Looking for structure: Is the two-word stage of language development in apes and human children the same or different?

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Abstract

Previously published corpora of two-word utterances by three chimpanzees and three human children were compared to determine whether, as has been claimed, apes possess the same basic syntactic and semantic capacities as 2-year old children. Some similarities were observed in the type of semantic relations expressed by the two groups; however, marked contrasts were also uncovered. With respect to the major syntactic mechanism displayed in two-word child language, namely word order, statistically significant differences were found in all three comparisons that were tested. These results indicate that chimpanzees do not exhibit the linguistic capacities of 2-year old children.

Keywords: language development, animal language, cross-species comparison, semantic relations, word order

In the 19th century it was demonstrated that man is not in a category apart from that of animals. Today it seems necessary to defend the view (before many psychologists) that man is not identical with all other animals – in fact that every animal species is unique . . . I propose that (man's) entire cognitive function, of which his capacity for language is an integral part, is species-specific. (Lenneberg, 1969, p. 642)

> The foundation for basic productive combinatorial symbolic communication, approximately what a human child does in the second year of life, is present in the two species of our most proximal clade, the bonobos and the chimpanzees. (Lyn, Greenfield, & Savage-Rumbaugh, 2011, p. 322)

Eric H. Lenneberg, widely known for producing what is arguably the most fully elaborated statement of the critical period hypothesis in his classic 1967 book, *The Biological Foundations of Language*, is also widely recognized as an early pioneer of the current biolinguistic approach to the study of language (Boeckx, 2013; Boeckx & Longa, 2011). Critical periods are hallmarks of biologically-based, species-specific behaviors (Newport, 2002) and, as the quote presented above makes clear, Lenneberg firmly held that the capacity for language is an exclusively human characteristic, one that is deeply rooted in biology.

Points of view concerning the species-specificity (or not) of language differ, of course, and research into the capacity for human-like language of a variety of animals, primarily apes but also dolphins and parrots among other nonprimates, has been on-going for several decades (e.g., Brakke & Savage-Rumbaugh, 1995; Fouts, 1975; Gardner & Gardner, 1969; Pederson & Fields, 2009; Pepperburg, 2014; Premack & Premack, 1972; Terrace, Petitto, Sanders, & Bever, 1979). However, it is the research involving *Pan paniscus* (bonobo chimpanzees) that is generally considered to have provided proponents for the linguistic talents of nonhuman animals with their best evidence (Anderson, 2004). In particular, Kanzi, the most famous of the bonobos, is reported to have "picked up" his linguistic skills spontaneously and without formal training (he was merely a witness to the training that his adoptive mother, a singularly "unlinguistic" ape, was undergoing), unlike all prior chimpanzees involved in language experiments who were expressly and extensively trained by their experimenters. Furthermore, two additional bonobos (Mulika and Panbanisha) and one common chimpanzee (Panpanzee) are also reported to have learned symbols without training (Savage-Rumbaugh et al., 1993). Observation of the apes' spontaneous communication as well as experimental investigation have led the researchers to postulate that chimpanzees follow and invent "simple syntactic rules . . . (and tend) to follow the ordering strategies of English" (Savage-Rumbaugh et al., 1993, p. 38), and generally possess productive abilities "in the arena of grammatical structure" equivalent to those of 2 year old human children, although "strong constraints – probably rooted in a smaller brain" prevent them from progressing beyond this level (Lyn, Greenfield, & Savage-Rumbaugh, 2011, p. 319). Effectively, the claim is that chimpanzees can reach a level equivalent to Brown's (1973) Stage I of early child language. Indeed, the above researchers draw several comparisons between their chimpanzee subjects and the children in Brown's study.

This position clearly runs counter to the biolinguistic approach which, while it fully endorses testing theories of language origin by identifying possible biological homologies and analogies of human linguistic mechanisms in nonhuman species (Fitch, 2010), nevertheless maintains both that the early acquisition by children of abstract syntactic knowledge can only result from a "genetic endowment of human beings that is responsible for the emergence of this remarkable linguistic capacity" (Narita & Fujita, 2010, p. 356), and furthermore that, as Chomsky says, "there comes a time when the (language acquisition) system just isn't working anymore" (as quoted in Bley-Vroman, 2009, p. 180). In short, such claims regarding the syntactic capacities of chimpanzees, if validated, would clearly pose a serious challenge to the biolinguistic claims concerning the species-specificity of language and its corollary notion of a critical period.

