Protolanguage, the Bioprogram Hypothesis, and Gestural Communication

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1. Introduction

A longstanding problem in the study of language has been how to account for the origins of language. The "origin of language" can be thought of in two ways: phylogenetically or ontogenetically. Phylogenetically the origin of language refers to the emergence and development of language during human evolution. Ontogenetically the origin of language refers to the emergence of language in a child during language acquisition. There are also cases in which a language emerges in a whole society. This happens when people with different native languages are brought together and interact by forming a rudimentary type of communication, called a pidgin. When the children of these pidgin speakers acquire this pidgin as a native language, it is then called a creole. Creoles are considered to be languages and the process of creolization can be considered to be the origin of a language because the creole that is formed often has properties that are different from properties of the pidgin speaker's native languages (the substrate languages) and from properties of the dominant language (the superstrate language).

A problem that arises in trying to account for the origin of language is the continuity paradox. Basically, this paradox is that in one way the origin of language seems to be continuous, whereas in another way the origin of language seems to be discontinuous. Phylogenetically the continuity paradox is that human language seems to be qualitatively different from animal communication, but language must have evolved out of some preexisting system. This is a paradox because the qualitative difference between animal communication and human language suggests an evolutionary jump from animal communication systems to language, whereas the evolution of language from some preexisting system suggests an evolutionary continuum from animals to humans. Ontogenetically the continuity paradox is that children's language is different from adult language, but children's language turns into adult language. The differences between child language and adult language suggest a jump during development, whereas the fact that children start by producing child language and end up producing adult language suggests a developmental continuum. In regards to creole languages the continuity paradox is that creoles are different from their superstrate and substrate languages and similar to each other, but creoles had to get structure from somewhere. The differences between creoles vs. their superstrate and substrate languages in addition to the similarities among creoles suggest some dissociation between creoles vs. superstrate and substrate languages, whereas the fact that creoles have to get structure somewhere suggests an association between creoles and their superstrate and substrate languages.

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To account for the paradox phylogenetically, three evolutionary hypotheses have been proposed: mutation, exaptation, and adaptation. Mutation is a genetic change. Hypotheses of the evolutionary origins of language which invoke mutation usually assume that language emerged as the result of a large genetic mutation. Exaptation occurs when a structure which was used for one purpose is taken over and used for another purpose. Hypotheses invoking exaptation assume that structures which had evolved for other purposes were taken over for the purpose of language. Adaptation is evolution which results from genetic variation or small genetic changes which give a selective advantage to an organism, in that the organism is able to survive longer and reproduce more and thus is able to pass on more genetic material. Hypotheses invoking adaptation assume that language emerged gradually bit by bit. Mutation is consistent with an evolutionary jump, whereas exaptation and adaptation are consistent with an evolutionary continuum.[1]

Two hypotheses have been proposed to account for the continuity paradox ontogenetically: nature and nurture. The nature hypotheses assume that much of language is innate. For example, some hypotheses assume that all humans are born with an innate grammar which specifies the kinds of grammatical structures which are possible in human languages. The nurture hypotheses assume that children learn languages including grammatical structures by being exposed to them in the environment.

The process of creolization is interesting because it could possibly provide insight into both ontogenetic and phylogenetic development. Creolization can provide evidence of ontogenetic innovation in that a group of children who have pidgin input produce a more structured creole. Creolization might also provide evidence of phylogenetic innovation because the emergence of a creole language could be similar to the emergence of language evolutionarily.

Derek Bickerton (1981, 1983, 1984, 1988a, 1988b, 1989, 1990, 1991, 1992) has advanced two hypotheses which he uses to account for the origins of language phylogenetically, ontogenetically, and in the development of creoles. One of Bickerton's hypotheses involves what he calls the "bioprogram", an innate specification of language properties unique to humans. Bickerton proposed the bioprogram hypothesis to account for the similarities between diverse creole languages and for some aspects of child language acquisition. Bickerton claims that the bioprogram is called upon by children during language acquisition especially when their input is impoverished. The bioprogram hypothesis has changed over the years from one based primarily on semantics to one based primarily on syntax. In 1981 Bickerton claimed that "the similarities between creole languages were in many cases closer and more consistent in the semantic component than they were in the syntactic component" (1981: 318). From 1983 on, however, the bioprogram hypothesis has been described primarily in syntactic terms. Thus, from 1981-1992 there has been a mixture of both syntax and semantics in the bioprogram, but the emphasis has changed from semantics to syntax.

[1] Based on notes taken in Robert Kluender's Linguistics 3A class, Fall 1993.

Bickerton (1992) explains that this shift from semantics to syntax was due to his ignorance of developments in generative grammar during the writing of his 1981 book (1992: 104). However, it seems that this change was unnecessary since, as I will discuss in section 3, most of the features of the bioprogram can be accounted for semantically.

Bickerton's other hypothesis is that there is something called "proto-language" which is a primitive form of language (1990: 118). He attributes this primitive language to children under two, adults who were deprived of language as children, speakers of pidgins, and trained apes. Bickerton uses his proto-language and bioprogram hypotheses together to account for the phylogenetic and ontogenetic origins of language. He claims that protolanguage evolved before language (1990: 128) and is distinct from language. To account for the continuity paradox phylogenetically, Bickerton uses a mutation hypothesis. He claims that there are no intermediate forms between protolanguage and language (1990: 165) and that the jump from protolanguage to language was the result of a genetic mutation in a single individual (1990: 174). To account for the continuity paradox ontogenetically, Bickerton assumes that children first use protolanguage and that at about the age of two their brains have developed enough to start producing language (1990: 112).

In this paper I argue that Bickerton's hypotheses of protolanguage (1988b, 1990) and the language bioprogram (1981, 1983, 1984, 1988a, 1989, 1990, 1991, 1992) cannot account for some of the innovations produced by deaf children and apes in their gestural communication.[2] I argue that these innovations could better be accounted for by assuming that there are continua of language-like properties. Phylogenetically this hypothesis suggests that language may have evolved gradually through adaptation, rather than suddenly through mutation as suggested by Bickerton. Ontogenetically this hypothesis suggests a gradual acquisition of language.

In the following sections, I begin by describing Bickerton's notion of proto-language (section 2). Then I describe Bickerton's language bioprogram hypothesis and list its properties which are based on the similarities across diverse creole languages (section 3).

It has been claimed that American Sign Language (ASL) has many creole properties and thus many properties of Bickerton's bioprogram (Bochner and Albertini 1988; Gee and Goodhart 1988). However, it has also been claimed that ASL has more morphology than creoles (Gee and Goodhart 1988). Since section 5 will compare gestural communication to the properties of Bickerton's bioprogram, which is based on spoken creoles, it will be useful to compare the properties of a sign language to the properties of the bioprogram in order to see if the bioprogram properties can account for the properties of what has been called a

[2] I use the term "gestural communication" to refer to any sign, gesture, or motion produced by the hands, face, or body in an attempt to communicate. In this sense "gestural communication" includes natural sign languages, such as ASL, invented sign languages, the signs produced by apes that have been exposed to ASL signs, and the gestures produced by deaf children who have not been exposed to any sign language.

signed creole, i.e. ASL. This comparison between the properties of ASL and the properties of the bioprogram is made in section 4.

Section 5 presents data from the gestural communication produced by three groups of deaf children with impoverished input: 1) deaf children who receive no language input, 2) deaf children who receive an invented sign system as input, and 3) a deaf child who receives ASL input from parents who acquired ASL late. Then I present data from the gestural communication of apes with ASL signs as input. I first discuss the properties of the gestural communication produced by these children and apes which are not present or are rarely present in their input; then I compare these properties with the properties of protolanguage and the bioprogram. The gestural communication produced by these children and apes provides evidence against Bickerton's hypotheses in two ways:

(1) Bickerton claims that protolanguage and language are distinct and that there are no intermediate forms between protolanguage and language. However, the gestural communication systems produced by the deaf children who have no sign input seem to be more deficient than the protolanguages described by Bickerton in terms of arbitrariness and displaced reference, and at the same time beyond the properties of protolanguage in terms of morphology and word order based on semantic roles. The gestural communication produced by the apes also seems to be beyond the properties of protolanguage in the use of some word order and morphology. Bickerton's protolanguage hypothesis cannot account for communication systems which cannot be considered to be language but simultaneously have properties that are beyond the properties of protolanguage.

(2) According to Bickerton's bioprogram hypothesis, linguistic forms that are not predicted by the bioprogram should not be innovated. Therefore, properties of the gestural communication produced by these children and apes which are not found in the input should be properties of the bioprogram. However, I provide evidence that these children and apes produce gestural communication with morphological properties which are not (or are only rarely) in the input and are not part of the bioprogram.

I conclude in section 6 by suggesting that the morphological properties in the gestural communication produced by these children and apes which cannot be accounted for by protolanguage or the bioprogram can be accounted for by a constraint on (or tendency for) languages to be produced quickly and efficiently (Bellugi 1980; Gee and Goodhart 1985, 1988; Gee and Mounty 1991; Slobin 1977; S. Supalla 1991). I also propose that the form of the innovated morphology can be accounted for because it is iconic and indexical. Lastly, to account for the properties of the gestural communication produced by Goldin-Meadow's subjects, which seem to be more deficient than protolanguage in some properties, but, along with the gestural communication produced by the apes, beyond the properties of protolanguage in other ways, I propose that there is no single characterization of protolanguage. Instead I hypothesize that there are a variety of continua of language-like properties along which communication systems can vary. This has implications for the origins of language in that it suggests that language could

have evolved gradually rather than as the result of large genetic mutation and a leap from protolanguage to language as Bickerton claims. This also has implications for language acquisition in that it suggests that properties of language are acquired gradually.

2. Bickerton's protolanguage hypothesis

Protolanguage: a primitive type of language that is produced by children under two, adults who were not exposed to language as children, speakers of pidgins, and trained apes.

Bickerton (1990) claims that protolanguage is primitive type of language which lacks many of the formal properties of true language. Furthermore, he claims that protolanguage is as much a part of our genetic makeup as language is, but that it is more robust than language, because it evolved first. There is also no "critical period" within which protolanguage must be acquired, i.e. protolanguage can be acquired by a human of any age. However, some type of lexical input is needed in order to acquire protolanguage because it is not completely innate (1990: 118). Bickerton hypothesizes that protolanguage is distinct from normal human language and is produced by the following four groups: children under the age of two, adults who were not exposed to language as children (for example, Genie, who was isolated and deprived of language until she was 13), speakers of pidgins, and apes that have been trained in language skills (1990: 122). He claims that the differences between protolanguage and language are that protolanguage does not have the following properties that a language has:

1) In a protolanguage, there are no principles based on formal structure that constrain variations in word order. Bickerton states that in language, order is determined by "functional considerations (what is being presupposed or asserted, emphasized or de-emphasized) and a formal structure that sharply constrains possible outputs". In protolanguage, however, there is no formal structure, but rather lexical items are simply strung together (1990: 126). Since there is no hierarchical structure, only functional considerations apply. For example, in protolanguage topics might be the initial constituent, not because of movement rules, but because they are the most important thing on the speaker's mind (1990: 123). However, since Bickerton claims that word order is determined in part by formal structure it is not clear how languages in which word order is almost entirely free, such as Warlpiri, could satisfy this property of language.[3] In Warlpiri there are some contexts in which an auxiliary must occur in second position, but aside from this, the word order is free (Simpson 1983: 88-91). Thus word order in Warlpiri does not seem to be sharply constrained by formal structure.

[3] This was pointed out to me by Farrell Ackerman.

2) The occurrence of null elements cannot be predicted in protolanguage, whereas in language the occurrence of null elements is principled and predictable. Bickerton claims that "in language we can state quite explicitly the circumstances under which the appearance of such elements is allowed ... In protolanguage, however, any item may be absent from any position. It is impossible to predict when this will occur, and in order to determine what has been omitted, the hearer can only rely on overall meaning, knowledge of the situation, and sheer common sense" (1990: 124). However, Hyams (1987), P. Bloom (1990, 1993), and Hyams and Wexler (1993) claim that the occurrence of null elements in the speech of children is at least partially predictable. P. Bloom claims that the occurrence of null subjects can be partially predicted by pragmatic factors and processing limitations. On the other hand, Hyams (1987) and Hyams and Wexler (1993) claim that the occurrence of null subjects can be partially predicted by assuming that children start out with a pro-drop grammar.[4]

3) In a protolanguage, subcategorized arguments of verbs are often left out (Bickerton 1990: 111, 120). Bickerton asserts that in contrast, in language all of the subcategorized arguments of a verb "will be overtly realized unless there are principled means ... by which they can be identified and linked to their expected locations or to appropriate referents" (1990: 124-125).

4) A protolanguage is not recursive, i.e. there are no principles for adding constituents to phrases to form complex phrases and no principles for combining phrases with other phrases to form complex clauses. Bickerton adds that protolanguage may have a few examples that look like expanded phrases or complex clauses, but that they might have been rote-learned and not constructed (1988b: 92, 1990: 125, 19). Protolanguage primarily contains strings of isolated utterances which do not have hierarchical structure. Since there is no structure, there are no structural positions to which complements can attach (1988b: 93, 1990: 126).

5) A protolanguage has no or few grammatical items. Grammatical items which are not usually present in protolanguages include: inflections for tense, number, or person agreement; auxiliary verbs for expressing tense, aspect, equation, or class membership; complementizers; markers of the finite/nonfinite distinction; conjunctions; prepositions; articles; and demonstratives (1990: 126). However, a

[4] P. Bloom (1990, 1993) and Hyams and Wexler (1993) examined data from two of the same subjects. P. Bloom used data from the subjects Adam between the ages of 2;3-2;7, Sarah between the ages of 2;3-2;7, and Eve between the ages of 1;6-1;10. Hyams and Wexler used data from the subjects Adam between the ages of 2;5-3;0 and Eve between the ages of 1;6-2;1. The subjects Adam and Sarah were over 2 years of age and Bickerton would probably consider them to be producing language. However, Eve was under 2 years of age and therefore should be considered to be producing protolanguage. Furthermore, the output from Adam and Eve had patterns of occurrence of null elements which were more similar to each other than to those of Sarah's output. This suggests that even in the speech of children under 2 years of age, the occurrence of null elements is partially predictable.

protolanguage might contain auxiliary verbs for expressing possibility or obligation; negators; question-words; pronouns; relative-time markers; quantifiers; and particles indicating location (1990: 126, 185). Bickerton claims that "the stronger the meaning element in a grammatical item, the more likely it is to appear in protolanguage, [however] ... the stronger its structural role, the less likely it is to appear" (1990: 126).

Bickerton assumes that protolanguage evolved before language (1990: 128). Furthermore, Bickerton claims that language did not develop gradually from protolanguage, but rather protolanguage changed into language with no intervening stage:

> "There is no evidence that language developed gradually. Such evidence might consist of ... some linguistic mode(s) intermediate between protolanguage and true language. But there is no evidence that any such mode exists. On the contrary, there is evidence ... that protolanguage can change into true language without any intervening stage, as well as evidence that there can be no plausible intermediate stage between the two" (Bickerton 1990: 165).

Bickerton claims that this change from protolanguage into language phylogenetically was the result of a mutation in a single individual (1990: 174), but that protolanguage probably contributed potential grammatical items and a range of thematic roles to language (1990: 187). He bases the belief that there are no intermediate stages between protolanguage and language on fossil evidence, evidence that he provides from child language acquisition, and evidence from the change of a pidgin into a creole.

Turning first to evidence from the fossil record, Bickerton assumes that there is a connection between tool use and language. He claims that there was little change in stone tools during *Homo erectus*, but when *Homo sapiens* appeared so did bladed tools and other artifacts, such as cave paintings and stone carvings (1990: 172). Bickerton hypothesizes that the change in tools from *Homo erectus* to *Homo sapiens* corresponded to a jump from the use of protolanguage by *Homo erectus* to the use of language by *Homo sapiens*. Furthermore, he claims that the change from protolanguage to language must have been sudden because if protolanguage had changed into language gradually during the period of *Homo erectus*, one would expect their tools to gradually improve (1990: 174).

Turning now to evidence from child language acquisition, Bickerton provides a sample of the output of a child at 21 months of age and compares it to a sample of that same child's output six months later. He claims that at 21 months, the child's output has the properties of protolanguage: 1) There are no principles based on formal structure that constrain variations in word order; 2) the occurrence of null elements is not predictable; 3) subcategorized arguments of verbs are left out; 4) there are no complex phrases or complex clauses; 5) there are no grammatical items. Bickerton argues that six months later, four of the five properties that distinguish language from protolanguage are present: the

occurrence of null elements is predictable (property 2); subcategorized arguments of verbs are supplied (property 3); there are expanded noun phrases, conjoined clauses, and embedded clauses (property 4); and there are grammatical items (property 5) which include a verb inflected for 3rd person singular, verbs inflected for tense, a noun inflected for plurality, an infinitive marker, articles, pronouns, quantifiers, a determiner, a conjunction, and a locative. Property 1, which links varied word orders to varied functions, is not clearly represented in this sample, and therefore may not yet have been acquired (1990: 166-168). Bickerton suggests that the reason this child might not have acquired property 1 yet is because the possibilities of word order change, e.g. subject and auxiliary inversion in questions, are language-specific, whereas "means for the expansion of structure, subcategorization-frames of verbs, and principles that govern identification of null elements are constant across languages". Therefore, Bickerton states that children probably need "rich, positive evidence" before they will change the word order of their utterances (1990: 168).

There are problems with drawing conclusions based on these data. First of all, Bickerton only provides data from one child. Other children might not show such a dramatic change in six months. Secondly, the data that Bickerton provides when the child is 21 months old contain only single word utterances, which cannot possibly satisfy properties 1-4. Furthermore, these data suggest that single word utterances are all the child is capable of producing. However, these data come from a situation in which the child's father is talking with some friends and the child keeps interrupting by naming things that are either present in the environment, or that are mentioned in the conversation by his father (1990: 114). Thus this might have been a special circumstance and there is no evidence that this child did not produce longer utterances at this age. Even if this child did not produce longer utterances at 21 months, Bickerton does not provide data on this child's two word stage. The data that Bickerton provides from when the child is six months older consist of sentences that are between 2 and 11 words long. What happened during these six months? The child might have acquired these four properties of language in six months, but these properties might not have all been acquired simultaneously as Bickerton claims. Bickerton does not provide enough evidence to resolve this question.

Turning to evidence from creolization, Bickerton defines a creole as a language that arises from a pidgin in one generation. A pidgin has the properties of a protolanguage: 1) There are no principles based on formal structure that constrain variations in word order, i.e. there is no fixed word order; 2) the occurrence of null elements cannot be predicted; 3) subcategorized arguments of verbs are often left out; 4) there are no principles for producing complex phrases or complex clauses; 5) there are few grammatical items. Creoles, on the other hand, have all of the properties of language that pidgins lack: 1) there are principled variations in word order based on formal structure; 2) there is principled identification of null elements; 3) all subcategorized elements of verbs are expressed or can be associated with their appropriate referents; 4) there are devices for expansion within and between clauses; and 5) the proportion of grammatical to lexical items is 50-50 (1990: 171), as is found in adult noncreole languages

(1990: 166).

With the support of this evidence, Bickerton claims that all of the properties that distinguish language from protolanguage appear as a cluster in both child language acquisition and in the change from a pidgin to a creole, i.e. that there is no intervening stage between protolanguage and language (1990: 167, 171). He argues that the properties that distinguish language from protolanguage are not acquired one by one, because the properties are interdependent. He claims that there is a connection between identifying null elements (property 2) and the obligatory expression of subcategorized arguments (property 3) because they both have to do with identifying an element in terms of grammatical function and reference. These two properties depend on the existence of a recursive structure (property 4) in order to determine what the referent of a null element is and whether a subcategorized argument is present. Furthermore, there must be a basic ordering of constituents (property 1) so that the grammatical function of constituents can be determined based on this basic ordering. The existence of grammatical items (property 5) assumes that there is a hierarchically structured system in which these items can operate (1990: 179-180). Thus Bickerton concludes that "wherever protolanguage gives place to something more complex, this 'something' should immediately exhibit all of the central, distinguishing properties of language" (1990: 180). Bickerton claims that the speech of children under two differs from the speech of children over two because parts of the brain that control formal syntax have not finished developing until approximately two years of age (1990: 112).

It seems that Bickerton's motivation for claiming that there are no intermediate stages between protolanguage and language stems from a desire to keep humans distinct from other animals, especially apes. Bickerton claims that apes which are trained in a language can produce protolanguage but not language. He finds similarities in the output of apes and the output of children under two, but claims that children under two are not producing language in order to avoid the claim that apes are producing language. The similarities in the output of apes and the output of young children "does not prove that Washoe [a chimp studied by Gardner and Gardner] was acquiring human language, so long as we accept that the children concerned were not acquiring language either" (1990: 114). Thus Bickerton claims that syntax, which protolanguage lacks, is what separates humans from other species (1990: 57).

