispheres. Rather it may be that Genie is primarily using her right brain and that the lack of linguistic input blocked the normal lateralization development. Since her primary input was visual and tactile, as little as those stimuli were, it was the right brain which developed.

There is no question about her ability to perform what are normally considered 'right hemisphere' tasks. In the Mooney faces test (Mooney 1957)--considered to be the most reliable and most widely used test for

gestalt perception ability and which has shown strong right hemisphere processing--Genie's responses are extraordinary. (The test involves silhouetted type figures and one must state whether they are real or false faces.) There are 70 stimuli, and of these, 50 are of real faces. Genie's identification of these was 100% correct. She missed only 6 of the 20 'incorrect faces'. This is far above the responses of a normal adult.

Similar results are shown on the Street Test, the Thurstone Gestalt Perception Test, and in the Harshman Figures Test (see Curtiss, forthcoming).

I could cite many other examples of her almost uncanny ability for special location memory, facial memory, etc.

What is not known is whether she is indeed using her right hemisphere for these tasks or whether she is a case of reverse lateralization. The environment-sounds dichotic listening test result suggests that this is not the case but much more evidence is needed. We are now in the process of administering a number of Tachistoscopic tests to see if we can answer this question. But such tests are not easy to administer to Genie. Although she is instructed each time to fixate on a star in the center, we cannot be sure that she is doing this. There are also other difficulties. We have so far administered a dot location test, a rhyming test, and a homonyms test using a T-scope.

The results so far are not conclusive and more testing is needed. But the results to date suggest a reversal in dominance. The dot location test is processed better in the left hemisphere, the verbal tests, better with the right (Curtiss, forthcoming).

It is still possible that she is using both hemispheres for these 'right hemisphere tasks' and only the right for the language tasks. It is also possible that as she develops linguistically the nonlanguage abilities will lessen, as has been shown to be the case with children and as Levy (1969) has demonstrated with left-handers who appear to have bilateral representation of language. Or it may happen that with greater language acquisition the left hemisphere will begin to show language processing ability.

Whether or not Genie will be able to answer many of the questions which are of interest to us concerning language acquisition, cerebral dominance, language and thought, etc., what is perhaps more important is that Genie, the human being, continues to learn, to grow, to live in the world.

NOTE

The work reported on in this paper was supported in part by a grant from the National Institute of Mental Health, U.S. Department of Health, Education, and Welfare, #MH-21191-03.

to say. On the other hand, there are elements in her production which at least under formal test conditions, she does not appear to comprehend. For example, as some of the foregoing example sentences show, she uses the present progressive. Yet she does not seem to be able to respond correctly to such sentences in the tense/aspect test described earlier. Moreover, as stated earlier, she does not appear to consistently comprehend N-V-N sequences as subject-verb-object on the word order tests, even though her own sentences show fixed word order: possessor + possessed, modifier + noun, and subject-verb-object.

Language vs. cognitive development

The relationship between cognition and language may be revealed by the semantic system. To investigate the kinds of semantic features Genie utilizes, a number of classification tasks were administered. She is presented with a number of picture cards for each such test and asked to put the pictures together that belong together. In one test the pictures are all of humans, some male and some female; in another the pictures are all animate but divided into human/non-human categories; in a third test the pictures are human and non-human divided into animate/inanimate classes; in a fourth test all the objects depicted are inanimate divided into edible/inedible groups, and in the final test the distinction is between whole body vs. part of body. When these tests were first administered about a year ago, Genie sorted 'correctly' except for the categories human/non-human and part/whole. Within a short time and as of now she has no difficulty in sorting any of these categories.

The independence of cognitive development from linguistic development seems to be clearly shown in the case of Genie. In her isolated state there was little input of any kind. She was closed off from the world of machines, buildings, flowers, toys, animals. Yet after her emergence her ability to generalize specific objects to general categories was very rapid. She seemed to learn simultaneously the generic terms and the names for the members of a class. Tory, the name of the household dog, was reserved for him but all other dogs were immediately recognized as dogs, as, of course, was Tory. One did not need to teach her, as she learned the words for dress, socks, shoes, tie, coat, sweater, that these were all clothes, nor that a toy which moved was not animate.

It is strange that some of her first words were color words and very early she could differentiate between different colors and different shapes and understood size relationships, pointing unerringly to the 'big red circle' vs. 'small red circle' vs. 'big yellow circle' etc. According to Church (1971): 'disadvantaged 4-year-olds are likely

not to know color names; yet even at her stage in language development where she was responding only to single words, Genie knew colors.

Further illustration of Genie's cognitive advance over linguistic development is that as soon as she began to understand and answer wh-questions she responded to why and how questions which usually come much later in normal children's development. As I pointed out, however, although Genie understands all questions she has not once asked a question herself, which may involve emotional problems as well as linguistic ones.

We have not discussed her psychological problems but clearly these impinge on every aspect of her life and development. While she has learned much language and seems to continue in her acquisition, she does not use language for communication where she can avoid it. She has little understanding of the social functions of language. Her emotional difficulties therefore also prevent us from getting a clear picture of what she is capable of producing linguistically.

Psychological testing with Genie has consistently yielded results that may be described as polarized. On certain related functions she achieves very low scores. For example, on WISC she has never achieved a verbal subtest score greater than two. On performance subtests, in contrast, she has achieved subtest scaled scores as high as eight and nine. Similarly, in May, 1973, her Leiter mental age was nearly twice that achieved on the Peabody and in February, 1974, on the ITPA her Psycholinguistic Age for 'visual association' was twice the age for 'verbal expression'. Qualitatively, the impression one gets of Genie is of a child whose gestalt and visuo-spatial perception is greatly superior to her capacity to process stimuli sequentially. She demonstrates great facility in remembering faces and names, possesses a large and continually growing vocabulary, and has no difficulty finding her way about in real space. It is interesting, however, that as she develops sequential skills, she may be losing some of her parallel non-sequential abilities to process the same stimuli. For example, at first Genie responded quickly and accurately when asked how many pennies appear in a random display of 0 to 7 pennies, gestalting the number as she did not yet know how to count. When she began to learn to count, she did so only with errors and distress and continued to rely on her ability to gestalt numbers. Now that she can count certain amounts accurately and fairly fluently, she appears to have 'lost' the ability to gestalt these amounts and will guess wrong when asked to do so.

Hemispheric dominance

Contemporary concepts of cerebral activity suggest that most language functions are localized in the left hemisphere, whereas