This paper, then, examines previously published corpora of two-word utterances produced by three chimpanzees (Greenfield & Savage-Rumbaugh, 1991; Lyn, Greenfield, & Savage-Rumbaugh, 2011) and compares them to the earliest available two-word productions of three human children, using the classic Brown (1973) data for Adam, Eve, and Sarah, from the CHILDES database (MacWhinney, 2000).

As is well known, Brown (1973) characterized Stage I child language primarily in semantic terms, and found that a set of eight "prevalent" two-term semantic relations (agent + action; action + object; agent + object; action + locative; entity + locative; possessor + possession; entity + attribute; demonstrative + entity) could account for approximately 70% of Stage I production (p. 178). In further characterizing Stage I language, Brown also listed three "operations of reference" (nomination, recurrence, and denial), noted that the modalities of interrogation, negation, and the imperative have their beginnings in Stage I (p. 180), and further noted that "word order seems to be the major syntactic mechanism controlled in Stage I English" (p. 203).

Pacesova (1981) provides a very useful and succinct summary of the grammatical patterns of Stage I English that express Brown's semantic relations:

> All the children evidently work on the expression of subject-verb-object relationships. Words in these roles are combined in subject-verb, verb-object, subject-object and subject-verb-object. Other productive patterns for most of the children are noun-locative, adjective-noun and demonstrative pronoun-noun. Word order is fairly stable, though inversion may occur in emotional speech. Personal pronouns are as yet rare, or completely absent. The grammar lacks provisions for copulas, prepositions and numerals. Inflection is not utilized. The constructions are simple and consist mostly of two or three morphemes. (p. 24)

The two key questions posed by this investigation are therefore:

1. Do the two sets of utterances resemble one another in terms of the semantic relations they encode?
2. Do the two sets of utterances resemble one another with respect to the major Stage I syntactic mechanism, namely word order?

An objection might be raised: Why should anyone expect English word order from chimpanzees who communicate by means of lexigrams, a set of abstract symbols made available to them by the researchers? The answer is two-fold: (a) The chimpanzees are exposed to a constant stream of Standard English input from caretakers who "conform to their English-based ordering strategy even in their gesture plus lexigram utterances" (Greenfield and Savage-Rumbaugh, 1991, p. 245). Illustrations are provided by Savage-Rumbaugh et al. (1993), who list 660 sentences spoken in scrupulously standard English that were presented to Kanzi and that ranged from "start a fire" (p. 115) to "take the telephone to the bedroom" (p. 153) and "can you get the orange that's in the potty" (p. 188). Examples of mixed spoken-English/lexigram input from Gillespie-Lynch, Greenfield, Lyn, and Savage-Rumbaugh (2011) include "you could PLAY with the ORANGOUTANs" (p. 453) and "PLAY hide with PANBANISHA and KAREN" (p. 451) (following the convention adopted in the chimpanzee research, words in capital letters designate lexigrams); (b) If the bonobos are truly functioning "in the arena of grammatical structure" at a level equivalent to that of a 2-year-old human child, then the word order test proposed above must surely be considered appropriate.

1. Method

1.1. The data: Chimpanzee corpus

As already mentioned, the data consist of previously published corpora for three chimpanzees and three children. The chimpanzee data were published in the appendices to two research reports, Greenfield and Savage-Rumbaugh (1991) and Lyn, Greenfield, and Savage-Rumbaugh (2011). In describing their approach to classifying the chimpanzees' two-element combinations, the researchers state that they followed "accepted methodology" (Greenfield & Savage-Rumbaugh, 1991, p. 241), citing Brown (1973) among others. The 1991 appendix presents a corpus of 717 spontaneous two-element combinations (that is utterances consisting of either two lexigrams or a lexigram and a gesture) produced over a five month period by Kanzi, a bonobo chimpanzee (*Pan paniscus*), beginning when he was 5.5 years old. The 2010 appendix presents two corpora, also of two-element combinations including mixed lexigram/gesture and a handful of gesture/gesture

utterances, one for Panpanzee (637 combinations), a common chimpanzee (*Pan troglodytes*), and one for Panbanisha (642 combinations), a bonobo chimpanzee. These data were also collected over 5 months, beginning when both were 3.5 years old. Kanzi's corpus consists of 51% of his total recorded combinatorial output during that period with most of the eliminated data having been dropped either because of the absence of a second observer to record context, or because they consisted of immediate imitations. Panpanzee's and Panbanisha's corpora represent the totality of their two-element utterances over the 5-month collection periods, also excluding immediate imitations.