Bickerton notes the similarities between the output of apes and the output of a child under two by comparing the English glosses of the signs produced by an ape with spoken English produced by a child. However, there are two problems with comparing English glosses of signs with spoken English. The first problem is that most of the apes that have supposedly been taught ASL have only been taught ASL signs for nouns and verbs. They have not been taught ASL grammar and in many cases they have not been exposed to fluent ASL signers. The child that Bickerton compares the signing of apes to is learning English from English-speaking parents. Unlike the apes, the child is exposed to fluent speakers. The second problem is that if the transcription of ASL is not detailed, grammatical inflections and grammatical facial expressions will not be transcribed and the

English glosses will look like the speech of a young child even if the signing was produced by a fluent, adult ASL signer. For example:

1INDEX DECIDE iINDEX SHOULD DRIVE SEE CHILDREN 1INDEX
'I decided he ought to drive over to see his children, I did.'

1INDEX means a first person pronoun. iINDEX means third person pronoun (Padden 1988: 88; but I have removed the verb agreement markers on the verb from the transcription in order to make my point). The above example seems to be telegraphic because there is no tense marker on the verb DRIVE and there is no infinitival marker. Bickerton provides examples of signed utterances produced by a chimp (Nim) (Bickerton 1990: 110 with data from Terrace 1979). These examples do not contain verb agreement or any other type of grammatical inflection. This might be because Nim did not produce any grammar, as Bickerton assumes. This is a reasonable assumption because Nim was probably not taught any grammar. However, it could also be the case that Nim did produce some inflections, but that these inflections were not transcribed because the researchers working with Nim did not recognize them as inflections. Thus, it would be better to compare the signing of apes with the signing of children learning ASL. In section 5.2 I compare the sign production of apes with: 1) the gesturing of children who have no ASL input, and 2) properties of ASL.

Trying to maintain a separation between protolanguage and language seems to cause some difficulties for Bickerton. These difficulties cause him to make arbitrary stipulations which render his hypothesis that there are no intermediate stages practically unfalsifiable. First of all, Bickerton provides acquisition data from only one child. Data from other children might not have shown such a dramatic change in six months. Secondly, as discussed above, Bickerton provides data of what he calls protolanguage from the output of the child at 21 months old and data of what he calls language from the output of this child at 27 months old. It seems that Bickerton does not provide data from the intervening 6 months in order to maintain his distinction between protolanguage and language. Furthermore, since the child's output does not contain one of the properties that Bickerton assumes a language should contain (i.e. variable word order), Bickerton arbitrarily suggests that this property takes longer to acquire because children need "rich, positive evidence" before they will vary their word order (1990: 168). Bickerton also tries to protect his hypothesis from claims that there are intermediate stages by stating the following: "Child speech, in the few months between protolanguage and the acquisition of a full (if not yet adult) language, must ..., from time to time, fall back on protolanguage" (1990: 168). Bickerton claims that children fall back on protolanguage because they have not acquired all of the grammatical items they need to use all of their syntactic abilities (1990: 168-169). Thus if one advances the claim that the output of a child has some properties of protolanguage and some properties of language and thus seems to constitute an intermediate stage, Bickerton can argue that it is not an intermediate stage, but rather that the child has language and is falling back on protolanguage. In section 6 I argue that the gestures produced by children who do not have any sign input and the signs produced by apes provide evidence that there is no single

characterization of protolanguage. I claim that rather than a distinct separation between protolanguage and language, there are various continua along which language-like properties of communication systems can vary.

3. Bickerton's bioprogram hypothesis

Bioprogram: an innate specification of the form of human languages which emerges in children when language input is inadequate.

Based primarily on evidence from creole languages, Bickerton (1981, 1983, 1984, 1988a, 1989, 1990, 1991, 1992) proposes that humans are born with an innate language bioprogram. Bickerton claims that this bioprogram governs the form of human language when the input is insufficient. He studies creoles which were formed in one generation, i.e. creoles spoken by people whose parents spoke pidgin, and claims that creoles "show similarities which go far beyond the possibility of coincidental resemblance, and which are not explicable in terms of conventional transmission processes such as diffusion or substratum [the various native languages of the pidgin speakers] influence" (1981: 132). He proposes that these similarities are the result of an innate language bioprogram and hypothesizes that this bioprogram emerges when humans have inadequate language input (1981: 133). This hypothesis is important because it attempts to account for the similarities between the diverse creole languages which Bickerton has studied and it makes predictions about properties that should be found in other creole languages and in other situations in which the language input is impoverished.

The properties that creole languages have in common are attributed to the bioprogram. The following is a list of the properties of the bioprogram:[5]

a) Movement rules: Constituents can be moved to sentence initial position (1981, 1984). The following are examples of movement:

Guyanese Creole (1981: 52)

(1) Jan bin sii wan uman
'John had seen a woman.'

(2) a Jan bin sii wan uman
'It was John who has seen a woman.'

[5] Bickerton does not mention all of these properties in each of his articles on the bioprogram and it is not clear if some of them have been eliminated since his 1981 book in which most of the properties are listed, so after each property I will list the references in which that property is mentioned.

(3) a wan uman Jan bin sii
'It was a woman that John had seen.'

(1) is a simple declarative sentence. In (2) the subject 'John' is clefted by placing the marker *a* in front of 'John'. In (3) the object is clefted by moving it to sentence initial position and placing the marker *a* in front of it.

b) Articles which distinguish presupposed specific, asserted specific, and nonspecific NP's (1981, 1983, 1984, 1988). Presupposed specific NP's have a particular referent and are known to the listener, for example when the NP has previously been mentioned in the discourse. Asserted specific NP's have a particular referent but are not known to the listener, for example when the NP has not previously been mentioned in the discourse (1981: 56). The term "nonspecific" refers to generic NP's, for example NP's that refer to a category, e.g. 'dogs' in general, or NP's that have a particular referent but the identity of that referent is irrelevant or unknown to the speaker (1981: 23). Nonspecific NP's are distinguished from the two types of specific NP's by the absence of an article (1981: 56). For example:

Papiamentu (1981: 57)

(4) mi tin *e* buki
'I have the book.'

(5) mi tin *un* buki
'I have a book.'

(6) mi tin buki
'I have books.'

(7) buki ta caru
'Books are expensive.'

(4) is an example in which 'book' is a presupposed specific NP, and it is preceded by the article *e*. (5) is an example in which 'book' is an asserted specific NP, and it is preceded by the article *un*. (6) and (7) are examples in which 'books' are nonspecific NP's, and they are not preceded by an article. (6) is an example of an existential in which the existence of books is asserted. (7) is an example of a generic NP in which books in general are referred to.

c) TMA (tense, modality, aspect) systems: The tense, modality, aspect systems of creoles make the following distinctions: tense = <+/–anterior>, modality = <+/–realis>, and aspect = <+/–punctual> (1981, 1983, 1984, 1988). These distinctions are expressed by free morphemes which mark <+anterior>, <–realis>, and <–punctual>. The opposite values, i.e. <–anterior>, <+realis>, and <+punctual>, are unmarked. These TMA morphemes precede the verb in this order. A marker which is <+anterior> refers to an action that occurred prior to the time

frame of the discourse, i.e. if speakers are talking about an event in the past, an anterior marker would be used for an action that occurred before the event about which they are talking. A marker which is <–realis> refers to actions which have not been performed, for example futures, conditionals, and imagined events (1981: 58; 1984: 182). A marker which is <–punctual> refers to actions which are extended over a period of time or repeated (1975: 46). For example, Hawaiian Creole English has the auxiliaries *bin* which marks <+anterior>, *go* which marks <–realis>, and *stei* which marks <–punctual> (1981: 26):

Hawaiian Creole English (1991: 66-67)

(8) he *bin* walk
'He had walked.'

(9) he *go* walk
'He will/would walk.'

(10) he *stei* walk
'He is/was walking.'

d) Complementizers: Many creoles have complementizers for accomplished vs. unaccomplished actions (1981, 1983, 1984, 1988a, 1989). "Accomplished" refers to actions that were performed, whereas "unaccomplished" refers to actions that may or may not have not been performed (1991: 65). The complementizer for an accomplished action is often derived from a word meaning 'go'. The complementizer for an unaccomplished action is often derived from a word meaning 'for' (1981: 61). For example:

Jamaican Creole (1981: 59)

(11) im gaan *fi* bied, bot im duon bied
'He went to wash, but he didn't wash.'

(12) *im gaan *go* bied, bot im duon bied

(11) is an example using the complementizer *fi*, which is used for unaccomplished actions. In this sentence, the complementizer *fi* indicates that the subject, 'he', did not necessarily perform the action, i.e. did not necessarily wash. Therefore, the action can be negated. (12) is an example using the complementizer *go*, which is used for accomplished actions. In this sentence, the complementizer *go* indicates that the action was necessarily performed, and therefore cannot be negated. Thus (12) is ungrammatical.

e) Negation: "In creoles generally, nondefinite subjects as well as nondefinite VP constituents must be negated, as well as the verb, in negative sentences" (1981: 65, 1991). For example:

Guyanese Creole (1981: 66, 1991: 68)

(13) *non* dag *na* bait *non* kyat
'No dog did not bite no cat.'

f) The same lexical item is used for existentials ("there is") and possessives ("have") (1981). For example:

Haitian Creole (1981: 66)

(14) *ge* you fam ki *ge* you pitit-fi
have one woman who have one child-daughter
'There is a woman who has a daughter.'

Sao Tomense

(15) *te* ua mwala ku *te* ua mina-mosa
have a woman who have a child-girl
'There is a woman who has a daughter.'

In (14) and (15), the first usage of *ge* or *te* is the existential use and the second usage is the possessive use.

g) Copula: Adjectives behave like stative verbs in most creoles, and therefore most creoles do not have copulas (1981). For example:

Guyanese Creole (1981: 68)

(16) i wok
'He worked.'

(17) i wiiri
'He is tired.'

(18) i a wok
'He is working.'

(19) i a wiiri
'He is getting tired.'

(20) au i wok!
'How he works!'

(21) au i wiiri!
'How tired he is!'

The above examples show the similar behavior of verbs and adjectives. (16),

(18), and (20) are examples with the verb 'work'. (17), (19), and (21) are the same forms with the adjective 'tired' substituted for the verb 'work'. (18) and (19) contain the Guyanese Creole nonpunctual marker *a*, and therefore refer to processes rather than to a single punctual event.

h) Questions: In creoles there is no difference in syntactic structure between yes/no questions and statements (1981: 70, 1991). Intonation alone is used to distinguish between yes/no questions and statements (1991: 68). For example:

Guyanese Creole (1981: 70)

(22) i bai di eg-dem
'He bought the eggs.'
(23) i bai di eg-dem?
'Did he buy the eggs?'

In the above examples, both the statement and the question have the same word ordering. The only difference is in the intonation.

i) In wh-questions, the question word is put in initial position and the rest of the sentence has the same word order as in the declarative (1981, 1988a). Furthermore, if the question-words are not equivalent to those of the superstrate, they are bimorphemic and the first morpheme consists of a superstrate question-word (1981, 1988a, 1989). For example, in a creole with an English superstrate, the first morpheme could be *we*, *wi*, or *wa* from the English question words *which* or *what*. The second morpheme, for example, could be a word meaning 'side', 'place', or 'edge' for the question word "where", 'way' for the question word "how", 'thing' for the question word "what", 'makes' for the question word "why", or 'hour' for the question word "when" (1981: 70-71). For example:

Haitian Creole (1981: 70)

(24) *ki kote* ou we pwaso-a?
what side you see fish-the
'Where did you see the fish?'

Guyanese Creole (1989: 24)

(25) *waplees*
what place
'where'

j) Embedded sentences (1984: 180) and complements of perception and causation verbs (1981: 100-104) are finite and can contain aspect markers and/or tense (1981, 1984). Furthermore, in his 1988 article, Bickerton claims that nonfinite structures usually not found in creoles (1988: 282). For example:

Saramaccan (1984: 180)

(26) a go a wosu faa bi-njan
he go locative house for-he had-eat
'He went home with the intention of eating [but did not].'

Guyanese Creole (1981: 100)

(27) mi hia drom a nak
I hear drum aspect (nonpunctual) beat
'I hear drums beating.'

(26) shows that the verb of the embedded clause, *njan* 'eat' can occur with the past tense marker *bi*. In (27), the perception verb complement, *drom a nak*, contains the nonpunctual aspect marker *a*.

k) Verb serialization is used to mark oblique cases in creoles that do not have prepositions, or do not have a complete set of prepositions, because creoles do not have overt case markings of nouns (1981: 118-121, 1984, 1988a, 1989). For example:

Sranan (1981: 124)

(28) Kofi teki a nefi koti a brede
Kofi took the knife cut the bread
'Kofi cut the bread with a knife.'

In the above example, *teki* marks *nefi* 'knife' as being in the instrumental case. However, Muysken (1988) claims that all creole languages have prepositions, and that some creoles with several prepositions also have serial constructions. Furthermore, he claims that aside from the use of serial verbs in place of prepositions, serial verbs are also used to form comparatives and to mark aspect. Therefore, Muysken argues that verb serialization is not only used to mark oblique cases, and that the absence of prepositions cannot account for the presence of serial constructions in creoles (1988: 296).

l) Creoles rarely have passive constructions (Bickerton 1981: 71).

m) Pluralizer: Creole languages have a pluralizer which is used to mark plural nouns (1984, 1988a, 1991). For example:

Haitian Creole (1988a: 276)

(29) zef
'egg'

(30) zef-yo-a
'egg-pluralizer-the'

n) Creoles have pronouns (1988a).

o) Creoles have at least one locative preposition (1988a):

Saramaccan (1984: 179)

(31) dee waka go *a* wosu
they walk go locative house
'They walked home.'

p) Most creoles have a relativizing particle (1981, 1988). However, Bickerton (1989, 1991) states that if a creole does not maintain the relativizer from the superstrate language, a relativizer will probably be reconstituted late relative to other bioprogram features, i.e. the creole might exist for several years without a relativizer (1989: 28, 1991: 26). The following is an example of a relativizer in Haitian Creole:

Haitian Creole (1981: 65)

(32) kapten *ki* te-arete-l-la t-ap-mete-l na-betiz
captain who tense-arrest-him-the tense-aspect-put-him in-ridicule
'The captain who had arrested him was making fun of him.'

q) Creoles have reflexives (1988a). For example, Haitian Creole has the forms *tet-li* (literally 'head-his') and *ko-li* (literally 'body-his') which can both be translated as 'himself' (1988: 280). However, Bickerton (1989) states that reflexives are usually reconstituted late relative to other bioprogram features and have not been reconstituted in some creoles (1989: 29).

r) Creoles have reciprocals (1988a). However, Bickerton (1989) states that reciprocals are often reconstituted late relative to other bioprogram features and have not been reconstituted in most French-based creoles (1989: 29). The following is an example of a reciprocal in Haitian Creole:

Haitian Creole (1988: 280)

(33) youn pale ak *lot*
one speak with other
'They talked to each other.'

Table 1 summarizes the properties of the bioprogram.

Properties of the bioprogram

a) movement of constituents to initial position
b) articles which distinguish specific vs. nonspecific
c) markers for <+anterior> tense, <–realis> modality, and <–punctual> aspect
d) complementizers for accomplished vs. unaccomplished
e) negation of verb, nondefinite subject, and nondefinite VP constituents
f) same lexical item for existentials and possessives
g) no copula and adjectives behave like stative verbs
h) yes/no questions have the same syntactic structure as statements
i) wh-word in initial position and rest of sentence has same word order as declarative sentence
j) embedded sentences and complements of perception and causation verbs are finite
k) verb serialization
l) no passives
m) pluralizer
n) pronouns
o) locative preposition
p) relativizing particle
q) reflexives
r) reciprocals

Table 1

As stated in the introduction, most of the properties of the bioprogram could be accounted for semantically, because many of these properties serve to mark some semantic distinction. Property (a) is used to move a clefted or topicalized constituent. Properties (b)-(d) mark semantic distinctions for specific/nonspecific, tense, modality, aspect, and accomplished/unaccomplished actions. Property (e) can be accounted for semantically if negating the subject, verb and VP constituents is used to negate the entire proposition, whereas negating the subject would only negate the subject. For example, suppose (13) "*non* dag *na* bait *non* kyat" means that the event of biting did not occur, whereas "*non* dag bait kyat" means that a dog did not bite the cat, but something else bit the cat. Bickerton does not state if this is possible, however, if this is the case the negation described in property (e) could be accounted for semantically in that in order to negate an entire proposition each constituent must be negated because the event did not occur and therefore none of the participants were involved in that event. On the other hand, if the event did take place each constituent that was not involved in the event is negated. Properties (f) and (g) can probably be accounted for by semantic similarities between existentials and possessives and between adjectives and stative verbs. Property (k) can be accounted for semantically if it is analyzed as causation. The order of the verbs mirrors the order in which the actions were performed and the second action is dependent on the occurrence of the first action. Properties (m)-(r) can be accounted for because they are used to make semantic distinctions, such as number, person, location, and coreference.

The ordering of the TMA markers as tense-modality-aspect-verb stem could be accounted for by intrinsicness (Langacker 1987: 160-161) in that the semantic distinctions that constitute part of the action are closer to the verb stem than markers which are a property of the discourse rather than the action itself. The marker for nonpunctual aspect is closest to the verb stem, and whether an action is nonpunctual or not is a property of the action itself. The irrealis marker is further from the verb stem than the nonpunctual marker, and it is less intrinsic semantically than aspect in that it does not refer to a property of the action, but rather to whether the action was performed or not. The anterior tense marker is the furthest removed from the verb stem. This marker is extrinsic to the action referred to by the verb because it does not have anything to do with how or whether the action of the verb was performed, but rather it has to do with when the action of the verb occurred relative to the time frame that is being used in the discourse.

The remaining properties can possibly be accounted for by a tendency to avoid syntactic complexity in creoles. Properties (h), (i), (j), and (l) involve no change in syntactic structure or TMA marking from simple declarative sentences. The lack of syntactic complexity in newly developed creoles might be because the pidgins they developed from did not have complex syntactic structures. If this explanation is correct, it argues against an innate syntactic component which provides its user with the capability of creating complex syntactic structures.

The fact that the bioprogram features can be accounted for by semantics and by a lack of syntactic complexity suggests that language does not have to be accounted for by an innate syntactic component that was the result of a sudden mutation. A semantic account of these distinctions is consistent with a gradual evolution of language phylogenetically in which semantic distinctions were slowly added over time as they were needed.

Bickerton states that most creoles have SVO word order (1981: 20, 1988: 282), and he hypothesizes that the first language ever spoken had SVO word order (1981: 292). However, he asserts that word order is not part of the bioprogram (1984: 215). If the bioprogram does not specify word order, why does Bickerton assume that the first language ever spoken was SVO? Pulling together statements that Bickerton made in his 1981, 1984, and 1990 works, it seems that SVO word order is predicted by the following assumptions that Bickerton makes: 1) "In a language with no formal means of marking case, the only way to distinguish the major cases (nominative and accusative) consistently is to place one before and one after the verb" (1984: 179). 2) During human evolution, the "assignment of case roles must have become automatic and underlying this must have been a hierarchy" of thematic roles - *agent-experiencer-patient* (1981: 274). Bickerton suggests that *agent* may have been ranked as the highest thematic role because the agent role involves a "deliberate, voluntary action necessarily involving some entity [the agent] distinct from whatever suffers the action, and showing some form of dominance over the latter (the Patient)" (1990: 186). Furthermore he states that, "the role of Agent may well have seemed, to a species seeking to understand and control its environment, both the most important and the most desirable of roles. It is for this reason, perhaps, that language sees the world

predominantly from an Agent's viewpoint, and gives Agent the highest rank among roles" (1990: 186). 3) The NP with the highest thematic role in a sentence was given the grammatical relation of subject and may have been ordered before the verb because of its higher thematic role (1981: 274). SVO word order is predicted by these assumptions in the following way: The subject (agent) precedes the verb because it has the higher thematic role, and the object (patient) follows the verb because it must be on the opposite side of the verb from the subject. Thus SVO word order is not part of the bioprogram, but is predicted by these assumptions Bickerton makes about ordering the subject and the object on opposite sides of the verb and the existence of a thematic hierarchy with agent ranked the highest.

In sum, there is a two-way distinction being made between protolanguage and language. Pidgins are protolanguages, whereas creoles are languages. Creoles have the five properties which Bickerton claims to be characteristic of language, whereas protolanguages lack these five properties. The bioprogram specifies the form for creole languages, not protolanguage. Creole languages are different from non-creole spoken languages in that non-creole spoken languages are complete languages when they are acquired by children. The creole languages that Bickerton studies change from a pidgin to a creole in one generation. The children that form the creole have input from a pidgin (protolanguage).

Bickerton proposed the language bioprogram hypothesis in order to account for the ability of children with inadequate, protolanguage input, such as a pidgin, to form a complete language, such as a creole. His bioprogram was proposed in order to account for this phenomenon in spoken languages. Similar language-learning situations occur when deaf children are born to hearing parents and when deaf children are born to deaf parents who acquired American Sign Language (ASL) late. These children have no sign language input or have input that is impoverished. These children go beyond their input and innovate morphology which resembles ASL morphology. Since the bioprogram can account for the ways in which children with spoken pidgin input go beyond their input, possibly the bioprogram could account for the ways in which these deaf children go beyond their gesture/sign input. First, however, it is necessary to look at claims that have been made that ASL is like a creole language in order to assess whether the bioprogram can account for the properties of what has been called a sign language creole.

4. Comparison of ASL to spoken creoles and the bioprogram

Some researchers (Bochner and Albertini 1988; Gee and Goodhart 1988) have claimed that ASL shares many properties with creole languages and the bioprogram. The following is a comparison of the properties of the bioprogram with properties of ASL (lettered according to the properties of the bioprogram above):

a) Movement rules: As in creoles and the bioprogram, in ASL constituents can be moved to sentence-initial position. In ASL this movement is used for topicalization (Bochner and Albertini 1988: 34; Gee and Goodhart 1988: 56; Singleton 1989: 33).

b) ASL does not have specific and non-specific articles like creoles and the bioprogram. However, Gee and Goodhart (1988) claim that ASL distinguishes between specific and non-specific NPs through its system of pronominal indexing (which I will discuss later) (Gee and Goodhart 1988: 56).[6]

c) TMA systems: ASL does not have free, analytic morphemes which mark <+anterior>, <–realis>, and <–punctual> as in creoles and the bioprogram. However, ASL has a verbal inflection for nonpunctual aspect (Bochner and Albertini 1988: 33). ASL also has a verbal inflection for irrealis (called "unrealized-inceptive aspect"), which means 'just about to begin to V' (Liddell 1984). ASL does not have a <+anterior> marker. Past and future tense are indicated by separate signs, such as PAST and WILL (Bochner and Albertini 1988: 33; Isenhath 1990: 191). Bickerton claims that the order of the TMA markers should be tense-modality-aspect-verb stem. The verbal inflections for nonpunctual aspect and irrealis are realized as movements which are produced simultaneously with the verb stem. The signs PAST and WILL are usually produced after the verb (Isenhath 1990: 198, 200). Thus, the markers for modality and aspect are not ordered with respect to each other and tense follows these markers and the verb. A sign for tense which follows the verb does not follow the order of tense preceding modality and aspect, which is predicted by Bickerton. However, the order of tense with respect to modality and aspect is consistent with Bickerton's claims in that, as in the bioprogram, tense in ASL is further removed from the verb stem than both modality and aspect.

d) Many creoles have complementizers for accomplished vs. unaccomplished actions. ASL does have a sign, which is glossed as FINISH and indicates completion of an action (Gee and Goodhart 1988: 56; Isenhath 1990: 202). However, this sign is not restricted to sentences with embedded clauses, so it cannot be considered to be a complementizer. I have not been able to find any reference claiming that ASL has complementizers for accomplished vs. unaccomplished actions.

e) In many creoles the subject, verb, and object are each negated in negative sentences. In ASL the negative sign NOT is used to negate a verb. The sign NOT can only occur once to negate a sentence and cannot occur with another negative sign (Isenhath 1990: 211), i.e. it is not used three times: once to negate the subject, once to negate the verb, and once to negate the object. Furthermore use of the sign NOT in a negative sentence is optional. On the other hand, negated

[6] Gee and Goodhart do not explain how specific vs. non-specific is actually distinguished within ASL's pronominal system nor do they cite a reference. I have also not been able to find any references on the specific vs. non-specific distinction in ASL.

clauses in ASL are accompanied by a negative marker which consists of a headshake, squeezed eyebrows, and a tensed upper lip. This negative marker is produced throughout the signing of a negated clause (Liddell 1977: 61, 128; Padden 1988: 89). Since this negative marker is produced simultaneously with the negated clause, it could be considered to be negating the subject, verb, and object as in creoles and the bioprogram, i.e. to be negating the entire proposition.

f) As in creoles and the bioprogram, the same lexical item, i.e. HAVE, is used for both existentials and possessives in ASL (Bochner and Albertini 1988: 34).

g) In ASL, as in most creoles and the bioprogram, there are no copulas and adjectives can occur with many of the morphological markers which are used with verbs (Gee and Goodhart 1988: 56; Klima and Bellugi 1979).

h) As in creoles and the bioprogram, in ASL word order in yes/no questions is the same as in statements (Bochner and Albertini 1988: 33). In ASL yes/no questions are distinguished from statements by the signer raising his/her eyebrows, and moving his/her head slightly forward (Isenhath 1990: 155; Liddell 1977: 4, 1980: 20).

i) In creoles, the wh-question word appears in initial position. In ASL, however, a question word can generally occur in the following positions: 1) A wh-word can occur *in situ*, i.e. in the position of the constituent which it is questioning. 2) A wh-word which questions a constituent in a matrix clause can occur in initial position of the matrix clause. 3) A wh-word can occur at the end of the sentence (Lillo-Martin 1990: 213-214). In ASL, as in creoles, the rest of the sentence has the same word order as declarative sentences.

j) Tensed and infinitival clauses are not morphologically distinguished in ASL (Gee and Goodhart 1988: 56; Padden 1988: 84). This is also true of creoles and the bioprogram.

k) ASL tends to use verb serialization as opposed to prepositions to mark oblique cases (Gee and Goodhart 1988: 56; and see T. Supalla 1990), as is typical of creoles and is specified by the bioprogram.

l) Like creoles and the bioprogram, ASL does not have passives (Bochner and Albertini 1988: 33; Gee and Goodhart 1988: 56).

m) A pluralizer: In ASL there are three basic ways to indicate that a noun is plural aside from preceding or following the noun sign with a number or quantifier. 1) A noun is interpreted as plural when it is used with any of a set of classifiers which refer to two or more objects (T. Supalla 1986: 188). 2) A noun is interpreted as plural when it is used with a classifier which is repeated a number of times (Klima and Bellugi 1979: 239). 3) A noun is interpreted as plural when it is accompanied by the production of pointing to more than one locus (Isenhath

1990: 180).[7] 4) A small group of nouns can be pluralized by repeating the movement of the sign while moving the sign horizontally (Cohen, Namir, and Schlesinger 1977: 26; Isenhath 1990: 182).

n) ASL has pronouns which indicate 1st, 2nd, and 3rd person, and singular, dual, and plural. Pronouns are produced with a pointing handshape for singular and plural and with a V handshape (the index and second finger extended and spread apart) for dual. The plural is distinguished from the singular in that the plural has a horizontal sweeping motion simultaneously produced with the pointing handshape, whereas the singular is just pointing. First person is a point toward the speaker and whoever else is included if using the dual or plural. Second person is a point toward the addressee(s). Third person is used for people or objects that are or are not present. For people or objects that are present, third person is a point toward that person/object. For people or objects that are not present, third person is a point toward an arbitrary location in space or a non-arbitrary location in space (e.g. toward a place that the person normally sits, in the direction of the person's house, etc.).

o) Locative prepositions: ASL has locative prepositions such as IN, ON, NEXT-TO, and BEHIND.

p) Relativizing particle: In ASL there are two main ways in which relative clauses are marked. 1) During the production of a relative clause the head is tilted back, the eyebrows are raised, and the upper lip is tensed (Liddell 1977: 214, 1978: 66, 1980: 137). 2) An optional relative pronoun, i.e. one of two special forms of the sign THAT, can be used with the facial expression and head position in (1) to mark a relative clause (Liddell 1977: 231-233, 1978: 74-77, 1980: 147-150).

q) ASL has reflexive pronouns which are produced like pronouns but with a different handshape. Reflexive pronouns are produced with the hand in the shape of a fist with the thumb sticking upward (Liddell 1977: 263, 1980: 170).

r) ASL has a reciprocal verb inflection which indicates that two agents performed the same action on each other (Padden 1988: 33).

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[7] In ASL, points in space are set up by the signer to refer to people and objects. These points in space are called loci and are used for pronominal reference. To refer to a person or an object that is present, the signer points toward that person or object. If a person or object that the signer wants to refer to is not present, the signer sets up a location in space to refer to that person or object. This is done by signing the name or sign of that person or object and then pointing to a location in space, signing the name or sign of a person or object in a location in space (Padden 1988: 28-30), or shifting the body toward a location in space or looking toward a location in space while signing the name or sign of a person or object (Liddell 1977: 274). This location in space then becomes the locus of that person or object. Any time the signer or addressee wants to refer to that person or object later in the conversation, he/she can point at that locus (i.e., produce a 3rd person pronoun).

Furthermore, the basic word order of ASL is SVO (Bochner and Albertini 1988: 33; Gee and Goodhart 1988: 56; Singleton 1989: 33) - the same word order that is found in most creoles. Thus ASL has most of the properties of creoles and the bioprogram.

The only property of creoles and the bioprogram that I have not been able to find in ASL is property (d) complementizers for accomplished vs. unaccomplished actions. Table 2 summarizes the comparison of the properties of ASL and the bioprogram. After each bioprogram property, a "yes" or "no" is listed. "Yes" indicates that ASL shares that property with the bioprogram. "No" indicates that ASL does not share that property with the bioprogram.

Comparison of ASL and the bioprogram

a) movement of focused constituents	yes
b) specific vs. nonspecific articles	no articles but the distinction might exist
c) TMA markers	yes (nonpunctual and irrealis), no (anterior)
d) complementizers for accomplished vs. unaccomplished	no
e) negation of verb, subject, and VP constituents	yes
f) same lexical item for existentials and possessives	yes
g) no copula and adjectives behave like stative verbs	yes
h) yes/no questions	yes
i) wh-questions	yes
j) no nonfinite clauses	yes
k) verb serialization	yes
l) no passives	yes
m) pluralizer	yes
n) pronouns	yes
o) locative preposition	yes
p) relativizing particle	yes
q) reflexives	yes
r) reciprocals	yes

Table 2

A major difference between the properties of ASL and the properties of creoles and the bioprogram is that ASL has a large amount of morphology, especially inflectional morphology of verbs and adjectives, whereas creoles and the bioprogram have little morphology (Gee and Goodhart 1988: 56). There is a group of verbs in ASL (i.e. agreement verbs) that can agree with arguments of the verb, such as agent, patient, goal, and/or recipient, through the location in space at which the verb sign is produced, the movement of the verb sign in space, and/or the orientation of the palm in the production of the verb sign. For example, the sign WANT can be produced near the agent or the patient, the sign GIVE moves from a point in space used to refer to the agent to a point in space used to refer to the recipient, and in the production of the sign OWE, the palm of the open hand

faces the agent and the back of the open hand faces the recipient (Fischer and Gough 1980: 159-162).[8] Verb signs can also be inflected for number and many different aspects, e.g. incessant, durational (i.e. nonpunctual), habitual, continuative, iterative (Klima and Bellugi 1979: 294), and unrealized-inceptive (i.e. irrealis) (Liddell 1984: 257). Similarly, adjectives can be inflected for many different aspects, such as predispositional, susceptative, continuative, incessant, frequentative, intensive, resultative, and iterative (Klima and Bellugi 1979: 253-265). Thus ASL has much more inflectional morphology than spoken creole languages and the bioprogram.

In sum, aside from morphology, ASL has many properties in common with creoles and the bioprogram. The properties that ASL shares with the bioprogram might arise in the gesturing/signing of deaf children who do not have adequate sign input, just as bioprogram properties arise in children who are exposed to spoken pidgin input. If this is the case, this would provide support for Bickerton's bioprogram hypothesis, because the properties that arise in spoken language when there is inadequate input would also be shown to arise in gestural communication when there is inadequate input. On the other hand, the gesturing of deaf children with no sign input and the signing of apes with sign input might resemble protolanguage. Deaf children that are not exposed to any form of sign language produce strings of gestures which have some language-like properties. Since these deaf children do not have any form of sign input, their gestures should not constitute language but should be able to be accounted for by protolanguage. Bickerton claims that apes cannot go beyond protolanguage. Thus their signing should also be able to be accounted for by protolanguage. In the following section, I compare the gestural communication produced by these deaf children and apes to protolanguage and the bioprogram.

5. Gestural communication in deaf children and apes

In this section I compare the gestural communication produced by deaf children and apes to predictions made by Bickerton's protolanguage and bioprogram hypotheses. In particular, I provide evidence that the gestural communication produced by deaf children who do not have any sign input and the gestural communication produced by apes with ASL sigs as input cannot be accounted for by the properties of protolanguage. The gestural communication produced by these deaf children and apes goes beyond the properties of protolanguage in terms of morphology and the use of word order based on semantic roles or the presence vs. absence of an object. Furthermore, the gestural communication systems used by the deaf children with no sign input seem to be more deficient than the protolanguages described by Bickerton in terms of arbitrariness and displaced reference. These findings are a problem for Bickerton's protolanguage hypothesis

[8] For arguments against a verb agreement analysis see Appendix.

because he proposes that protolanguage and language are distinct and that there are no intervening stages. With regard to Bickerton's bioprogram hypothesis, I provide evidence that properties of the gestural communication produced by deaf children with different degrees of gesture/sign input and apes with ASL signs as input cannot be accounted for by the bioprogram. These children and apes seem to have innovated ASL-like morphology and this morphology is not predicted by the bioprogram.

5.1. The gestural communication of deaf children

Deaf children can be divided into three different groups according to the history of deafness in their family: 1) deaf children of hearing parents (DH), 2) deaf children of deaf parents and hearing grandparents (DDH), and 3) deaf children of deaf parents and deaf grandparents (DDD).[9] The first group (DH) is the largest, because 90%-95% of all deaf children have hearing parents (Newport 1991: 118). DDD children are very rare.

These groups of deaf children can be further divided according to the language input they receive. DH children can be divided into two main groups. Some of these children receive no gestural communication input of any kind because their parents want them to learn spoken English. These children are trained to speak and lipread and the use of signs is forbidden. This method is not very successful in cases in which the child is congenitally and profoundly deaf. Other DH children do get some form of gestural sign system as input, but they often get many different forms from different sources. The different sign systems that these children receive as input may include one or more of the following:

(1) Manually Coded English (MCE) systems: These are sign systems invented by educators for the purpose of helping deaf children learn English (Perlmutter 1991: 65). These sign systems are based on English and use English word order and invented signs for English morphology (S. Supalla 1991: 87).

(2) Pidgin Sign English (PSE): There is a continuum of PSE used by deaf people (Woodward and Markowicz 1980: 58). This form of signing is characterized by ASL signs in English word order with fewer grammatical features of ASL than pure ASL (Woodward and Markowicz 1980: 63). However, it is not an invented sign system, such as MCE.

(3) ASL: The natural, conventional sign language of the Deaf community in the United States and most of Canada (Perlmutter 1991: 65).

DDH children are exposed to ASL input from their parents from birth. However, the parents of DDH children have hearing parents. So the parents of

[9] Following abbreviation conventions as in Gee and Mounty 1991, the first letter in the abbreviation refers to the deafness/hearing ability of the child. The next letter stands for the deafness/hearing ability of the child's parents. The last letter stands for the deafness/hearing ability of the child's grandparents.

DDH children most likely either had no gestural sign system as input early in life and only acquired ASL later, or had a variety of sign systems as input. Therefore the input to DDH children from their parents is probably more variable and inconsistent than it would be if the parents had been exposed to ASL from birth. DDD children are exposed to ASL from birth by native signers, because their parents were also exposed to ASL from birth. Both groups of deaf children of deaf parents (DDH and DDD) most likely are also exposed to some form of MCE, especially at school. Thus the sign input to most deaf children, if they have any sign input at all, is usually variable.

The situation of deaf children and their language input is interesting in terms of Bickerton's bioprogram in cases in which they do not have any input, in cases in which they only have MCE input, and in cases in which their ASL input is impoverished. DDD children acquire ASL as a native language from birth from parents who acquired ASL as a native language from birth. Thus these children are acquiring ASL just as a hearing child would acquire English as a native language from parents who are native speakers. Therefore according to Bickerton, it would not be useful to look at the language output of these children for bioprogram features, because their input is not impoverished. They will learn the properties of ASL even though some properties of ASL cannot be accounted for by the bioprogram. Evidence for the bioprogram is only found when children do not have a sufficient language model. DH and some DDH children are in this situation.

The situations in which DH children do not receive any sign system as input are interesting because these children do produce some gestures. These gestures have some language-like properties and therefore these language-like properties could possibly be accounted for by Bickerton's characterization of protolanguage. The situations in which DH children have only an invented sign system as input, i.e. a form of MCE, seem similar to the situations of children that have a spoken pidgin as input. Children of pidgin speakers receive pidgin input from non-native speakers. Similarly, these deaf children receive MCE input from non-native MCE signers. Thus deaf children in these situations might be forming something like a creole, and if their output has properties of creoles and the bioprogram, this would be support for the bioprogram hypothesis. DDH children have ASL input from their parents that is somewhat impoverished, i.e. the input is not like the input from a native signer because of the situations under which their parents learned ASL. For example, their parents may have had input from MCE or PSE in addition to ASL in childhood, or their parents may not have been exposed to ASL until after childhood. Thus it would also be interesting to analyze the signing of these children as compared to the signing of their parents to see if there is any evidence for the innovation of bioprogram properties in the children's output.

In the following sections, I present data from three groups of children: 1) deaf children of hearing parents (DH) who receive no sign system as input, 2) deaf children of hearing parents (DH) who receive an invented sign system as input, and 3) a deaf child of deaf parents and hearing grandparents (DDH), who receives ASL input from parents who are late learners of ASL.

5.1.1. Deaf children of hearing parents: no sign system as input

In this section, I describe the gestures produced by DH who do not have any sign input. I show that these gestures go beyond properties of protolanguage in terms of morphology and word order, but seem to be more deficient in terms of displaced reference and arbitrariness than the protolanguages that Bickerton describes. Bickerton proposes that protolanguage and language are distinct and that there are no intermediate stages between them. Thus he cannot account for communication systems that cannot be considered to be language but have properties which are beyond the properties of protolanguage. Then I show that Bickerton's bioprogram hypothesis cannot account for the morphological properties of the gestures produced by these children.

Some hearing parents of deaf children want their children to learn to speak and understand spoken English, but do not want their children to learn any form of sign system. Many children who have been profoundly deaf since birth have trouble learning to speak and lipread English. In these cases, since the children are not acquiring English and are not exposed to a sign system, they have little or no language input. Even though these children do not have much language input, they do produce gestures in an attempt at communication. The gestures produced by these children have been studied by Goldin-Meadow and her colleagues to discover if the gestures contain any properties of language (Feldman, Goldin-Meadow, and Gleitman 1978; Goldin-Meadow 1979, 1982, 1985, 1987; Goldin-Meadow and Feldman 1975, 1977, 1980; Goldin-Meadow and Mylander 1984a, 1984b, 1990a, 1990b, 1990c, 1991; Mylander and Goldin-Meadow 1991).

These studies describe the gestures of a total of 10 deaf children, whose ages range from 1;4 (years;months) to 4;1 at the beginning of the data collection and from 2;6 to 5;9 at the end of the data collection (Goldin-Meadow and Mylander 1990a: 327). None of these children had been exposed to a form of Manually Coded English (MCE) or ASL, and none of their parents, teachers, siblings, or classmates knew MCE or ASL (Goldin-Meadow and Mylander 1984b: 15, 1990a: 327-328). The gestures produced by these children are classified into two types: 1) deictic gestures, i.e. pointing gestures, and 2) characterizing gestures, i.e. "motor-iconic signs that specify actions, objects, and less frequently, attributes" (Goldin-Meadow and Feldman 1977: 401-402).

Goldin-Meadow et al. analyze deictic gestures as nouns. For example, if a child made eye contact with someone and then pointed at a cat, Goldin-Meadow assigns this gesture the meaning 'cat'. If the child pointed at a dog, the meaning is 'dog'. Iconic characterizing gestures are similar to the pantomiming of an action or attribute. These characterizing gestures are analyzed as adjectives and verbs. Goldin-Meadow et al. justify analyzing characterizing gestures as verbs and adjectives rather than as nouns by arguing that by using some sort of pantomimic gesture, the child is describing an action associated with or a property of some object (Goldin-Meadow and Mylander 1984b: 25). For example, if a child pointed at a picture of a bird and then moved his/her arms up and down, this movement was assigned the meaning 'fly'. Furthermore, this situation in which a child first pointed at a picture of a bird and then moved his/her arms is interpreted

as a sequence of gestures and is assigned the meaning 'bird fly'.

The children usually used pointing and characterizing gestures to refer to people, objects, and actions in their immediate environment. Occasionally these children used "their pointing gestures to refer to objects that were not present in the here and now, and did so by pointing at a real-world object that was similar to the (absent) object they intended to refer to". For example, one child pointed to an empty bubble jar and produced a 'blow' gesture, because he wanted the full jar of bubbles, which was not present, be blown (Goldin-Meadow and Mylander 1990a: 332). Thus the pointing gestures of these children, though typically indexical, did not always have to refer to objects in the immediate environment. Similarly, these children did not have a way of marking past or future actions, however they could use their characterizing gestures to refer to actions that were not occurring or had not occurred in the immediate context. For example, after being shown a picture of a shovel one child produced a digging gesture, a gesture in which he moved his hands up his leg to refer to putting a boot, a point toward the door, a gesture in which he held out his arms and fluttered his fingers to refer to falling snow, and a point to the floor to refer to the basement where the shovel was kept (Feldman, Goldin-Meadow, and Gleitman 1978: 407). In this example, the child used characterizing gestures to refer to putting on boots and falling snow, which were not actions that had occurred or were occurring in the immediate context. He also used pointing gestures to refer to outside and to the basement, i.e. locations which were not visible in the immediate environment. If Goldin-Meadow et al.'s analysis of the gestures produced by these children is accepted, some interesting regularities, which are similar to regularities in natural languages, can be found in these children's gestures.