The lexigrams, which provide the main medium for chimpanzee communication, are a set of geometric symbols, 392 of which are listed in Segerdahl, Fields, and Savage-Rumbaugh (2005). In the laboratory, the symbols are available to the chimpanzees on a computer keyboard. When a key is pressed, the selected symbol becomes brighter and a spoken word is produced by means of a speech synthesizer. In the field, laminated boards with pictures of the lexigrams are used, to which both chimpanzees and experimenters can point. The lexigram set comprises a large number of content "words" including many nouns (well over 200), a smaller number of verbs (under 70), and a few adverbs, adjectives, and prepositions. A certain number of additional function words are also included, such as some determiners, pronouns, and *wh*-words. In addition, some bound inflectional morphemes are supplied (e.g., *-ing*, *-ed*, "plural"). At the time of the studies, the three chimpanzees are reported to have had productive vocabularies ranging from 70 to 105 lexigrams. As already noted, the chimpanzees also make use of gestural signs. However, before these are discussed, the problem of how to count utterances needs to be raised briefly, with particular attention to the distinction between counting tokens and counting types.

In the present context, *tokens* would refer to the total sample of two-word utterances, including multiple instances of a single utterance, while *types* would refer to distinct utterances that fall into the same category. For example, thirty repetitions of "Mommy read" would count as thirty tokens of the agent + action category of semantic relations but as only one type, while "Mommy read" said twice and "dog play" said four times would count as two types (and six tokens) of the same category. It is instructive to note that two of the researchers centrally responsible for elaborating the "accepted methodology" purportedly followed in the chimpanzee research clearly make the token-type distinction. Thus, Brown (1973) specifically draws the reader's attention to the fact that the frequencies he presents for his "prevalent semantic relations" in Table 22 (p. 174) are for "multi-morpheme types (or distinct utterances as opposed to 'tokens')" (p. 184). Bloom, Lightbown, Hood, Bowerman, and Maratsos

(1975) do the same, stating that it is "the frequencies of semantic-syntactic re-lations in utterance types, not tokens" (p. 14) that are presented in their results in Table 2 (p. 15). Yet, the token-type distinction is never acknowledged in either Greenfield and Savage-Rumbaugh (1991) or Lyn, Greenfield, and Savage-Rumbaugh (2011), not even in Table 2 (p. 313) of the latter study. This table is labelled "the most frequent types of two-element combination constructed by Panbanisha, Panpanzee, and Kanzi," but all the frequencies presented in the various columns are actually token counts.

Why is such emphasis being placed on the token-type distinction? Because, as Ellis (2002) puts it, "type frequency determines productivity" (p. 166). That is, a higher number of distinct utterances encoding a particular relation or pattern makes it less likely that the pattern in question is being used as an unanalyzed "chunk," and makes it more likely that the pattern has been acquired produc-tively. Therefore, in assessing the extent to which learners may have acquired certain structural patterns, it is more useful to count types than tokens (although, of course, there are other circumstances when counting tokens will be called for). More generally, one could point out, it has been a long-held tenet of linguistics that the linguist "is interested in types, not tokens" (Lyons, 1977, p. 28), or, simi-larly, that "linguistics offers generalizations concerning sentence-types, not sen-tence-tokens" (Fiengo, 2003, p. 253). This study, then, will be careful to keep the reader apprised of the exact nature of any counts that are presented.

Returning to the topic of the chimpanzees' gestural signs, two aspects im-mediately stand out. First, the vast majority of mixed lexigram/gesture utterances follow a single pattern: lexigram-first, gesture-last. Table 1 illustrates this aspect.

Table 1 Frequencies and percentages of chimpanzees' mixed utterance follow-ing the gesture-last order

	Frequency	Percent
Kanzi	94	70.7
Panpanzee	114	82.0
Panbanisha	90	80.4
Combined	298	77.6

Note: These counts represent frequencies in utterance types, not tokens.

Second, pointing gestures, rendered as "that" and "you" in the Kanzi cor-pus, and as "indicates ___/dg" (where *indicates* is followed by an agent, object, goal, etc., and where *dg* stands for "deictic gesture") in the Panpanzee and Pan-banisha corpora account for the vast majority of the gestures used in mixed ut-terances. Another category of gestures, labelled "representational gestures" (or *rg* as opposed to *dg*), is described as comprising a few informal and American Sign Language gestures and includes signs for "go" (by far the most utilized of

the *rg* signs), "come," "hide," and several others. Strikingly, adding the token frequencies for the *rg* "go" to the token frequencies for the deictic signs yields totals that account for over 95% of the gestures used in the mixed utterances of all three chimpanzees, as can be seen in Table 2.