5.1.1.1. Gestural innovations: gesture order

Some regularities are found in an analysis of the order of gestures in two-gesture phrases. Three of the ten children tended to produce pointing gestures before characterizing gestures. Thus in gesture sequences that are composed of a pointing gesture and a characterizing gesture, these children used an ordering system based on the form of the gesture (Goldin-Meadow 1985: 239-240). However, an ordering based on the form of the gesture cannot account for the gesture orders of seven of the children, and cannot account for the gesture order in combinations of two pointing gestures or two characterizing gestures. Some of these regularities in gesture order can be accounted for if the semantic roles that the referents of the gestures play in the context are considered. The following semantic roles were used by Goldin-Meadow et al.: act, actor (i.e. a person or object that performs an action to change its own location or state or to change the location or state of a patient), patient (i.e. a person or object that is acted on or manipulated in some way), and recipient (i.e. a person or location toward which someone or something moves) (Goldin-Meadow and Mylander 1984b:30). Nine of the ten children tended to produce patients before acts, and two children produced actors

before acts. Both of these orders consist of a pointing gesture followed by a characterizing gesture, and therefore, can be analyzed as an ordering based on the form of the gesture. However, patients and recipients are both referred to with pointing gestures and nine of the ten children ordered patients before recipients more often than recipients before patients. Furthermore, eight of the ten children ordered more acts before recipients than recipients before acts. An act followed by a recipient is a characterizing gesture followed by a pointing gesture, i.e. it is the opposite of the point-characterizing order found in the output of three of the children. Thus the ordering of patients before recipients and acts before recipients can be accounted for by semantic roles, but not by ordering a pointing gesture before a characterizing gesture (Goldin-Meadow and Mylander 1984b: 35-36). Each child tended to produce at least two of these orderings. This indicates that all of these children had some sort of ordering in their gestures based on the form of the gesture, semantic roles, or both.

Table 3 summarizes the gesture orders found. The gestures sequences that are listed in terms of semantic roles are followed in parentheses by the form (point vs. characterizing) of the gesture. The number of children listed is the number of children that produced the order specified in the table more often than they produced the opposite order, i.e. 9 children produced more patient-act sequences than act-patient sequences.

Ordering in 2-gesture sequences

Gesture order	# of children out of 10
point-characterizing	3
patient (point) - act (characterizing)	9
actor (point) - act (characterizing)	2
patient (point) - recipient (point)	9
act (characterizing) - recipient (point)	8

Table 3

One child, David, used order to distinguish actors from patients in transitive gesture strings. David was the only child who produced enough phrases containing transitive and intransitive actors to show an order preference between them. He tended to produce gestures for intransitive actors and patients before the verb; however he tended to produce gestures for transitive actors after the verb. This ordering is similar to ergative systems found in some languages in which direct objects (usually patients) of transitive verbs and subjects (usually actors) of intransitive verbs are marked (or in many cases unmarked) the same way, whereas subjects of transitive verbs are marked differently (Goldin-Meadow

1979: 168-169, 1985: 224; Goldin-Meadow and Mylander 1984b: 39, 1990a: 337).

5.1.1.2. Gestural innovations: production probability

Another regularity that is found is that some semantic roles are more likely to be expressed than others. Goldin-Meadow calls this "production-probability", i.e. the likelihood that a child would produce a gesture for a referent playing a particular semantic role when that semantic role was relevant to the context (Goldin-Meadow and Mylander 1984b: 36). All ten of the children were more likely to produce a gesture for the patient than to produce a gesture for an actor in a context in which both a gesture for a patient and a gesture for an actor could be produced, i.e. with a transitive action (Goldin-Meadow and Mylander 1190a: 336-337). Dividing the class of actors into actors of transitive actions and actors of intransitive actions shows a further regularity in the gesturing of nine of the ten children. These children were as likely to produce a gesture for an actor of an intransitive action as they were to produce a gesture for a patient of a transitive action, whereas they were less likely to produce a gesture for an actor of a transitive action (Goldin-Meadow and Mylander 1990a: 337).[10]

5.1.1.3. Gestural innovations: recursion

The children in these studies also produced phrases which, according to Goldin-Meadow et al., contain more than one proposition. The children produced strings of gestures which contained more than one characterizing gesture. Each characterizing gesture is analyzed as a predicate, and therefore strings of gestures containing more than one predicate are analyzed as multi-proposition sentences. For example, while looking at a picture of a bird pedalling a bicycle, one of the children produced the following gesture sequence: bicycle-PEDAL-bird picture-WING (FLY?),[11] which Goldin-Meadow interprets as containing a relative clause: 'bird who wings (flies?) pedals bicycle' (Goldin-Meadow 1982: 58). Thus according to these criteria, the children's gesture systems are recursive: "Our results suggest that a deaf child exposed only to a degraded linguistic input can

[10] The spontaneous gestures of the mothers, who were the primary caretakers of these children, were also analyzed to see if the the mothers' gestures were influencing these properties of the children's gestures. However, "the mothers showed no reliable gesture-order patterns" and "the production-probability patterns in the mothers' gesture strings differed from the production-probability patterns in the children's strings" (Goldin-Meadow and Mylander 1990a: 344).

[11] In descriptions of the children's gestures, the referents of pointing gestures are in lowercase letters and the referents of characterizing gestures are in uppercase letters (Goldin-Meadow 1979: 144).

develop a communication system that has the property of recursion, the ability to conjoin two propositions within the boundaries of one sentence" (Goldin-Meadow 1982: 68).[12] However, these examples are subject to a variety of other interpretations. The above example could be interpreted to mean 'the bird is flapping his wings and riding a bicycle', which is simple coordination rather than more complex subordination. Furthermore, since no relativizers or conjunctions were used by these children, it is hard to know if this constituted recursion. Another problem is that it is not entirely clear that characterizing gestures should be analyzed as verbs, which this analysis of recursion crucially depends on. For example, the above example could also mean 'this is a bird and this is a bicycle'.

5.1.1.4. Gestural innovations: morphology ("classifiers")

One of the children's gestures, David's, were analyzed for morphological structure. Approximately 99% of his gestures were found to consist of 5 different handshapes and 9 different motions (Goldin-Meadow and Mylander 1990a: 339). These handshapes and motions have consistent meanings across gestures. For example, a fist handshape (fingers curled into palm) was associated with the meaning 'handle a small, long object', because it was used to refer to utensils, balloon strings, flag poles, and steering wheels. A short arced movement of the hand was associated with the meaning 'reposition' (Goldin-Meadow and Mylander 1984a: 126, 1990a: 340), because it was used to describe contexts which were glossed as 'remove hat', 'Katie sit', 'lift bag', and 'put bear' (Goldin-Meadow and Mylander 1984: 129).

Handshapes were used to represent both the handgrip used with objects of different shapes and sizes and the objects themselves. For example, David used the C-handshape (hand open, thumb and fingers opposed, fingers together) to mean 'handle a large object of any length' and to mean 'a curved object' (Goldin-Meadow and Mylander 1990a: 341). These handshapes seemed to be used in discrete, i.e. categorical, ways rather than just being analogue forms which were used to mimic the way a hand is placed around an object in the real world. For example, David used the fist handshape to describe holding a balloon string, a drum stick, a banana, and a steering wheel, even though these objects have different diameters. In the real world, the hands are not completely closed into a fist when they are gripping a banana or a steering wheel, whereas the hands are completely closed into a fist when holding a balloon string. However, David used closed fists to describe holding these objects regardless of the diameter of the object. On the other hand, he did distinguish objects with small diameters, e.g. balloon strings, drumsticks, bananas, and steering wheels, with which he used a fist handshape, from objects with large diameters, e.g. cups, guitar necks, and wide knobs, with which he used a C-handshape (Goldin-Meadow and Mylander

[12] Sentence boundaries were identified by relaxation of the hand after the production of a gesture or a sequence of gestures (Goldin-Meadow and Mylander 1990a: 330).

1984a: 127; Goldin-Meadow and Mylander 1991: 323; Mylander and Goldin-Meadow 1991: 59). Similarly, David used an O-handshape (palm and fingers curved, fingers and thumb opposed, tip of index finger touching or almost touching tip of thumb) to describe a Christmas tree ball and a bubble, although these objects are different sizes. He seemed to categorize these as small, round objects as opposed to larger curved objects which he represented with a C-handshape, e.g. the back of a turtle and the way a cowboy's legs fit around a horse (Mylander and Goldin-Meadow 1991: 50; and see Goldin-Meadow and Mylander 1991: 323-324). In the manual modality it is possible to represent the handgrip around objects and the shape of objects by using a handshape that would actually be used when holding the object and to represent the shape and size of objects by using both hands and placing them different distances apart. However, rather than using a large number of handshapes and varying the distance between his hands to specify the actual size of an object, David used a restricted set of handshapes and categorized objects into a small number of groups based on rough approximations of size and shape. This is important because discreteness (which will be discussed further in the following section) is a characteristic of human language and of some (but not all) animal communication systems.

These handshape forms are similar to classifiers in ASL. One type of classifier in ASL, called semantic classifiers, groups referents according to semantic categories. For example, in ASL there are different classifiers for vehicles, humans, and animals (T. Supalla 1986: 184, 190-193). These classifiers are similar to David's use of a flat palm to refer to vehicles and animate objects (Goldin-Meadow and Mylander 1990c: 548). Another type of ASL classifier, called size-and-shape-specifiers, groups referents according to the size and/or shape of the referent itself, i.e. the handshape represents the size and/or shape of the object (T. Supalla 1986: 184). For example, in ASL an extended index finger can be used to refer to an arrow or a stick (T. Supalla 1986: 187). These classifiers are similar to David's handshapes which represent the shapes of objects, such as his use of a curved C-hand to refer to a turtle's back (Goldin-Meadow and Mylander 1984: 126). Another type of ASL classifier, called instrumental hand classifiers, groups referents according to how they are held by a person. For example, in ASL a fist handshape is used to refer to holding long, thin objects (T. Supalla 1986: 196). These classifiers are similar to David's use of a fist handshape to refer to holding small, long objects (Goldin-Meadow and Mylander 1990c: 539).

David was observed to combine most of his handshapes with more than one of his motion forms, and vice versa (Goldin-Meadow and Mylander 1990c: 542). The meanings of the gestures that contain combinations of handshapes and motions can be predicted by the meanings of the parts, i.e. by the meaning associated with the handshape plus the meaning associated with the motion. Thus David was capable of compositionality and productivity (which will be discussed in more detail in the following section). Compositionality and productivity are characteristics of human language but are also found in some (but not many) animal communication systems. For example, David used a C-handshape (meaning 'a curved object') while moving his hand in a straight path (meaning 'change

location'). This gesture meant 'a curved object changes location'. David used this handshape and movement combination to describe a toy turtle moving forward (Goldin-Meadow and Mylander 1990a: 341). Furthermore, David could use combinations of handshapes and motions to refer to classes of related events, rather than to just a single event. For example, David used a C-handshape (in this case meaning 'handle a large object') while moving his hand in a circle (meaning 'move in a circular path or rotate around an axis'). He used this handshape and motion combination to refer to opening a jar, turning a large knob, and moving a train around in a circle (Goldin-Meadow and Mylander 1984a: 129; Goldin-Meadow and Mylander 1990a: 343). Thus David's gesture system had compositionality and productivity, traits characteristic of languages, i.e. David used handshapes and movements as morphemes that could be combined to create new forms. Furthermore, this productive combination of handshape and motion forms is similar to the use of classifiers with verbs of motion in ASL.[13]

5.1.1.5. Gestural innovations: morphology ("verb agreement")

David and two other subjects whose gestures were analyzed for morphology by Goldin-Meadow and Mylander modified some of their gestures in ways which are similar to the inflectional morphology of verb agreement in ASL (1990a: 346-347). These children were observed to move their characterizing gestures toward objects or produce them near objects. For example, one child produced a 'twist' gesture near a jar (1990a: 342). With transitive predicates these children typically displaced the characterizing gesture toward the object playing the patient role (1990a: 342, 346-347). In the above example, David wanted someone to open the jar, and the gesture was displaced toward the jar, i.e. the patient. With intransitive predicates David (it is not mentioned if the other children did this) typically displaced the characterizing gesture toward a location. For example, David "moved his 'go' gesture toward the open end of a car-trailer [i.e. a location] to indicate that cars go into the trailer" (1990a: 342). This use of

[13] The gestures of David's mother were analyzed for morphology according to the system developed to analyze David's gestures. David's mother produced the same 5 handshapes and 8 of the 9 motion forms that David produced. However, only 50% of David's mother's handshapes and only 51% of her motions corresponded to David's form-meaning pairings for handshapes and motions (Goldin-Meadow and Mylander 1990a: 344). Goldin-Meadow and Mylander claim that David might have used his mother's gestures as input for constructing a morphological system. However, they argue that David went beyond the gestural input from his mother in two ways: 1) He produced most of the handshape/motion combinations that his mother produced and in addition, he produced 34 handshape/motion combinations that his mother did not produce. 2) David could use his handshape/motion combinations to refer to classes of related events, whereas his mother used most of her handshape/motion combinations to refer to individual events (Goldin-Meadow and Mylander 1990c: 557). For example, David's mother used the C-handshape combined with a circular motion only to refer to opening a jar, whereas David used this handshape and motion combination to refer to opening a jar, turning a wide knob, and moving a train in a circle (Goldin-Meadow and Mylander 1990a: 345, 1990c: 556).

varying the placement of a gesture in space is like verb agreement in ASL because it specifies both an action and some participant in or recipient of the action (1990a: 342).[14]

In sum, the gesture strings produced by these deaf children who were not exposed to any sign system contain regularities and some properties which are similar to properties found in spoken and sign languages. These children consistently ordered some of their gestures, they had a tendency to produce certain semantic roles more often than others, they possibly had recursive systems, at least one child used gestures in ways which are similar to the use of classifiers in ASL, i.e. in terms of categorization and compositionality, and these children displaced gestures in ways which are similar to agreement morphology in ASL. Thus it would be useful to determine which of the necessary properties of language the gestures produced by these children display. I will do this by comparing the children's gestures with the properties of Hockett's design-features of animal communication.

5.1.1.6. Comparison to Hockett's design-features of animal communication

Hockett (1960) identifies what he calls thirteen "design-features" of animal communication. He claims that various animal communication systems have different subsets of these features. According to his analysis, human language is the only communication system which has all thirteen features. The following are Hockett's thirteen design features of animal communication:

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[14] The group of verbs that have been called "agreement verbs" in ASL do not agree with locations, instruments, or possessors as do some of the signs/gestures produced by the deaf children with no sign input and by the apes. However, the apes displaced signs to specify locations, instruments, and possessors in the same way that they displaced signs to specify agents. In all of these cases, the apes produced the sign on the specified entity. On the other hand, it could be argued that the gestures produced by Goldin-Meadow's subject David which specified a location are similar to a group of verbs in ASL that have been called "verbs of motion and location" by Supalla (1982) and "spatial verbs" by Padden (1988, 1990). These verbs can be used to indicate the beginning and end points of a motion. For example:

1INDEX j-WALK-k
'I walked from there (a place represented by locus j) to there (a place represented by locus k)' (Padden 1988: 44).

Goldin-Meadow's subject David produced something similar when he moved a 'go' gesture toward a trailer to indicate that cars go into the trailer. Rather than comparing this to person agreement in ASL, this could be compared to verbs of motion and location/spatial verbs in ASL. However, I am interested in the use of movement and displacement to specify additional entities, and in this way the movement and displacement of signs/gestures are similar to the use of verb agreement in ASL. Therefore, I will discuss the similarities between verb agreement in ASL and the movement/displacement produced by deaf children with no sign input and by apes, and leave a detailed comparison of the movement/displacement produced by these children and apes vs. verb agreement and verbs of motion and location/spatial verbs in ASL for future research.

1) **Vocal-auditory channel** (1960: 90).

2) **Broadcast transmission and directional reception**: A signal can be heard by an auditory system within earshot and the source can usually be located by the hearer's auditory system (1960: 90).

3) **Rapid fading**: A signal is produced and then disappears. Signals do not wait for someone to perceive them. For example, animal tracks do not satisfy this feature because they can be seen long after they have been produced (1960: 90).

4) **Interchangability**: Speakers can reproduce any message they can understand. For example, the courtship motions of the male and female stickleback fish do not satisfy this feature. The male and female stickleback fish have different courtship motions and do not produce the behavior of the opposite sex (1960: 90).

5) **Total feedback**: Speakers can hear everything they say. For example, the courtship behavior of the male stickleback fish does not satisfy this feature because he cannot see the colors of his belly which he uses as a visual display for the female stickleback (1960: 90).

6) **Specialization**: The sound waves for speech are only used to communicate meaning. For example, the panting of dogs does not satisfy this feature because panting is used for the biological function of cooling (1960: 90).

7) **Semanticity**: The parts of a signal convey meaning because they have a fixed association with entities in the real world.

8) **Arbitrariness**: The association of a signal and its referent is arbitrary (1960: 90). For example, the predator calls of the vervet monkey satisfy this feature, because the calls are not patterned on any property of their referent (Bickerton 1990: 12).

9) **Discreteness**: A small set of sounds which contrast with each other, rather than a continuous range of sounds, are used (Hockett 1960: 90). For example, bee dances do not satisfy this feature. The duration of the straight run in a bee dance shows the distance to the food source and the amount of abdomen waggling shows the richness of the food source (Wilson 1972).

10) **Displacement** (displaced reference): Objects and events which are not present in the immediate environment can be referred to. For example, this feature is satisfied by bee dances because they are not performed in the presence of the food source (Hockett 1960: 90).

11) **Productivity**: Novel utterances can be produced and understood (Hockett 1960: 90). For example, the predator calls of vervet monkeys do not satisfy this feature because there are only three possible calls (Bickerton 1990: 15). On the other hand, bee dances do have this feature because the duration of the run and

the amount of abdomen waggling can be combined in different ways to indicate the distance and richness of different sources of food.

12) **Traditional transmission**: Language is transmitted from one generation to another by teaching (Hockett 1960: 90).

13) **Duality of patterning**: The sounds which make up the signal have no meaning in themselves, but they are combined into words which have meaning (Hockett 1960: 90).

Since it is now known that natural, conventional sign languages, such as ASL, are languages, design-feature (1) can be disregarded. I will also disregard feature (6) because it does not seem to hold as a criteria for either spoken or sign language. Both the vocal apparatus and the hands can be used for purposes other than to communicate meaning. Even the specific sound patterns used in speech can be used without the intent to communicate meaning. For example, someone can say or sing "lalalalala" just because he/she feels like it, but it does not mean anything. Furthermore, both deaf and hearing people can use the hands to communicate. For example, waving when meeting or departing from someone, moving your index finger to your lips to tell someone to be quiet, raising your hand in class to tell the teacher you want to be called on, etc. When the hands are not being used to reach for or manipulate an object, they can be used for other non-communicative purposes, such as tapping your fingers or twiddling your thumbs. Hockett's other features can apply to both spoken and sign languages if references to sounds are changed to include movements of the hands, fingers, and body, and if references to the auditory system are changed to include the visual system.

Goldin-Meadow's subjects have features (2) and (3) because their gestures can be seen by any visual system that is near provided that there is nothing obstructing the view, the source of the signal can be located by the visual system, and their gestures are produced and then disappear. Since these children are not encouraged to gesture, they are not normally gestured to, and therefore they usually do not have an opportunity to imitate gestures. However, given the opportunity, these children most likely would be able to imitate someone's gestures as required by feature (4). The gestures produced by these children also have feature (5) because they can see and/or feel the production of their own gestures. The gestures produced by Goldin-Meadow's subjects also have feature (7), semanticity. When the children point, the point specifies whatever they are pointing at. When the children produce a characterizing gesture, the gesture usually refers to an iconically related action. As mentioned earlier, feature (9), discreteness, was found to be a property of David's gestures. For example, he had a fist handshape which was used to represent holding objects with small diameters even when these objects could not be held with a closed fist, such as a banana. This handshape contrasted with a C-handshape (hand open, thumb and fingers opposed, fingers together) which he used to represent holding objects with large diameters, such as cups and wide knobs. Goldin-Meadow's subjects were able to

produce novel utterances, as required by feature (11), because they were the ones inventing the system. Thus most of their productions were novel. Furthermore, David had meaningful handshape morphemes and motion morphemes which he could combine in novel ways resulting in meanings which were predictable from the combination of the meaning of the handshape with the meaning of the motion, i.e. his system had the property of compositionality. However, these children were normally not presented with novel utterances for them to understand.

The remaining features are either not present or only rarely present in the gestures produced by Goldin-Meadow's subjects. Feature (8) states that the signal is arbitrary; however the gestures produced by Goldin-Meadow's subjects were mostly non-arbitrary. The pointing gestures were associated with their referents in that the referents usually had to be present for a pointing gesture to be directed at them. The characterizing gestures were associated with their referents in that they were usually an imitation of some action. However, all of their gestures were not iconic. For example, David used a non-iconic flat palm to represent vehicles and animate objects in his handshape-motion combinations. These children were limited in their ability to use non-arbitrary gestures because they did not have a conventional lexical input. They had to invent their own gestures and their gestures had to be iconic in order to be understood.

Feature (10), displacement, was also not used much by these children. As stated earlier, there were occasional uses of displaced reference, such as pointing at an empty bubble jar to refer to a full bubble jar, and producing gestures referring to putting on boots and falling snow when shown a picture of a shovel. This shows that these children were capable of using displaced reference. However, in the situations in which these children used displaced reference, it was obvious from objects present in the immediate environment what they were referring to. These children might have used displaced reference in cases in which it was not obvious from the immediate environment what they were referring to; however in these situations they were probably not understood. These children were restricted in their use of displaced reference because they did not have any conventional lexical items. Without conventional lexical items they were mainly restricted to objects and events present in the immediate environment in order to be understood. In order to use displaced reference without reliance on objects present in the immediate environment, these children would have to consistently refer to an object or event with a particular gesture (used only for that object or event) a number of times in the presence of an addressee so that the addressee would understand them when the object was not present. This is different from natural languages in which displaced reference is used often. This is also different from the protolanguages which Bickerton describes, i.e. pidgins, the speech of children under two, the speech of adults deprived of language as children, and the signing of apes, in that there are conventional lexical items in the languages that these groups of speakers/signers are exposed to. Thus displaced reference is not restricted in the protolanguages Bickerton describes as it is in the gestural communication produced by Goldin-Meadow's subjects.

Feature (12) traditional transmission was present only in the spontaneous gestures produced by the parents of these children. As stated above in the

description of the gestures, these children surpassed their gestural input, and therefore the gestural systems they produced were largely untaught. With respect to feature (13), duality of patterning, David's gestures could be analyzed into smaller meaningful morphemes; however feature (13) refers to something more like a phonology because it refers to smaller meaningless segments. It is possible for a gestural communication system to have a phonology because ASL has a phonology. To my knowledge, however, the gestures of these children have not been analyzed at a phonological level.

In sum, the gestural communication systems of Goldin-Meadow's subjects have Hockett's design-features of broadcast transmission and directional reception, rapid fading, total feedback, semanticity, discreteness, productivity, and probably interchangability. Because these children have to invent their own communication systems, their gestural communication systems are more deficient than natural languages in terms of arbitrariness and displacement. These children lack traditional transmission because they are not being taught a conventional language. It is not known if their gestural systems display duality of patterning.

These children did not have any conventional lexical items as input; however, they did have pointing and the spontaneous gestures produced by their parents which may have served as lexical input.[15] Bickerton claims that protolanguage requires some form of lexical input, and the spontaneous gestures produced by the parents of these children might have served this function. In spite of whether this can be considered lexical input or not, these children did produce gesture strings which seem to be language-like. If these children are producing something language-like, they should be producing protolanguage, since protolanguage is more primitive than language and these children do not have any language input. The following section compares the output of these children with the properties of protolanguage.

5.1.1.7. Comparison to the properties of Bickerton's protolanguage

Since the only input the children in Goldin-Meadow et al.'s studies had was the spontaneous gestures produced by their parents, one might expect that they would not produce anything resembling language. However, the above research suggests that the gestures of these children do resemble language in some ways. Therefore, we might expect that these gestures would fit under Bickerton's description of a protolanguage, such as the communication of children under two, adults who were deprived of language when they were young, speakers of a pidgin, and trained apes. If the gesture systems of these children are like protolanguage, then they should lack the five properties of language that protolanguages lack.

[15] This was pointed out to me by Farrell Ackerman.

It is not apparent that the gesture systems of these deaf children have language property 1, i.e. principles based on formal structure that constrain variations in word order, a property which protolanguage supposedly lacks. However, some of these children did have a preferred order of gestures: patients > acts > recipients, whereas in pidgins there is no preferred word order. The word order produced by an individual pidgin speaker is predominantly the word order of his/her native language (Bickerton 1980: 10-12). Furthermore, Bickerton claims that in Genie's speech word order is purely functional, i.e. topics are placed first, not because of movement rules, but rather because they are foremost in her mind (Bickerton 1990: 123). He also claims that the ability to order different word-classes fairly consistently is a characteristic of both apes and children under the age of two (Bickerton 1990: 114). The gesture orders produced by seven of Goldin-Meadow et al.'s deaf children seem to have more of a grammatical function, however, because they tend to be based on semantic roles, rather than being purely functional or based on word-classes. This is especially evident in the gesturing of David, who distinguished patients from transitive agents (both of which belong to the same word-class, i.e. nouns) by placing patients before the verb and transitive agents after the verb. Thus at least some of these deaf children seem to use word order to make semantic role distinctions, whereas in protolanguage word order is not used for this reason.

Language property 2, i.e. the predictable occurrence of null elements, is apparent in the gesture systems of these children to a certain extent, although this is a property which protolanguages lack. In the gestures of these children, the occurrence of null elements cannot be predicted by any formal grammatical device, but their probability of occurrence can be predicted according to their semantic role. Bickerton does not discuss production probability in protolanguages, however Goldin-Meadow and colleagues reanalyzed data from four hearing children acquiring English (using data from Bloom, Miller, and Hood 1975: 12-15) in terms of production probability. These children were around 2 yrs. old (between 20;2 and 27;1 months old) when these data were collected. Goldin-Meadow et al. claim that these children learning English also produced patients and intransitive actors in their utterances much more often than they produced transitive actors (Goldin-Meadow 1979: 175; Goldin-Meadow and Mylander 1984b: 63). According to Bickerton's hypothesis, since these children are around 2 yrs. old, they might be producing protolanguage rather than language. Assuming that these children are producing protolanguage, this production probability pattern is found in protolanguage and should not be considered to partially satisfy language property 2, i.e. the predictable occurrence of null elements. Therefore, Goldin-Meadow's subjects would be considered to lack the second property of language.

Along the same lines, P. Bloom (1990, 1993), Hyams (1987), and Hyams and Wexler (1993) have proposed hypotheses to account for the occurrence of null subjects in the utterances of children, in particular children learning English. Hyams (1987) and Hyams and Wexler (1993) propose that children often leave out subjects because children start out with a pro-drop or topic-drop grammar and then, if their language is a non-pro-drop or non-topic-drop language, the children will set their parameter for non-pro-drop or non-topic-drop at some time later in

development. This hypothesis is consistent with Bickerton's protolanguage hypothesis in that children speaking non-pro-drop or non-topic-drop languages will be considered to have protolanguage at the stage before they set their parameter to non-pro-drop or non-topic-drop. However, it is not apparent how a child's use of protolanguage can be distinguished from language in terms of this property in pro-drop and topic-drop languages. On the contrary, P. Bloom (1990, 1993) proposes that children omit subjects because of pragmatic factors and processing limitations. He also provides evidence that there is not an abrupt transition in which children change from omitting subjects to not omitting them, but rather the change is more gradual (1993: 731). An abrupt transition would be predicted by both Bickerton and Hyams and Wexler, and therefore a more gradual transition is evidence against their hypotheses.

The third language property, i.e. overtly realizing all of the subcategorized arguments of verbs, is not found in the gesture systems of these children. Subcategorized arguments are often omitted in the gestures of these children, as they often are in protolanguages. This is also related to the above discussion of subject omission in child speech. Thus, under P. Bloom's hypothesis, this should also be able to be accounted for by a more gradual transition than would be predicted by Bickerton.

Goldin-Meadow claims that the gesture systems of these children have the fourth language property, i.e. recursion. However, as stated above, it is not clear if this is really recursion since there are other possible analyses of these examples. Furthermore, the above example, i.e. bicycle-PEDAL-bird picture-WING (FLY?), seems to exemplify Bickerton's characterization of protolanguage: "... both words and utterances are simply strung together like beads, rather than assembled according to syntactic principles" (Bickerton 1990: 122). Thus it is doubtful that the gestural communication systems of Goldin-Meadow's subjects were recursive.

According to property 5, protolanguages do not have any, or have only a few, grammatical items. However, as discussed above, David's gestures have the property of discreteness/categorization which is a characteristic of language. He uses handshapes to refer to classes of similar items, and thus can be considered to be grammatical items, such as classifiers. Furthermore, David's gestures have the properties of compositionality and productivity which are also characteristics of language. David could combine his handshape morphemes with his motion morphemes to produce new forms with meanings predictable from the meanings of the parts. Characterizing gestures produced by three of the children also seem to have inflectional morphology that specifies a participant in an action. Bickerton claims that a protolanguage might contain particles indicating location (1990: 185). David indicated locations by adding movements to his gestures. This is different from particles in spoken languages, because particles in spoken languages are free morphemes, whereas the motions indicating location are similar to bound morphemes, such as inflections, because they were produced simultaneously with the verb stem. Bickerton does not mention inflections for location, however he claims that protolanguages rarely have any kind of inflection, including person agreement (1990: 126). Thus the gestures produced by three of

Goldin-Meadow's subjects contain inflections for person and David's gestures contain inflections for location, whereas such inflections are rarely found in protolanguage. On the other hand, like protolanguages, the gesture systems of these children do not contain the following grammatical items: inflections for tense (they could not mark actions as referring to the past or future) or number; auxiliary verbs for tense, aspect, equation, or class membership; complementizers; markers of the finite/nonfinite distinction; conjunctions; prepositions; articles; or demonstratives.

In sum, the gesture systems of these children, like protolanguages, lack some of the properties that languages have, i.e. properties 3 (overt realization of subcategorized arguments) and probably 4 (recursion). Property 2 (null elements) could be considered to be a continuum, and therefore it is not even consistent with a strict separation between protolanguage and language (This will be discussed further in section 6). The gesture systems of these children seem to go beyond protolanguage in properties 1 (word order) and 5 (grammatical items). Therefore it might be useful to compare the language-like properties of these gesture systems to properties of the bioprogram to see if the bioprogram can account for the ways in which the gestures produced by these children go beyond the properties of protolanguage.

5.1.1.8. Comparison to the properties of Bickerton's bioprogram

The gestures produced by these deaf children have the language-like properties of word order and a few grammatical items. The bioprogram does not specify any particular word order, but Bickerton claims that creoles typically have SVO word order and he makes assumptions that predict SVO word order for the first language ever spoken. Furthermore, the basic word order of ASL is also SVO. However, in the gesture systems of these deaf children, the word order is usually OV. In his two gesture sequences, David used the word orders SV for intransitive actions and OV or VS for transitive actions. This pattern does not fit the pattern of most creoles and is not like ASL. Three of Goldin-Meadow's subjects displaced gestures in ways which are similar to verb agreement morphology in ASL. David used gestures in ways which are similar to ASL's use of classifiers. However, classifiers and agreement morphology for person and location are not part of the bioprogram. Thus the bioprogram cannot account for the ways in which the gestures of these children seem to go beyond properties of protolanguage, i.e. in terms of word order and grammatical items.[16]

The gestures produced by these children cannot be considered to be language under Bickerton's hypothesis, because they do not have all of the

[16] I recently discovered that Singleton, Morford, and Goldin-Meadow (1993) also claim that David and Simon (a child of deaf parents who were late learners of ASL, and who I will discuss in section 5.1.3) have more morphology than Bickerton would predict. However, they only note this in a paragraph and do not attempt to give a detailed analysis (1993: 711).

properties which he claims are necessary for language. Furthermore, as mentioned above, the gestural systems used by these children were more deficient than natural languages in terms of the arbitrariness and the ability to use displaced reference. This was not because these children lacked the ability to use or invent arbitrary gestures or to use displaced reference. In fact there is evidence that they occasionally did use arbitrary gestures and displaced reference. The reason that their gesture systems were deficient in terms of arbitrariness and displaced reference is because these children did not have conventional lexical items and were thus primarily restricted to the use of non-arbitrary gestures and reference to objects and events present in the immediate environment in order to be understood. In contrast, the protolanguages that Bickerton describes have conventional lexical items and thus these systems have arbitrariness and displaced reference. This suggests that the gesture systems produced by Goldin-Meadow's subjects are more deficient than protolanguage in terms of arbitrariness and displaced reference, but are beyond properties of protolanguage in terms of word order and morphology.

In sum, the gesture systems produced by these children are similar to protolanguage in that they lack language properties 3 (overtly realizing all of the subcategorized arguments of verbs) and probably 4 (recursion). Their gesture systems seem to be further removed from language than protolanguage in that the ability to use arbitrariness and displaced reference is more deficient in these gesture systems. On the other hand, their gesture systems seem to go beyond properties of protolanguage in that they have word order based on semantic roles and they have some morphology. Bickerton proposes that there is a single characterization of protolanguage, that protolanguage and language are distinct, and that there are no intermediate stages between protolanguage and language. Thus Bickerton's protolanguage hypothesis cannot account for communication systems which do not have all of the properties necessary to be considered a language but at the same time have language properties which protolanguage does not have. Bickerton's protolanguage hypothesis also would not predict the existence of communication systems which are both deficient in some properties that protolanguages have, and beyond protolanguage with respect to other properties.

5.1.2. Deaf children of hearing parents: an invented sign system as input

The language learning situation of DH children who receive an invented sign system, such as Manually Coded English (MCE), as input can be compared to the language learning situation of children whose parents are pidgin speakers, because both of these groups of children receive input that is impoverished in form and modeled by non-natives. DH children receive MCE input from adults who are not native signers, and it has been claimed that "MCE input is ... beleaguered with deletions of vital morphological markers in both the teachers' and the parents' usage" (S. Supalla 1991: 108). Even though this input is impoverished and produced by non-natives, this does not mean that it is as

unstructured and variable as the input received by children of pidgin speakers. On the other hand, since the input to these DH children is impoverished, their output should be compared to the properties of creoles and Bickerton's bioprogram, because Bickerton's bioprogram hypothesis predicts that these children should not innovate properties which are not part of the bioprogram.

S. Supalla (1991) studied deaf children whose sign input was a form of MCE called Signing Exact English (SEE2). The lexicon of SEE2 is based mainly on ASL; however most morphological markers in ASL are spatial and simultaneous, whereas morphological markers in SEE2 are not spatial, and are sequential rather than simultaneous. For example, in ASL a repeated circular movement is added to the verb IMPROVE to derive a noun. This repeated circular movement is a morphological device used in ASL to derive nouns from verbs. In SEE2, on the other hand, to change the verb IMPROVE into a noun, an invented sign representing the English suffix -MENT is produced after the sign IMPROVE (1991: 87-88). Another difference between ASL and SEE2 is in the production of verbs. As stated earlier, in ASL a large number of verbs can show agreement with some of their arguments through movement and/or orientation. SEE2 does not use spatial movement or orientation to indicate agreement. In SEE2, as in English, a verb only agrees with a third person singular subject in the present tense. In this case, a fingerspelled 'S' is produced after the sign for the verb. The arguments of a verb are indicated by sign order in SEE2, which is SVO, as in English. A third difference between SEE2 and ASL is in their pronominal systems. Pronouns in ASL consist of pointing gestures to specific places in space that have been established to refer to a certain entity. In SEE2 pronouns are produced with non-pointing handshapes close to the signer's head and are not associated with any specific place in the signing space (1991: 92).

Eight children were used in Supalla's study. These children were 9-11 years old and were profoundly and congenitally deaf. They came from two schools which were 2,000 miles apart and had no contact with each other. The schools taught SEE2. The families of these children had little or no SEE2 signing skills, and therefore their teachers (all of whom had used SEE2 for at least five years) were the primary models for these children. None of the deaf children used in the study and no one in their schools had had any contact with ASL. To provide a model to compare the children's responses with, Supalla also tested a teacher who was a native speaker of English and had had eight years' of experience with SEE2 (1991: 94-95).

The test investigated the production of verbs and pronouns in the signing of these children. The children were shown videotapes of 45 scenes, 27 of which were targets and 18 of which were fillers. Each target scene consisted of two people performing an action together. The filler scenes had one person performing an action. After seeing the videotape, pictures of the people in the videotape were set up beside the video screen and the subjects were asked to describe what happened. A videotape of someone signing the uninflected form of the verb that the subjects were supposed to use to describe the scene was shown to the subjects before each scene. The subjects were told to use that verb to describe the event in the scene (1991: 94).

The purpose of this test was to see (1) if the children modified the verb signs by moving them toward or away from the pictures of the people in the videotape, thereby indicating the arguments of the verb by the movement of the verb sign, and (2) if the children used pointing gestures as pronouns. Since these devices are not used in SEE2, they were presumably not present in the children's input.

The children correctly produced 20% of the SEE2 nonspatial verbs, i.e. verbs that do not use location, movement, or orientation to indicate agreement, and 4% of the SEE2 nonspatial pronouns, i.e. pronouns that were not pointing gestures, but rather were produced with nonpointing handshapes close to the signer's head. On the other hand, the teacher correctly produced 89% of the SEE2 nonspatial verbs and 96% of the SEE2 nonspatial pronouns (1991: 97-99). 80% of the verbs produced by the children were spatially modified, i.e. the verbs signs were moved to show agreement with one or both of the participants, and 86% percent of the pronouns were spatial, i.e. pointing gestures. The teacher also produced spatially modified verbs and pronouns, however to a much lesser extent. Only 11% of the teacher's verbs were spatially modified, and only 7% of the pronouns were spatial. These data indicate that either the children were using forms that were very rarely present in their input, or they were innovating these spatial forms.

In my opinion, there is one problem that can be argued to be affecting these data: the fact that pictures of the participants in the videotape were set up by the screen. This could have biased the data in that more spatial pronouns and spatially modified verbs were produced than these children would produce in normal conversation. This experiment shows that these children probably point at objects and people and move verbs signs toward objects and people that are present in the immediate environment when they are signing. However, this experiment does not show what these children do when they are referring to objects and people that are not in the immediate environment: Do they use the SEE2 nonspatial pronouns and nonspatial verb forms in such cases? Or do they point and move verb signs in the direction of actual locations of objects that they cannot see, as in ASL? Do they set up arbitrary loci for referents that are not present and use pointing gestures and move verb signs toward or away from these arbitrary loci, as in ASL? Because of this problem, there is not enough evidence that the pointing gestures that the children used to refer to the people in the pictures are like spatial pronouns in ASL. In this experiment, the children were pointing to the pictures. Hearing people often point at things and I would expect that hearing children might do the same thing, however, I would not want to claim that the hearing children were producing ASL-like pronouns. This experiment does not provide any evidence that these children could use pointing gestures to refer to non-present referents.

On the other hand, there is a limited amount of evidence for spatially modified verbs in the productions of these children. One might assume that the children used pointing gestures because of the presence of the pictures. However, if this is the case, one would probably assume that the children would, for example, point to the picture of the subject (the predominant sign order of these children was SVO like their SEE2 input), produce a nonspatial SEE2 verb, and then

point to the picture of the object. This was not the case. In most instances, while producing the verb, the children added a movement to the verb sign which they directed toward the picture of the subject, the object, or both. This use of moving a verb sign, which is produced with a handshape that is not an extended index finger, as in pointing, is not something that is usually done (or not so obviously done) by hearing people when describing events. Therefore, unlike pointing gestures, I would not expect hearing children to move different hand gestures towards or away from participants when describing a scene. Thus the use of verb movement by the children in this experiment is interesting, but the evidence for it being like verb agreement in ASL is limited. In ASL, spatial verb agreement can be used to refer to both present and non-present objects and people. Present and non-present referents are both indicated by locating, moving, and/or orienting a verb sign at or towards a point established in space to refer to a particular person or object. Thus, this experiment shows that these children can move verb signs to agree with referents that are present, but there is no evidence that the children can move verb signs to agree with non-present referents.

Like Goldin-Meadow's subjects, Supalla's subjects seem to have innovated verb agreement. As I stated above in the discussion of Goldin-Meadow's subjects, Bickerton's bioprogram does not predict that children would innovate verb agreement. On the other hand, the spatially modified verbs that both Goldin-Meadow's subjects and Supalla's subjects produce are similar to spatial verb agreement in ASL, which is one of the ways in which the properties of ASL differ from the properties of the bioprogram.

5.1.3. Deaf child of deaf parents who are late learners of ASL

DDH children with deaf parents who were late learners of ASL have input from their parents which is probably not as consistent and grammatical as ASL produced by native signers, i.e. signers that were exposed to ASL from birth. Newport (1991) has shown that on tests of production and comprehension of ASL morphology, late learners of ASL, i.e. people who were first exposed to ASL after the age of 12, performed worse than native signers and early learners, i.e. people who were first exposed to ASL between the ages of 4-6. Late learners produced more whole-word signs that lacked internal morphological structure, they used ASL morphology inconsistently, and frequently used ungrammatical forms (1991: 119-121). If the only input to ASL that a DDH child has is his/her late learner parents, this child is receiving impoverished input just as children of pidgin-speaking parents receive impoverished input. However, as I will claim later, the input received by the child in this section was a lot more structured than pidgin input. On the other hand, this child did surpass his input in a number of ways and these innovations should be able to be accounted for by the bioprogram.

Singleton (1989) studied a profoundly deaf child named Simon. His parents were also deaf, but they had learned ASL at the ages of 15 and 16. Prior to learning ASL they attended day schools where they received oral training in English,

but sign language was prohibited. At about age 15, they were exposed to ASL after meeting some deaf peers who knew ASL. Simon was 9 years old at the time of Singleton's study. He attended a day school in which Signed English (a form of MCE) was used. All of the teachers at his school were hearing and did not know ASL. None of the deaf children at his school had deaf parents and none of them knew ASL. Furthermore, no one who had ever attended his school had known ASL at the time of their attendance. Therefore, Simon's parents were his only source of ASL input.

Singleton compared the comprehension and production of Simon's parents with Simon's comprehension and production. As data Singleton used videotapes of the spontaneous production of the subjects in conversation with another ASL signer and the results of two tests: 1) Sign Order Comprehension, and 2) Verb Inflection Production (1989: 29). The Sign Order Comprehension test was a test of the comprehension of the basic ASL word order (SVO) and grammatical word orders that are marked by topicalization.

In ASL, a constituent that is topicalized is moved to the front of the sentence and marked by a facial expression in which the eyebrows are raised and the chin is lifted during the production of this topicalized constituent. Thus the following word orders are possible in ASL (Topicalized constituents are italicized and separated from the rest of the sentence by a comma.) (1989: 33):

SVO ex.: BOY TELL GIRL
S,VO ex.: *BOY*, TELL GIRL
O,SV ex.: *GIRL*, BOY TELL
VO,S ex.: *TELL GIRL*, BOY

To test the comprehension of these different word orders, subjects watched a videotape of a native signer producing short sentences in ASL. After each sentence, the subject had to choose which one of two pictures the signed sentence corresponded to. Each subject was shown 36 randomized sentences using 9 verbs in each of the four word orders (1989: 36). Table 4 shows the results from the Sign Order Comprehension test.[17] The number correct is the number of correct responses out of a possible nine.

Simon's mother scored 100% on SVO and *S*,VO word orders. She answered 7 out of 9 correctly with the *O*,SV word order, and only 1 out of 9 correctly with the *VO*,S word order (1989: 43). She usually interpreted *VO*,S incorrectly as *VS*,O (1989: 44). Simon's father also scored 100% on SVO and *S*,VO word orders. He answered 2 out of 9 correctly for *O*,SV and 2 out of 9 correctly for *VO*,S (1989: 48). Simon's father usually interpreted *O*,SV incorrectly as *S*,OV and *VO*,S incorrectly as *VS*,O (1989: 50). Simon performed better than his parents with *O*,SV and *VO*,S word orders. He scored 100% on SVO, *S*,VO, and *VO*,S word orders, and answered 8 out of 9 correctly with *O*,SV word order (1989: 62).

[17] This table was adapted from Singleton (1989: 62).

Number correct on the Sign Order Comprehension test

	SVO	*S*,VO	*O*,SV	*VO*,S
mother	9	9	7	1
father	9	9	2	2
Simon	9	9	8	9

Table 4

Out of 68 spontaneously produced sentences, Simon's mother produced primarily SVO order with one topicalized *S*,VO order. She did not correctly produce *O*,SV or *VO*,S orders. However, she did produce one *O*,SVO (1989: 41-42). Out of 95 spontaneously produced sentences, Simon's father produced primarily SVO order with eight topicalized *S*,VO orders. He also did not correctly produce *O*,SV or *VO*,S orders. However, he did produce two *O*,SVO (1989: 47). There was not much data on the spontaneous signing of Simon and these data did not contain any examples of topicalized sentences (1989: 52-53).

Combining the data from the spontaneous production with the data from the Sign Order Comprehension test, it seems that Simon only had input for SVO and *S*,VO from his parents. He probably did not have *O*,SV order from his mother, because although she answered 7 out of 9 correctly on the comprehension test, she was not observed to spontaneously produce a correct *O*,SV. She attempted to produce one *O*,SV sentence, but it was ungrammatical because it did not have the correct facial expression marking on the object (1989: 42). Furthermore, during the comprehension test, she interpreted the first two *O*,SV sentences incorrectly as *S*,OV, then answered the following seven *O*,SV sentences (randomized with the other types of topicalized sentences) correctly (1989: 57). This seems to indicate that she had difficulty recognizing *O*,SV at first. Therefore, it is not likely that she would comprehend *O*,SV sentences in running conversation without the use of context. However, both she and Simon's father produced *O*,SVO sentences. Thus Simon had input for SVO, *S*,VO, and *O*,SVO from both parents. Simon went beyond his input because he could comprehend the *VO*,S order that neither of his parents comprehended, and he could comprehend the *O*,SV order that his father could not comprehend and that his mother seems to have had difficulty comprehending.

For the Verb Inflection Production test, subjects watched a series of videotape segments. Each segment consisted of an event in which an actor performed an action once, twice, repeatedly, or repeatedly for a long time. Furthermore, the action was performed with one or two (DUAL) recipients. So that the subject would use the expected verb to describe the event, a video segment of a signer producing the uninflected form of the verb was shown before the target event. After seeing the target event, subjects were asked to describe the event they had seen (1989: 69). The target verbs contained the following inflections: 1) uninflected, i.e. not inflected for number or aspect, 2) singly inflected, i.e.

inflected for only one of the following - dual (DUAL), repeated action (REP), or continuative (SLOW REP), and 3) multiply-inflected, i.e. two inflections - dual + repeated (DUAL+REP) or repeated + dual (REP+DUAL). For example, these six inflections were required for six different scenes involving a man blowing out candles. Trick candles that relit were used in the REP and SLOW REP conditions (1989: 66, 69-70):

Uninflected:

SINGLE: "Man blows out one candle on one cake." (The verb sign BLOW is moved away from the signer's mouth toward the cake.)

Singly inflected:

DUAL: "Man blows out one candle on two separate cakes." (The verb sign BLOW is moved away from the signer's mouth toward cake 1, then it is moved back to the signer's mouth, and then it is moved toward cake 2.)

REPEATED (REP): Man blows out candles on one cake again and again. (The verb sign BLOW is moved away from the signer's mouth toward the cake, then it is moved back to the signer's mouth, then it is moved toward the cake again...).

CONTINUATIVE (SLOW REP): Man blows out candles again and again (over a long time) on one cake. (The verb sign BLOW moved toward the cake again and again with a superimposed circular pattern.)

Multiply-inflected:

DUAL+REP: "Man blows out one candle on cake 1, then one candle on cake 2; then repeats the sequence again and again." (The verb sign BLOW is moved toward cake 1, then it is moved to the signer's mouth, then it is moved toward cake 2, then it is moved to the signer's mouth, then it is moved toward cake 1, then it is moved to the signer's mouth, then it is moved toward cake 2...).

REP+DUAL: Man blows out candles on cake 1 again and again, then blows out candles on cake 2 again and again. (The verb sign BLOW is moved toward cake 1, then it is moved to the signer's mouth, then it is moved toward cake 1 again... Then the verb sign BLOW is moved toward cake 2, then it is moved to the signer's mouth, then it is moved toward cake 2 again...).

Table 5 shows the results from the Verb Inflection Production test.[18] The number correct for each category is the number of correct responses out of six. The total number of possible correct responses is 36.

[18] This table was adapted from Singleton (1989: 92).

Number and percent correct on Verb Inflection Production test

	SINGLE	DUAL	REP	SLOW REP	DUAL+REP	REP+DUAL	total
mother	6	4	6	5	2	1	24 (67%)
father	6	0	3	2	0	0	11 (30%)
Simon	6	6	5	6	6	6	35 (97%)

Table 5

Simon's total test score on the Verb Inflection Production test was 97% correct, whereas his mother's score was 67% correct and his father's score was 30% correct (1989: 72). Simon's mother answered 6 out of 6 correctly in the SINGLE and REP contexts. She answered 5 out of 6 correctly in the SLOW REP contexts, and 4 out of 6 correctly in the DUAL contexts. On the other hand, she only answered 2 out of 6 correctly in the DUAL+REP contexts and only 1 out of 6 correctly in the REP+DUAL contexts. Simon's father answered 6 out of 6 correctly in the SINGLE contexts. He only answered 3 out of 6 correctly in the REP contexts, and only 2 out of 6 correctly in the SLOW REP contexts. He did not answer any correctly in the DUAL, DUAL+REP, and REP+DUAL contexts (1989: 92). Simon scored perfectly (6 out of 6) in the SINGLE, DUAL, SLOW REP, DUAL+REP, and REP+DUAL contexts. He answered 5 out of 6 correctly in the REP contexts.

Simon's mother showed a difference in the percentage she answered correct in the singly-inflected contexts, i.e. DUAL, REP, and SLOW REP, versus the multiply-inflected contexts, i.e., DUAL+REP and REP+DUAL. With respect to this difference, Singleton claims that Simon's mother seems to have command over both number (DUAL) and temporal aspect (REP and SLOW REP) in singly-inflected forms. In contrast, Simon's father had trouble with REP and SLOW REP forms and did not produce any DUAL forms (1989: 76). Rather than producing multiply-inflected forms, i.e. DUAL+REP and REP+DUAL, Simon's parents usually inflected the verb for the primary inflection, i.e. the DUAL part of the DUAL+REP and the REP part of the REP+DUAL, and expressed "the secondary inflection with a periphrastic device [such as using the sign BACK-AND-FORTH instead of the REP inflection] rather than a recursive application to the output of the primary inflection" (1989: 84). That is, his parents usually did not use two inflections on the same verb stem.

In spontaneous production, Simon's mother and father were found to produce REP and SLOW REP forms. These data, along with the Verb Inflection Production test data indicate that Simon had some input for REP and SLOW REP from both parents and input for DUAL from his mother. In multiply-inflected contexts, he might have had some input for DUAL+REP and REP+DUAL from his mother. However, from both parents he had more input for production of the primary inflection with a periphrastic device to express the secondary inflection in these contexts. Thus Simon surpassed his input by using multiple inflections in contexts in which his parents generally used a single inflection and a periphrastic

device.

To account for the areas in which Simon seems to have gone beyond his input, i.e. in the comprehension of *O*,SV and *VO*,S orders and in the production of multiply-inflected verbs, Singleton discusses several hypotheses. One of the hypotheses she discusses is Bickerton's language bioprogram hypothesis. Bickerton claims that the bioprogram is used when humans have to form an adequate language from inadequate materials (Bickerton 1981: 133), but it is not apparent that the input that Simon received from his parents was inadequate for acquiring language. They did not sign like native signers, because they had problems with different word orders for topicalization and complex morphological inflection. However, Simon's input was a lot more structured than the input that children of pidgin speakers get. According to Bickerton, pidgin is protolanguage and therefore lacks properties that are necessary for a language. The language of Simon's parents had properties that protolanguages lack: they had a basic word order, and they could topicalize objects in *O*,SVO word order; subcategorized arguments were not left out; and the language was recursive and highly inflected, but not as inflected as the ASL produced by native signers. However, since Simon's comprehension and production did surpass his input, it seems that Bickerton's bioprogram should be able to account for the areas in which Simon's performance surpassed that of his parents.

Bickerton's bioprogram contains movement rules that move constituents to sentence initial position. Singleton claims that this can account for Simon's *O*,SV order, but not his *VO*,S order (Singleton 1989: 106). She makes this claim because Bickerton does not consider VP to be a constituent in the earliest stages of creoles; however he claims that VP can become a constituent through decreolization by having contact with a language that has a VP constituent, or by internal change (Bickerton 1981: 53). Singleton claims that the input that Simon received from his parents does not provide evidence for a VP constituent, and therefore he should not be able to move VO (Singleton 1989: 106). However, Simon had *S*,VO and *O*,SVO input and from these he could have generalized that S, VO, and O are possible constituents, and these are the constituents which he could interpret as being topicalized.[19] If this is the case, Bickerton's bioprogram can account for Simon's comprehension of *VO*,S order even though he did not have input for it, because movement of constituents is part of the bioprogram and is found in many creoles.[20] On the other hand, as suggested by Singleton (1989: 161-162), it

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[19] This was suggested to me by Robert Kluender.

[20] Singleton also claims that Bickerton's bioprogram cannot account for Simon's comprehension of the topic marking facial expression with *O*,SV and *VO*,S orders, because topic marking is language specific (Singleton 1989: 106). However, Bickerton's bioprogram accounts for structures that children do not have input for. Simon had input for the topic marking facial expression, and therefore Bickerton's bioprogram does not seem to apply in this case. Simon's comprehension of the topic marking facial expression can probably be accounted for by generalization. Simon had input for the topic marking facial expression with *S*,VO word order and *O*,SVO word order. Thus Simon had input for the topic marking facial expression with S and O, and he might have generalized this facial expression to the VO constituent. Singleton accounts for this by assuming that there is a learning mechanism which "has the potential to broaden the domain over which the rule applies, in spite of the limited scope of application modelled in the input" (1989:

seems that Simon's comprehension of *O*,SV and *VO*,S orders could simply be the result of generalization and that Bickerton's bioprogram is not needed to account for this.[21] However, since only Simon's comprehension was tested and not his production and since there were no ungrammatical topicalized sentences on the test, it is not known how Simon would have interpreted an ungrammatical topicalization such as *SV*,O. Would Simon consider SV to be a constituent and assume that it could be topicalized?[22]

Simon correctly produced the REP, SLOW REP, and DUAL verb inflections. He had some input for REP and SLOW REP from both of his parents; however, he had input for DUAL only from his mother. Since Simon had all of these inflections in his input, the bioprogram is not needed to account for his production of these. On the other hand, Simon could combine REP and DUAL inflections simultaneously on one verb stem even though he had little or no input for it. Bickerton's bioprogram hypothesis does not address this type of innovation. Thus the bioprogram cannot account for Simon's production of multiple inflections.

In sum, Bickerton's protolanguage and bioprogram hypotheses cannot account for all of output produced by three groups of deaf children. Bickerton claims that protolanguage and language are separate and that there are no intermediate stages between them. However, I have provided evidence that the gestures produced by Goldin-Meadow's subjects seem to go beyond the properties of protolanguage in terms of word order, verb agreement, and classifiers, but these gesture systems are more deficient than protolanguage in terms of arbitrariness and displaced reference. This is problematic for Bickerton's characterization of protolanguage, because his protolanguage hypothesis does not predict the existence of a communication system which is more deficient than protolanguage with respect to some properties but goes beyond the properties of protolanguage with respect to other properties. Furthermore, Bickerton's bioprogram hypothesis cannot account for all of the innovations that these children produce. The bioprogram does not contain morphological classifiers, but these were produced by Goldin-Meadow's subject David. The bioprogram also does not contain verb agreement morphology, but this was produced by Goldin-Meadow's subjects and Supalla's subjects. The bioprogram also cannot account for the multiple inflections which were produced by Singleton's subject Simon.

160). Therefore, Simon applies the topicalization rule and the topic marking facial expression to a broader domain than his parents do.

[21] This was pointed out to me by Farrell Ackerman.

[22] This was suggested to me by Robert Kluender.

5.2. The signing of apes[23]

Bickerton claims that apes cannot go beyond protolanguage. In this section, I provide evidence of signing by some apes in which they produce word order and agreement morphology that cannot be accounted for by protolanguage.

A number of researchers have attempted to teach apes ASL. Some of these include Terrace, Petitto, Sanders, and Bever (1979 and 1980) with their chimpanzee Nim; Gardner, Gardner and colleagues (1980, 1989, and 1992) with their chimpanzees Washoe, Moja, Pili, Tatu, and Dar; Greenfield and Savage-Rumbaugh (1990) with their chimpanzee Kanzi; and Miles (1990) with her orangutan Chantek; The input to these apes was very variable: all of these apes had researchers who were not fluent in ASL trying to teach them ASL.

Most of these apes did not have real ASL input, but rather they were taught a few ASL signs. The researchers working with Kanzi and Nim usually used a few ASL signs in English word order while speaking English. In addition, Kanzi had a board with symbols which his researchers called lexigrams. These lexigrams were arbitrary symbols used to stand for objects. Miles had some deaf researchers, however she claims that they usually used English word order rather than true ASL. Her hearing researchers also spoke English while signing. The Gardners also had some deaf researchers who knew ASL. However, unlike all of the other researchers, the Gardners did not allow spoken English to be used with the chimpanzees. Thus aside from the Gardner's chimpanzees, all of these apes had spoken English input in addition to ASL signs. Furthermore, all of these apes had input from a number of different researchers, who all had different signing abilities. Additionally, in the cases in which some of the researchers were fluent in ASL and some were not, the ones that were not probably used English word order while the ones that were might have used ASL. In many cases the researchers who were not fluent in ASL just taught the apes a few signs. The signing of these non-fluent researchers usually did not contain any grammatical devices of ASL, in particular their signing did not contain ASL's rich inflectional morphology. For example, Greenfield and Savage-Rumbaugh state that Kanzi's "caregivers, not being fluent signers, presented almost no sign inflections to Kanzi in their input" (1990: 555). Thus the input to all of these apes was variable, inconsistent, and usually impoverished.

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[23] I recently discovered that Jackendoff (1994) discusses Goldin-Meadow's subjects, apes which have been taught language, and Bickerton's perspective on creoles in a chapter of his book (1994: 126-140). He does not try to apply Bickerton's bioprogram to the output of Goldin-Meadow's subjects or the apes as I do here. He notes the similarity in the spatial displacement of signs by deaf children with only MCE input and by Goldin-Meadow's subjects. However, he claims that the literature on apes acquiring language "does not suggest that chimps improvise a grammatical use of space or simultaneous patterns of inflection, so characteristic of children exposed to Manual English" (1994: 138), although he notes that a gorilla named Koko (studied by Patterson and Linden 1981) occasionally used space in this way. In contrast, I will argue that apes do displace signs in ways similar to Goldin-Meadow's subjects, children learning MCE, and verb agreement in ASL.

One of the regularities found in the output of these apes is word order. When Kanzi produced lexigram-gesture sequences, he produced the lexigram before the gesture. This was unlike his input because, for example, he would typically produce a lexigram action before a gesture agent, which is VS order, whereas his input was always SVO order (Greenfield and Savage-Rumbaugh 1990: 560-561). He even produced this order when the gesture referred to an object that was present and was closer to him than the lexigram board: "At one point Kanzi was observed to move away from a person he later would indicate as agent, go to the board (where he indicated an action lexigram), and then return to the person (using a gesture to designate her as agent)" (Greenfield and Savage-Rumbaugh 1990: 564). When Kanzi produced lexigram-lexigram sequences, he tended to produce the action before the patient, for example: HIDE PEANUT. He thus produced VO order with lexigram sequences, like the SVO input from his human researchers (Greenfield and Savage-Rumbaugh 1990: 558). Kanzi also produced sequences of two action lexigrams. The order in which he produced these lexigrams was the order in which the actions were to be performed. For example, he pointed to the lexigram CHASE then to the lexigram BITE to ask a researcher to chase him and then bite him. The researcher tried to bite him first, but he would not let her bite him until she had chased him (Greenfield and Savage-Rumbaugh 1990: 565-566). A regularity was also found in Kanzi's three element sequences of one lexigram and two gestures. These were produced in the order action (lexigram) - agent (gesture) - patient (gesture), which is VSO order (Greenfield 1991: 585). This is also an order which was not present in Kanzi's input. However, if the VS part of this three element sequence is disregarded, because it is probably the result of ordering a lexigram before a gesture, the SO order of the gestures is consistent with Kanzi's SVO input.

Nim tended to produce his signs in the following orders: agent-action (SV), agent-patient (SO), and patient-beneficiary. He did not have an ordering of action and patient (Terrace, Petitto, Sanders, and Bever 1979: 895). The SV and SO orders that he did produce are consistent with his SVO input. However, Terrace et al. claim that Nim did not produce a broad enough range of agents and beneficiaries to be sure that his ordering was not the result of lexical position habits rather than an ordering based on semantic roles. For example, in patient-beneficiary sequences, 99% of the beneficiaries were *Nim* and *me*, and in agent-patient sequences, 76% of the agents were *you* (1979: 896).

Miles (1990) only describes one ordering pattern found in Chantek's output. Chantek would sign GIVE followed by the name of an object (VO order) if the object was not present. However, he would sign the name of an object followed by the sign GIVE (OV order) if the object was present. Only the English VO order was present in Chantek's input (1990: 519).

Most of the order regularities found in the output of these apes is consistent with their SVO input. The only regularities that were not present in the input are Kanzi's ordering of a lexigram before a gesture and Chantek's OV order when the object is present. Kanzi's ordering of a lexigram before a gesture is an ordering based on form. This is similar to three of Goldin-Meadow's subjects, who tended to produce pointing gestures before characterizing gestures.

Rimpau (1987) and Rimpau, Gardner, and Gardner (1989) claim that their chimps Washoe, Moja, Tatu, Dar, and Pili sometimes varied the place of articulation of signs.[24] They observed this in their chimps at an age as early as 11 months (Rimpau, Gardner, and Gardner 1989: 245). The output produced by only one of the chimps, Dar, was analyzed. The data used in the analysis comes from videotapes of Dar when he was 40-49 months old (Rimpau 1987: 14; Rimpau, Gardner, and Gardner 1989: 245). Dar was observed to change the place of articulation of signs (which were not simply points) to include agents, locations, instruments, and possessors. For example, Dar included an agent in his production of the sign TICKLE in the following contexts. When a human researcher, Tony, signed WHO TICKLE? (which they interpret to mean something like 'Who do you want to tickle you?'), WHAT ME DO?, and WHAT WANT?, Dar signed TICKLE on Tony's arm. Thus Dar produced the sign TICKLE on a researcher's arm in response to questions which could be answered with 'you tickle' (Rimpau 1987: 41; Rimpau, Gardner, and Gardner 1989: 259). Dar included a location in his productions of the sign GROOM when Tony signed WHERE GROOM? (which they interpret to mean 'Where do you want to be groomed?'). For example, in response to this question Dar signed GROOM on the top of his (Dar's) head. Dar was also observed to include a location in his production of the sign BRUSH in response to the question WHERE BRUSH by signing BRUSH on various parts of his body, and he was also observed to produce the sign TICKLE on various parts of his body (Rimpau 1987: 42-43; Rimpau, Gardner, and Gardner 1989: 259).[25] Dar included an instrument in his productions of the sign TICKLE by signing TICKLE on a toy which his researchers used to tickle him with. He did this when he was asked what that toy was used for and when asked if he would rather be tickled with the toy or by a researcher (Rimpau 1987: 42; Rimpau, Gardner, and Gardner 1989: 259). Dar included a possessor in his production of the signs SHIRT and WRISTWATCH. He signed SHIRT on the possessor's shirt in response to the question WHOSE SHIRT? and WRISTWATCH on the possessor's wrist in response to the question WHOSE WRISTWATCH? (Rimpau

[24] Miles (1990) claims that her orangutan Chantek learned the sign GO, and "without any instruction from his caregivers ... [he] would articulate the sign in a directional orientation in order to control his caregiver's movements toward one location or another" (1990: 525). However, Miles describes this sign as a point. The ASL sign GO is usually produced with two hands with pointing handshapes. The pointing fingers are held so that they are pointing up and then the arms move forward and the wrists are flicked down. This sign is usually produced towards the direction that someone/something went/is going/will go. If Chantek did not have any input for moving the sign GO in the direction he wanted to go, it is not apparent to me what his input was. Additionally, this sign uses a pointing handshape and hearing people often point at things and to places they want to go. I would be surprised if Chantek did not have any input for this. Therefore, I am not including Chantek's displacement of the GO sign in the data I am analyzing.

[25] These references do not state whether the situations in which Dar produced signs on his body were tested for meaning. For example, did the researchers try to BRUSH, GROOM, or TICKLE Dar in an area other than the one on which he produced the sign? If they did, what was Dar's response? Did Dar insist that they brush, groom, or tickle him in that place? If so, then this resembles locative agreement. If not, then maybe Dar was just producing the sign in different places for fun.

1987: 44-45; Rimpau, Gardner, and Gardner 1989: 260). Rimpau et al. claim that they sometimes produced signs on the chimps' bodies as deaf parents do with their deaf children (1989: 241). However, Rimpau et al. not specify which signs were produced on the chimps' bodies, and if these were the same signs that the chimps produced on the humans' bodies. They also do not specify whether they were incorporating arguments when they signed on the chimps' bodies, or whether they were simply producing a sign on a chimps' body to teach the chimp that sign. I have observed deaf adults producing signs on deaf children. This seems to be done simply to teach the children signs. There is no indication that an argument is incorporated. For example, I have seen adults produce the signs HORSE and LION on children's heads when showing the children a toy horse and a toy lion, respectively. In these cases the adult is not incorporating an argument by producing the sign on the child's head, i.e. the adults were not saying that the child was a horse or a lion. Since Rimpau, Gardner, and Gardner compare what they were doing when they made signs on their chimps' bodies to deaf parents making signs on deaf children's bodies, I will assume that Rimpau et al. were not incorporating arguments into their signs when they made signs on the chimps' bodies. Therefore I will also assume that Gardner and Gardner's chimps did not have input for incorporating arguments into their signs by producing them on a person or object.

Bickerton claims that trained apes can acquire protolanguage but not language (1990: 122). The output of the apes discussed here seems to lack the properties of language 1-4, just as protolanguages do. Language property 1, i.e. principles that constrain variations in word order, is not present in the output produced by these apes. While they have some ordering tendencies, they do not have different orders for different functions, such as to indicate focus. On the other hand, like Goldin-Meadow's subjects, some of these apes have some kind of word ordering, which is more than what pidgins have. The output of these apes is probably lacking property 2, i.e. the predictable occurrence of null elements, and property 3, i.e. the realization of subcategorized arguments. These apes often leave out subcategorized arguments and there does not seem to be a principle by which these arguments are left out. Property 4, i.e. recursion, also seems to be lacking in the output of these apes. Property 5 states that protolanguages have no or few grammatical items. Most of the signing of these apes did not contain any grammatical items; however, Gardner and Gardner's chimps varied the place of articulation of some of their signs incorporating agents, locations, instruments, and possessors. This is similar to the spatial movement of action gestures/signs produced by Goldin-Meadow's subjects and Supalla's subjects and to spatial verb agreement in ASL, because the displaced signs produced by Dar specify both the referent of the sign and a referent which is in some way related to the referent of the sign. Bickerton cannot account for agreement morphology in the output of these apes, because he claims that protolanguages do not usually have any kind of inflections (Bickerton 1990: 126).

Like Goldin-Meadow's subjects, these apes seem to have gone beyond their input in some of the word orders they produced and in their production of agreement morphology. Bickerton claims that most creoles have SVO word order and

hypothesizes that the first language ever spoken was SVO. Kanzi's lexigram-gesture order is based on the form of the symbol, rather than on semantic roles or grammatical relations. Therefore it does not seem reasonable to compare it to word ordering in spoken creoles, because word ordering in creoles is based on grammatical relations and since spoken words are the only medium in these creoles, there cannot be an ordering based on form, such as a spoken word vs. a lexigram ordering. Chantek produced OV order when the object was present, and VO order when the object was not present. This ordering is based on the presence vs. absence of an object in the immediate environment rather than on semantic roles (such as the gesture order produced by some of Goldin-Meadow's subjects), grammatical relations (such as the word order in creoles), or grammatical categories (which Bickerton claims word order in protolanguage can be based on). Unlike Kanzi's lexigram-gesture order, Chantek's ordering is a logically possible ordering in spoken languages. However, since most creoles have SVO order, Chantek's use of OV order cannot be accounted for by Bickerton's assumptions that motivate creoles to have SVO order. Similarly, Bickerton cannot account for the apes' production of inflection for agent, location, instrument, and possessor, because protolanguage and the bioprogram (which is not supposed to apply to apes) do not contain this kind of inflection.

In sum, Bickerton assumes that protolanguage and language are separate and that there are no intermediate stages between them. However, Goldin-Meadow's subjects and the apes produce word order, agreement morphology, and classifiers (Goldin-Meadow's subject David only) which seem to be beyond the properties of protolanguage. In addition, the gesture systems produced by Goldin-Meadow's subjects are more deficient than the protolanguages described by Bickerton in terms of arbitrariness and displaced reference. This is a problem for Bickerton's hypothesis because Bickerton's characterization of protolanguage does not predict the existence of a communication system which does not have all of the properties necessary to be considered a language but has properties which are beyond the properties of protolanguage. His protolanguage hypothesis also does not predict a communication system which is beyond the properties of protolanguage in some ways but is more deficit than protolanguage in terms of other properties. Furthermore, Bickerton's bioprogram cannot account for the agreement morphology produced by Goldin-Meadow's subjects, Supalla's subjects, and the apes, the classifiers produced by Goldin-Meadow's subject David, or the multiple inflections produced by Singleton's subject Simon.

6. Problems for the protolanguage and bioprogram hypotheses

Bickerton's protolanguage and bioprogram hypotheses cannot account for the morphology and word orders innovated by the groups of children and apes that have been discussed. In this section I will discuss previously proposed hypotheses and propose some hypotheses of my own to account for the innovations made by these children and apes.

The preceding section discussed language production/comprehension in apes and in three groups of children: DH children who did not receive a sign system as input, DH children who received an invented sign system (SEE2) as input, and a DDH child whose parents were late learners of ASL. Table 6 lists the grammatical forms found in their output that were not present, or only rarely present, in their input.

Innovations found in the gestural communication of deaf children and apes

Goldin-Meadow et al.: deaf children with no sign input
(1) OV order, David: OV and VS for transitive, SV for intransitive
(2) morphology: classifiers
(3) morphology: inflectional agreement morphology for person and location

Supalla: deaf children with MCE input
(4) morphology: inflectional agreement morphology for person

Singleton: deaf child (Simon) of deaf parents who are late learners of ASL
(5) movement rules: *O*,SV and *VO*,S
(6) morphology: multiple inflectional verbal morphology (REP+DUAL and DUAL+REP)

Apes
(7) Chantek's OV order when the object was present
(8) morphology: inflectional agreement morphology for person, location, instrument, and possessor

Table 6

As stated above in the discussions of these data, Bickerton's bioprogram hypothesis can account for the movement rule in (5). However, as stated in section 5.1.3, this could also be accounted for by assuming that Simon generalized topicalization to *O*,SV and *VO*,S based on the topicalization of *S*,VO and *O*,SVO which were present in his input. Bickerton's bioprogram cannot account for the morphology in (2), (3), (4), (6), and (8), or for the word orders in (1) and (7). Hypotheses which have been proposed to account for ASL's simultaneous morphology are discussed in section 6.1. In this section I will propose that the morphological innovations produced by Goldin-Meadow's subjects, Supalla's subjects, Simon, and Dar can be accounted for by a hypothesis for the rapid production of language and a hypothesis that the forms produced by Goldin-Meadow's subjects and Dar are based on iconicity and indexicality. Hypotheses which have been proposed to account for word order in creoles and for word order in Goldin-Meadow's subjects are discussed in section 6.2. In section 6.3 I propose a continuum of language properties which is compatible with evolutionary adaptation as an alternative to Bickerton's protolanguage/language dichotomy.

6.1. Morphological innovations

In this section I propose that the morphological innovations produced by Goldin-Meadow's subjects, Supalla's subjects, Simon, and Dar can be accounted for by two hypotheses: 1) a hypothesis for the rapid production of language, and 2) a hypothesis that the form of the gestures produced by Goldin-Meadow's subjects and Dar is based on iconicity and indexicality.

Bickerton's bioprogram hypothesis cannot account for the morphological innovations ((2), (3), (4), (6), and (8) above) produced by the deaf children and apes discussed in this paper. The bioprogram hypothesis cannot account for most of this morphology because creoles do not have much morphology, and therefore Bickerton does not ascribe much morphology to the bioprogram. The bioprogram cannot account for the innovation of classifiers, agreement morphology, or Simon's use of two inflections simultaneously. A possible explanation for the existence of this morphology in the gestural communication systems of these children and apes might become apparent by looking at features of ASL.

ASL has almost all of the features that creole languages have. Therefore, according to Bickerton's hypothesis, ASL must be very close to the bioprogram. On the other hand, ASL also has morphological properties which are not found in the bioprogram. Some of these morphological properties are very similar to the morphology found in the gestural communication systems of the deaf children and apes discussed in this paper. There are two proposals that have been made to try to account for ASL's simultaneous morphology.

One proposal, which I will call the processing constraint hypothesis, claims that ASL's simultaneous morphology can be accounted for by a processing constraint. Although a sign takes twice as long to produce as a spoken word, the proposition rate of spoken English and ASL are equivalent (Klima and Bellugi 1979: 185-186; S. Supalla 1991: 88). MCE, however, has a proposition rate that is twice as long as spoken English and ASL (Klima and Bellugi 1979: 193; S. Supalla 1991: 88-89). Therefore it has been suggested that invented sign systems such as MCE might violate processing constraints by exceeding short-term memory limitations (Bellugi 1980: 135-136). A major difference between MCE and ASL is that MCE has sequential morphology, whereas ASL has simultaneous morphology. This suggests that ASL's simultaneous morphology is needed in order to meet processing constraints (Bellugi 1980: 136; S. Supalla 1991: 109). If this hypothesis about processing constraints is correct, then it can explain ASL's deviation from the bioprogram in terms of complex, simultaneous morphology.[26]

[26] As stated earlier, the spatial pronouns produced by the children with MCE input could be accounted for as an artifact of the testing situation, i.e. the fact that the pictures of the participants were hung up by the screen. However, it is also possible that the processing constraint could account for these forms, in that spatial pronouns are faster to produce than the MCE pronominal forms, and pronominal forms in a language are usually quicker, more efficient ways to refer to an entity.

The second proposal is based on Slobin's (1977) claim that there is a tendency for languages to be quick and easy; I will call this the innate norm hypothesis (Gee and Goodhart 1985: 308, 1988: 64; Gee and Mounty 1991: 69). Slobin suggests that this tendency results from speakers' desires to express themselves quickly and easily (Slobin 1977: 186); however Gee et al. interpret this tendency as being innate and therefore claim that "children require a language that is fast and efficient" (Gee and Mounty 1991: 69). According to this hypothesis, children exposed to MCE will produce ASL-like forms because ASL-like forms "are specified at least in part by their internal norms for language", which include the requirement that languages be quick and easy (Gee and Mounty 1991: 69). This proposal is similar to the first proposal in that both suggest that ASL has simultaneous morphology so that it will be produced quickly and that children exposed to MCE produce ASL-like forms rather than MCE forms because MCE is too slow. The difference between the two proposals is that the first invokes a processing constraint, whereas the second invokes innate norms to which languages must conform.

There is also the possibility of a third proposal, which I will call the speaker efficiency hypothesis. This hypothesis uses Slobin's suggestion that the tendency to be quick and easy results from the desire of speakers wanting to express themselves efficiently (Slobin 1977: 186). This proposal is similar to the other two proposals in that it also suggests that ASL has simultaneous morphology so that it will be produced quickly. However, this proposal does not suggest that ASL needs to have simultaneous morphology so that it can be processed or in order to meet innate language norms, but rather that ASL has simultaneous morphology because signers want to express themselves quickly. This proposal also does not claim that MCE is too slow to be processed or to meet innate language norms, but rather that children produce ASL-like forms instead of MCE forms because MCE forms cannot be produced quickly enough for signers' desires to express themselves efficiently.

Assuming the validity of any one of the above proposals, the existence of ASL's complex, simultaneous morphology can be explained. Once ASL's complex morphology is explained, then ASL is very close to the bioprogram. Some researchers have claimed that a possible reason that ASL has so many creole properties is because most deaf children have hearing parents, and therefore these children have variable and/or impoverished input, and their acquisition of ASL is similar to the acquisition of a creole from pidgin input: "Given ASL's small generational depth and the variable conditions under which it is acquired, ASL must stay close to the internal norms for language" (Gee and Mounty 1991: 81).

If one of the above proposals can account for ASL's deviation from creole languages and the bioprogram, it might also be used to account for the morphology that these children and apes produce, i.e. (2), (3), (4), (6), and (8). The morphology innovated by these children and apes is similar to some of the morphology found in ASL, and it also cannot be accounted for by the bioprogram hypothesis. Any of the above proposals could conceivably be used to try to account for the morphology found in the gestural communication systems of these children and apes. However, there are important differences in the interactions of

these hypotheses and the groups of deaf children and apes discussed in this paper. The processing constraint hypothesis might be able to account for the morphology produced by Supalla's subjects. His subjects were 9-11 years old and they may have been producing complex sentences that were long enough to be subject to a processing constraint. On the other hand, Goldin-Meadow's subjects were only 1;4 - 5;9 years old and they were not producing complex sentences. Similarly the apes were not producing complex sentences. In these cases, it doesn't seem that a processing constraint could account for their simultaneous morphology, because their utterances were probably not long enough to be subject to this constraint. Since Simon was 9 years old, his utterances might have been long enough to be subject to a processing constraint, and thus this would account for his use of multiple simultaneous morphology. On the other hand, Simon's parents used simultaneous morphology, but rarely used multiple simultaneous morphology. In situations calling for multiple simultaneous morphology, Simon's parents usually used one morphological inflection plus a periphrastic device. If a processing constraint based on short-term memory limitations caused Simon to produce multiple simultaneous morphology, one might expect that this processing constraint would also cause his parents to produce multiple simultaneous morphology. Alternatively, it could be assumed that the processing constraint only applies to children acquiring language and that it did not apply to Simon's parents because they were first exposed to ASL when they were 15 and 16 years old. Overall, however, it does not seem that the processing constraint hypothesis can account for the morphology produced by all of these groups.

The innate norm hypothesis can account for the production of simultaneous morphology by Goldin-Meadow's subjects, Supalla's subjects, and Simon. This hypothesis could also account for the lack of multiple simultaneous morphology in Simon's parents' utterances, if it is assumed that the innate norm is a constraint on the acquisition of languages by children but not on the acquisition of languages after puberty. On the other hand, in order for the innate norm hypothesis to account for the production of simultaneous morphology by the apes, one would have to assume that apes have an innate norm for languages to be quick and easy. This is not impossible, however it does not seem to be a reasonable hypothesis since apes in the wild are not considered to have language. Thus it does not seem that the innate norm hypothesis can account for the morphology produced by all of these groups.

The production of simultaneous morphology by Goldin-Meadow's subjects, Supalla's subjects, Simon, and the apes can be accounted for by the speaker efficiency hypothesis. The production of simultaneous morphology by the subjects in all of these groups could be the result of these subjects wanting to communicate quickly and easily. However, the absence of the production of multiple simultaneous morphology by Simon's parents is hard to explain. Perhaps Simon's parents can be accounted for if it is assumed that multiple simultaneous morphology was too complex for them to acquire at the ages of 15 and 16 (just as some structures are hard for second language learners to acquire). To account for why they would not innovate multiple simultaneous morphology, it could be assumed that children and apes do not try to mirror their input as much as adults

do, and therefore children and apes are more likely to innovate forms that can be produced faster. Since it seems that the speaker efficiency hypothesis is best suited to account for the simultaneous morphology produced by all of these groups, I will base the following discussions on this hypothesis. However, similar arguments could also be made with the other two hypotheses.

The speaker efficiency hypothesis can be used to account for the innovations (2), (3), (4), (6), and (8) listed above. The inflectional agreement morphology, i.e. (3), (4), and (8), in the output of these children and apes can be accounted for by assuming that children and apes use this morphology because they want to express themselves quickly and easily. Simon's use of multiple inflectional morphology, i.e. (6) the simultaneous combination of two inflections, can be accounted for similarly. The speaker efficiency hypothesis assumes that Simon innovated multiple inflectional morphology so that he could express himself more efficiently. David's use of different handshapes in combination with different motions, (2) above, can also be accounted for by the speaker efficiency hypothesis. David used handshapes to represent the semantic class of an object, the shape of an object, or the handgrip around an object. Similarly to the way in which classifiers are used with verbs of motion in ASL, David's handshapes were used simultaneously with a motion. Thus the motion and a property of an object were produced at the same time. Without these classifiers, the semantic class, shape, or handgrip around an object might have to be specified separately from the verb. The speaker efficiency hypothesis assumes that David innovated these morphemes so that he could express himself more efficiently.

In trying to account for the morphology produced by these children and apes these hypotheses for the rapid production of language are missing an explanation of why this innovated morphology resembles morphology in ASL. A possible way to account for this resemblance is that much of the morphology innovated by these children and apes is either iconic or indexical. Peirce (1960) defines a sign (something which stands for something else) as iconic if the sign represents the object it refers to through some kind of similarity with that object (Peirce 1960, vol. 1: 195). For example, paintings and diagrams are icons (Peirce 1960, vol. 2: 157-158). Peirce defines a sign as an index if there is a physical connection between the sign and the object and the sign calls attention to the object (Peirce 1960, vol. 1: 195-196). For example, a weather vane is an index of the direction of the wind (Peirce 1960, vol. 2: 161) and a pointing finger is an index of what is being pointed at.

Both Goldin-Meadow's subjects and Supalla's subjects moved gestures/signs toward objects. The movement of action gestures/signs produced by Goldin-Meadow's subjects seems to be iconic. Three of Goldin-Meadow's subjects usually moved transitive characterizing gestures toward objects playing the patient role and David moved intransitive characterizing gestures toward locations. This movement is iconic because it patterns movement in the real-world. In the real-world, transitive actions usually consist of an agent directing an action toward a patient, and intransitive actions often consist of an agent moving toward some location. For example, when David produced a twist gesture near a jar to indicate that he wanted someone to open the jar, this was iconic. He moved his

gesture toward the jar and produced a twisting motion. This is the same motion that someone would have to perform in order to actually open the jar except that they would also have to place their hand in contact with it. On the other hand, the verb movement produced by Supalla's subjects seems to be iconic only to a limited extent. When Supalla's subjects moved a verb sign, they first moved the verb toward the subject then toward the object (S. Supalla 1991: 105). This mirrors the real-world situation of something moving from the subject to the object. This would be relatively iconic for a verb such as "hit" in which the subject's fist moves to the object. These children were also observed to move verbs, such as YELL, which do not involve some visible thing moving from the subject to the object, and therefore this movement is not iconic. However, it could be argued that movement with verbs like "yell" is patterned after movement with verbs like "hit". Alternatively, the movement from subject to object produced by these children is could be the result of their SVO input. If this is the case, then iconicity is not needed to account for the movement of verb signs produced by these children; only a hypothesis for the rapid production of language is needed.

Simon's use of multiple inflectional morphology can also be accounted for by iconicity. The DUAL+REP and REP+DUAL multiple inflections that Simon produced patterned real-world actions. For the example of the man blowing out candles on cakes, the real-world situation for the DUAL+REP inflection consisted of a man blowing out a candle on one cake, blowing out a candle on a second cake, and then repeating this sequence again and again. Simon signed this by producing the BLOW sign toward a location representing the first cake, followed by a BLOW sign toward a location representing the second cake, and then repeating this sequence. This use of multiple inflections patterns the real-world situation more closely than the responses that his parents typically gave for similar situations. For example, in the above situation his parents might produce the BLOW sign toward a location representing the first cake, followed by a BLOW sign toward a location representing the second cake, and then produce the sign BACK-AND-FORTH.

Goldin-Meadow's subject David used handshapes to represent the semantic class, shape, or handgrip around an object. To represent an object moving, he used a handshape with a motion. This can also be accounted for by iconicity. Using a handshape which represents a property of an object while moving the hand patterns the real-world situation more than the alternative in which the handshape representing the object is not produced simultaneously with the motion. For example, David moved a C-handshape (meaning 'a curved object') in a linear motion to describe a toy turtle moving forward (Goldin-Meadow and Mylander 1990a: 341). This is more iconic than first producing the C-handshape to describe the shape of the turtle, then producing the linear motion with a different, neutral handshape. The first example is more iconic because it simultaneously describes the turtle and its action. The second example is less iconic because it separates the description of the turtle from the turtle's action, which were simultaneous in the real-world situation.

Gardner and Gardner's chimp Dar usually displaced his signs indexically rather than iconically. When Dar was asked where he wanted to be tickled or

groomed he sometimes replied by producing the sign TICKLE or GROOM on the part of his body on which he wanted to be tickled or groomed. This is iconic in that it patterns the activity of someone tickling him or grooming him where he wants to be tickled or groomed. This is also indexical because it is like a pointing gesture in that it indicates where he wants to be tickled or groomed, and the interpretation of the utterance is dependent on the location in which the sign is produced. Dar was also observed to produce signs on agents, instruments, and possessors. Producing a sign on an agent, instrument, or possessor is not iconic because it usually does not mirror action in the real-world. In real-world situations, actions typically move from an agent to a patient. Agents initiate an action, instruments help an agent carry out an action, and possessors participate in a relationship with an object but not an action. Producing a sign on an agent, instrument, or possessor does not reflect real-world movement. However, Dar's production of signs on agents, instruments, and possessors can be described as indexical. Dar produced the sign on whatever object the question asked about. When the question was WHO TICKLE?, Dar produced TICKLE on the agent the question was asking for. When the question was WHERE TICKLE?, Dar produced TICKLE on some part of his body, i.e. on the location the question was asking for. When the question was WHAT THIS (indicating a toy) DO?, Dar produced TICKLE on the object that the question asked about. When the question was WHOSE SHIRT?, Dar produced SHIRT on the possessor that the question asked for. The placement of his sign was dependent on the presence of whatever was being asked about and the interpretation of his sign depends on the context. Thus Dar displaced these signs indexically.

There are two possible explanations for the iconic vs. indexical use of gestures/signs by Goldin-Meadow's subjects and Dar, respectively. One explanation could be that Dar produced signs on people and objects, because his caregivers produced signs on him. Thus Dar had input for producing displaced signs. Goldin-Meadow's subjects, on the other hand, only had the spontaneous gestures of their parents as input and their parents might not have produced gestures on objects. However, a more plausible explanation is that this difference in iconicity vs. indexicality was the result of a difference in the situations in which these data were gathered. Dar was being asked questions, whereas Goldin-Meadow's subjects were trying to describe actions. In most cases Dar could answer the question he was being asked with a point or a point plus a sign. For example, when Dar was asked WHAT WANT? he could have pointed to the caregiver and then produced the sign TICKLE. Instead, he produced the sign TICKLE on the caregiver's arm. Similarly when Dar was asked WHOSE SHIRT? he simply could have pointed (or he could have used the correct ASL possessive pronoun, i.e. a flat hand with the palm facing the addressee). Instead, he produced the sign SHIRT on the possessor's shirt. The use of signs indexically is similar to pointing because they are both indexical, i.e. they both depend on the presence of the reference and call attention to the referent. Goldin-Meadow's subjects were not being asked questions, but rather they were trying to describe actions and specify participants in those actions. Most of these actions could not be described indexically, i.e. by producing a gesture on an object. For example, if a child wanted to describe a toy turtle walking across the floor, the child would need to use a

gesture which traversed some portion of space. Producing a gesture on the stationary turtle would not describe the turtle walking across the room. Thus Dar's indexical use of signs vs. Goldin-Meadow's subjects iconic use of gestures is probably the result of the different situations in which the data were gathered. An interesting question for further research is whether apes ever move signs iconically to simultaneously describe actions and specify participants.

I hypothesize that the form of the morphology produced by the groups of deaf children discussed in this paper can be accounted for by its iconicity. This can also account for the resemblance of the morphology produced by these children to ASL's morphology because some of ASL's morphology looks iconic. By proposing this hypothesis, I am suggesting that real-world situations are the basis for the form of the morphology produced by these children, however I am not suggesting that this is the basis for ASL's morphology, at least not synchronically. ASL's morphology has become grammaticalized and there are many agreement verbs that do not refer to an observable transfer of motion from one participant to another, e.g. TEASE, CHOOSE, and ASK. Furthermore, there is evidence that children who have ASL input acquire this morphology morpheme by morpheme rather than "in an analogue or holistic fashion" as a patterning of real-world situations (Newport and Meier 1985: 901). It seems that the hypothesis that the groups of deaf children discussed in this paper produce morphology that is based on real-world situations might be able to account for the form of their morphology and that the proposals about the rapid production of language would not be needed.

Iconicity can account for the forms produced by Goldin-Meadow's subjects without the proposals for the rapid production of language. The forms produced by Goldin-Meadow's subjects are based on real-world actions and do not seem to need a proposal for rapid language production to motivate their use. On the other hand, the proposals for the rapid production of language do seem to be needed to account for why Supalla's subjects and Simon produce simultaneous morphology rather than the sequential morphology of their input. The form of the morphology produced by Supalla's subjects and Simon could be accounted for by the hypothesis that the morphology they innovate is at least partially based on real-world situations; however the proposals for the rapid production of language are needed to account for the motivation these children have to innovate these simultaneous forms even though they have alternative sequential forms in their input. The proposals for the rapid production of language hypothesize that these children innovate simultaneous morphology so their production will be faster.

Bickerton claims that his language bioprogram is specific to humans. Therefore, his bioprogram should not be needed to account for the apes' productions. Indeed, Bickerton's bioprogram is not needed to account for the apes' productions because it *cannot* account for them. Both the OV word order produced by Chantek, and the morphological inflections produced by Dar cannot be accounted for by the bioprogram. The fact that Dar produces morphological inflections rather than always producing strings of signs can be accounted for by one of the above proposals for the rapid production of language if it is assumed that these proposals are not unique to humans. The form of Dar's morphological inflections

can be accounted for by indexicality.

Bickerton claims that protolanguage and language are distinct and that there are no intermediate forms between them. I have argued that properties of the gestures produced by Goldin-Meadow's subjects and the apes cannot be accounted for by Bickerton's protolanguage because Goldin-Meadow's subjects and the apes produce gestures which seem to be beyond properties of protolanguage in terms of morphology. However, it could be argued that Bickerton's protolanguage can account for the verb agreement and classifiers produced by Goldin-Meadow's subjects and the agreement morphology produced by Gardner and Gardner's chimps, because Bickerton claims that "the stronger the meaning element in a grammatical item, the more likely it is to appear in protolanguage" (1990: 126). The iconic and indexical use of agreement morphology by these children and apes and the iconic classifiers used by Goldin-Meadow's subject David are strongly tied to their meaning. The type of verb agreement produced by Goldin-Meadow's subjects and David's use of classifiers with motion gestures mirror actions in the real-world. The type of agreement morphology produced by Dar relies on context for its production and comprehension. Therefore the use of agreement morphology and classifiers in gestural communication could be argued to be accounted for by protolanguage, because in the manual modality agreement morphology and classifiers can have a strong meaning element. On the other hand, Bickerton states that protolanguage "will seldom if ever have ... any number- or person-agreement" (1990: 126), and that "it is inconceivable that a protolanguage without any formal structure should have invented 'pure' grammatical items such as agreement-markers" (1990: 185). Bickerton claims that grammatical items that have meaning include the following: negators, question words, quantifiers, conditionals, conjunctions, modal auxiliaries, pronouns, relative-time markers, and locative particles (1990: 120, 185). It could be argued that agreement morphology and classifiers in the manual modality have a stronger meaning element than in spoken languages because they can be iconic or indexical in the manual modality. However, it seems that agreement morphology and classifiers also have a strong meaning element even in spoken languages. For example, in pro-drop languages, i.e. languages in which sentences which would have a pronoun for the subject can occur without a subject pronoun, the agreement on the verb is the only indication of the person and number of the subject when the subject pronoun is not expressed. Since Bickerton claims that pronouns have a strong meaning element, why doesn't he claim that agreement morphemes also have a strong meaning element? Is it only because he has not found agreement markers in pidgins? Classifiers also have meaning since they are used to group objects with different properties such as size, shape, and use. Thus, Bickerton's reliance on grouping grammatical items into those which have "strong meaning elements" as opposed to those that do not is vague and seems to be an arbitrary distinction he makes on the basis of the types of grammatical of items that are found in pidgins.

6.2. Word order innovations

Table 7 is the word order portion of the table given at the beginning of section 6.

Word order innovations

Goldin-Meadow et al.: deaf children with no sign input
(1) OV order, David: OV and VS for transitive, SV for intransitive
Apes
(7) Chantek's OV order when the object was present

Table 7

Bickerton's protolanguage and bioprogram hypotheses cannot account for the word order innovations (1) and (7). However, Goldin-Meadow (1979: 175-176) provides a possible explanation for (1). She claims (citing data from Bloom et al. 1975) that in their acquisition of English, hearing children display an ergative system in terms of production probability: "intransitive actors resemble transitive patients in terms of production probability, and differ from transitive actors", which have a much lower production probability. This is the same pattern that she found in her deaf subjects. This suggests that there might be some innate predisposition for patients and intransitive actors to be produced more often than transitive actors by children acquiring language. She hypothesizes that this predisposition for similarity in production probability of intransitive actors and transitive patients could lead to similar patterns in word ordering, i.e. to an ergative system in which intransitive actors and transitive patients occupy the same position with respect to the verb, and in which transitive actors occupy a different position. Furthermore, she hypothesizes that the patient will be ordered first because it has priority over other semantic roles in terms of both production probability and ordering. This predicts the order OVS for transitive sentences and SV for intransitive sentences as produced by David in (1). However, she claims that children will not produce this word order if the language input contradicts it. Thus children learning English do not exhibit OVS word order because their input contradicts this word ordering pattern, while the deaf children in Goldin-Meadow's study have no such contradictory input (Goldin-Meadow 1979: 175-177).

On the other hand, children of pidgin speakers do not have input to contradict OVS word order either. Children of pidgin speakers may have many different word orders in their input, because speakers of pidgins tend to use the word order of their native language (Bickerton 1981: 18-20). Since the input to these children does not have a consistent word order, Goldin-Meadow's hypothesis would predict that children of pidgin speakers should have OVS for transitive sentences

and SV for intransitive sentences. However, this is not the case in creole languages. Bickerton's assumptions that agents tend to be placed first and that subjects and objects should be placed on opposite sides of the verb can account for the SVO order of creoles, but not the OV(S) order of Goldin-Meadow's subjects. Thus Bickerton's predictions for SVO word order cannot account for both the word order patterns of creole speakers and of Goldin-Meadow's subjects; for that matter, neither can Goldin-Meadow's hypothesis.

A possible hypothesis to account for these word orders would be that there is a tendency to consistently order words. It does not matter what the ordering is based on, i.e. this ordering can be based on form, the presence vs. absence of a referent, grammatical relations, or semantic roles. If words are ordered by grammatical relations or semantic roles, then there is a tendency in transitive sentences to have one argument on one side of the verb and one argument on the other. This tendency to consistently order words would account for Kanzi's ordering of lexigram-gesture sequences by form, Chantek's ordering of verb and object based on whether the object is present in the immediate environment, the SVO order of creoles, and the OV(S) order of Goldin-Meadow's subjects. However, this would not account for the lack of OVS order in creoles or for why Goldin-Meadow's subjects did not tend to produce SVO. This hypothesis would predict that there should be approximately an even distribution of SVO creoles and OVS creoles and that some of Goldin-Meadow's subjects should tend to produce SVO while others tend to produce OVS, but this is not the case. Thus none of these hypotheses can account for both the SVO word order found in most creoles and the OV(S) order produced by Goldin-Meadow's subjects. Further research is needed to find an explanation for why creoles are usually SVO, whereas Goldin-Meadow's subjects tended to produce OV(S).

6.3. An alternative to Bickerton's protolanguage/language dichotomy

I claim that the gestures produced by Goldin-Meadow's subjects do go beyond the properties of Bickerton's protolanguage in terms of word order and morphology but are more deficient in terms of the ability to use displaced reference and arbitrariness than the protolanguages that Bickerton describes. Bickerton's protolanguage hypothesis cannot account for a communication system that has properties which are beyond protolanguage, but that is also more deficient than protolanguage with respect to other properties, because he proposes a single characterization of protolanguage and a strict separation between protolanguage and language. I propose that there is no single characterization of protolanguage, but rather that there are a number of language-like properties each of which can vary in degree along its own continuum; I will call this the "continua of language" hypothesis. Both languages and communication systems that are not considered to be complete languages (such as pidgins) can have different degrees of various properties. For example, ASL has much more inflectional morphology than languages such as English and Chinese. Natural languages which have

native speakers have some point on these continua below which they do not go. Pidgins and other communication systems which are not considered to be complete languages have some properties which fall below the level required for a complete language.

The gesture systems produced by Goldin-Meadow's subjects are more distant from language than Bickerton's characterization of protolanguage in terms of the possibility for displaced reference. Thus I suggest that there is a continuum of displaced reference. Pidgins have a degree of displaced reference which is close to that of language. The gesture systems produced by Goldin-Meadow's subjects have a degree of displaced reference which is somewhere below that of pidgins. Bee dances have a degree of displaced reference which is even lower, because they are only able to use displaced reference to refer to food sources. Finally, displaced reference is practically non-existent in the predator calls made by vervet monkeys. On the other hand, the degree of inflectional morphology is higher in the gesture systems produced by Goldin-Meadow's subjects and the signs produced by the apes than in pidgins.

The continua of language hypothesis could be applied both phylogenetically and ontogenetically. Phylogenetically this hypothesis is consistent with an adaptationist view of evolution. This hypothesis suggests that language could have evolved by slowly acquiring higher and higher degrees of language-like properties. Likewise, ontogenetically this hypothesis suggests that children gradually acquire higher and higher degrees of language-like properties. P. Bloom's (1993) data that the decline in the omission of subjects by children learning English is more of a gradual transition than an abrupt change supports this hypothesis and suggests that there is a continuum for the overt realization of the subject.

In sum, the only innovation that can be accounted for by Bickerton's bioprogram hypothesis is Simon's movement rule. However, as suggested in section 5.1.3, this could also be accounted for by Simon generalizing the topicalization rule to other constituents based on the topicalization structures present in his input. I propose that the morphological innovations produced by the children and apes discussed in this paper can be accounted for by a proposal for rapid language production and the assumption that the morphology children and apes innovate is iconic and indexical. However the word orders produced by Goldin-Meadow's subjects, which are based on semantic roles, and Chantek's word orders, which are based on the presence vs. absence of an object, remain unaccounted for.

7. Conclusion

The innovations produced by these deaf children and apes in their gestural communication systems include the following: movement rules, word order, agreement morphology, classifiers, and the simultaneous use of more than one morphological inflection. Bickerton's bioprogram can only account for the innovation of movement rules. The gestural communication systems produced by the children and apes discussed in this paper contain morphology that is not found in

creoles, and therefore is not part of Bickerton's bioprogram. The simultaneity of this morphology can be accounted for by a constraint or tendency for rapid language production, and the form of this morphology can be accounted for by iconicity and indexicality. Contrary to Bickerton's hypothesis that there is a distinct separation between protolanguage and language and that there are no intermediate stages between them, I propose that the data from Goldin-Meadow's subjects and Dar provide evidence that there is no single characterization of protolanguage, but rather that there are a variety of continua along which language-like properties of a communication system can vary. Phylogenetically this hypothesis is consistent with an adaptationist view of evolution, and ontogenetically this hypothesis is consistent with a gradual acquisition of language. However, there is one unresolved problem: creoles usually have SVO word order, whereas many of Goldin-Meadow's subjects and Chantek produce OV word order. Further research is needed to account for this difference between word order usually found in creoles vs. the word order produced by Goldin-Meadow's subjects and Chantek.

Appendix

There have been arguments that what I have defined as verb agreement is in fact cliticization or non-linguistic, deictic gestures. Lillo-Martin (1986) uses criteria established by Zwicky and Pullum (1983) to argue that this is agreement inflection rather than cliticization. She shows that this phenomenon in ASL has the four characteristics that are more consistent with affixes than with clitics: 1) Affixes exhibit a high degree of selection, whereas clitics do not. Agreement in ASL is selective because there are classes of verbs which cannot occur with agreement morphology. 2) Arbitrary gaps in the set of possible combinations are more common with affixes than with clitics. Within the class of verbs that can occur with agreement morphology, some verbs can occur with both subject and object agreement, some verbs can only occur with subject agreement, and some verbs can only occur with object agreement. 3) Morphological idiosyncrasies are more common with affixes than with clitics. Lillo-Martin claims that for first person object agreement, final contact with the signer's body is optional. However, some verbs, such as SEND and FEED have a morphological idiosyncrasy in that final contact with the body is never realized. 4) Semantic idiosyncrasies are more common with affixes than with clitics. The agreement shown by some verbs moves from agent to patient, e.g. TELL, whereas the agreement shown by other verbs moves from patient to agent, e.g. TAKE. Thus, Lillo-Martin concludes that verb agreement in ASL is inflectional rather than cliticization (Lillo-Martin 1986: 44-48).

On the other hand, Padden (1990) considers verbs which can be produced with movement and/or orientation to indicate the person and number of an argument to be agreement verbs, e.g. GIVE and OWE, but she does not consider verbs which can be articulated at a locus (a point in space which is associated with a referent) in order to specify an argument, e.g. WANT, to be agreement verbs. Instead she claims that when the articulation of these verbs is displaced in space, they contain pronoun clitics. She bases this claim primarily on the fact that nouns and adjectives can also be displaced in space to specify entities. For example, the sign DOG can be produced three times in different places to specify three different dogs and their relative positions to each other. Padden argues that analyzing these as pronoun clitics is consistent with Zwicky and Pullum's (1983) claim that clitics show a low degree of selection with respect to what they can occur with, whereas affixes show a high degree of selection. These pronoun clitics show a low degree of selection because they can occur with verbs, nouns, and adjectives.

However, I am concerned with the movement or displacement of a sign/gesture in which the sign/gesture refers to an action or object and the added movement or displacement refers to some related entity. Both verb agreement and the use of pronominal clitics with verbs fall into the category of phenomena that I am concerned with. Therefore I will call both of these phenomena "verb agreement", and leave a detailed analysis of the differences between verb agreement, pronoun clitics, and the movement and displacement in the signs/gestures

produced by deaf children with no sign input and by apes for further research.

Liddell (1993, in press) also argues against a verb agreement analysis and claims that what has been called verb agreement is in fact non-linguistic, deictic gesturing. He claims that verbs do not move to some locus at about chest level in signing space, but rather that each verb has a particular height on the body to which it must move. For example, the verb GIVE moves toward the recipient's chest and the sign ASK moves toward the chin of the person being questioned. Furthermore, pronouns and verbs can move to an unlimited number of points in the signing space, because they can move toward any place a person or object could actually be. He argues that directing a verb sign toward a location cannot be considered to be a morpheme because 1) a grammar cannot store an unlimited number of location or direction morphemes, and 2) morphemes cannot have an indeterminant form. Thus he concludes that pronouns and the movement of verbs in ASL are non-linguistic, deictic gestures.

I do not think that the arguments that verbs do not have to move to a locus at chest level and that there are an unlimited number of points in the signing space toward which verbs can move are incompatible with a verb agreement analysis. The direction of movement, location in space, and/or orientation of a verb sign specifies one or more participants in an action, which may or may not be separately specified by a full noun or a pronoun (Lillo-Martin 1986: 65). In this way, the direction of movement, location in space, and/or orientation of a verb in ASL are similar to verb agreement in some spoken languages which have been called "pro-drop" languages. For example, the "pro-drop" languages Italian and Spanish have a subject agreement marker on the verb and do not require the subject to be separately specified by a full noun or a pronoun. Furthermore, I think that there are some problems with Liddell's claim that pronouns and the movement of verbs in ASL are non-linguistic, deictic gestures. Liddell's analysis does not account for why it is possible to move verb signs toward participants and why it is possible to move some verb signs but not others. Why not simply use verb roots and pointing gestures to indicate participants? His analysis also does not seem to be able to account for three findings made by Petitto (1986) in her study of the acquisition of pronouns in ASL: 1) Deaf children acquiring ASL go through a stage in which they stop pointing at people. If ASL pronouns are non-linguistic gestures why would the children suddenly stop pointing at people?. 2) When the children start pointing at people again, they only point within signing space, whereas their pointing formerly extended outside of signing space. If ASL pronouns are non-linguistic gestures why are they constrained to signing space? 3) When the children start pointing to people again they make errors, such as pointing to the addressee when referring to themselves. If ASL pronouns are non-linguistic gestures, why would children make these kinds of errors? Therefore, along with Lillo-Martin (1986), Meier (1982), S. Supalla (1991), and others I will call this phenomenon in ASL verb agreement.

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