Table 2 Frequencies and percentages of different chimpanzee gestural signs

Signs	Kanzi	Panpanzee	Panbanisha
Deictic gestural signs:			
"that"	258 (58.8%)	–	–
"you"	133 (30.3%)	–	–
"indicates"	–	211 (82.1%)	216 (73.7%)
Representational gestural signs:			
"go"	26 (5.9%)	40 (15.6%)	63 (21.5%)
"come"	10 (2.3%)	2 (0.8%)	7 (2.4%)
all other signs	12 (2.7%)	4 (1.6%)	7 (2.4%)

Notes: These counts represent frequencies in utterance tokens. The deictic gesture "indicates" essentially consists of pointing at agents, objects, entities, and locations. This gesture was reported for Panpanzee and Panbanisha, but not Kanzi. However, Kanzi's two most frequently used gestures ("that" and "you") seem to be rough equivalents to the "indicates" gesture.

Greenfield and Rumbaugh (1990, 1991) and Lyn, Greenfield, and Savage-Rumbaugh (2011) argue that the gesture-last ordering strategy is evidence that the chimpanzees have invented a formal, linguistic rule. This argument can be critiqued on at least two grounds. First, the deictic gestures, which are used in 75% or more of the chimpanzees' mixed utterances, do not appear to be truly "linguistic" gestures. Take Kanzi's deictic "you"; it is quite different in nature from the pronoun "you" in American Sign Language. Indeed, while pronominal reference in ASL does make use of pointing, it crucially also involves establishing within the signing space in front of the signer's body a series of points of reference which identify the objects, persons, and locations which will be referred to (Friedman, 1975, p. 946). Furthermore, even though extending the index finger is the handshape most commonly employed for pronominal reference, at least eight other possible shapes are also available (Baker-Shenk, 2002, p. 205). It was considerations of this nature that led Rivas (2005) to conclude, after an examination of 3448 signed utterances by five veteran signing chimpanzees, that "there was no evidence for the use of YOU and ME as actual pronouns. . . (and that) THAT could not always be interpreted as a demonstrative" (410-411). Rivas then suggested that the gestures in question be referred to simply as "pointing" (413); clearly, such pointing can only be categorized as an extralinguistic feature of communication. Secondly, a modality-based rule that applies independently of the semantic-syntactic context is not a "linguistic" rule. As Anderson (2004) puts it, a combining principle which simply places the gesture in

last position is "as if, in English, we wrote the first word of the sentence, spoke the second, and e-mailed the third" (p. 42); such a principle might be intriguing, but it has nothing to do with syntax.

Therefore, this study will only consider the two-element combinations from the chimpanzee data that consist of two lexigrams. In addition to the more theoretical objections raised above, practical considerations also dictate this choice: With just two or three gestural signs accounting for 95% of the mixed utterances produced by Kanzi, Panpanzee, and Panbanisha, and with mixed utterances accounting for approximately 40% of total utterances, any attempt to uncover statistical evidence for syntactically driven word order will be falsified by the effect of the nonsyntactic "gesture-last" rule. Table 3 illustrates how the original total count for all three chimpanzees of 1996 utterance tokens is winnowed down to the 614 lexigram-only utterance types which are analyzed in this paper.

Table 3 Summary description of chimpanzee corpus

Name	Age (years)	Two-element utterances		
		All tokens	All types	Lexigram-only types
Kanzi	5.5 to 6	717	303	170
Panpanzee	3.5 to 4	637	326	184
Panbanisha	3.5 to 4	642	372	260
Total		1996	1001	614

Note. All data are drawn from the appendices in Greenfield and Savage-Rumbaugh (1991) and Lyn, Greenfield and Savage-Rumbaugh (2011).

1.2. The data: Child language corpus

As previously discussed, the child language data sets of two-word utterances are drawn from the CHILDES database (MacWhinney, 2000). Specifically, the following files were selected:
- for Adam: adam01.cha
- for Eve: eve01.cha through eve03.cha
- for Sarah: sarah001.cha through sarah007.cha

The earliest files available were selected to ensure that the children were clearly at Stage I. The difference in the number of files used for each child resulted from the considerable differences in overall length of the various files and in the number of two-word utterances contained therein. Two-word utterances were counted as follows:
- two-word sequence, followed by a period, or a question or exclamation mark: *tie shoe .*
- two-word sequence, followed by a pause: *tie shoe (.) Mommy .*
- two-word sequence as a retracing: *tie [/] tie shoe .*

- two-word sequence follows the expression "oh": *oh tie shoe .*

In all of the above examples, *tie shoe* would be counted as a two-word utterance. Below are two examples where *tie shoe* would not be counted:

- unintelligible material is present: *xxx tie shoe .*
- a pause occurs between the two words: *tie (.) shoe .*

In cases where two words appeared to be used as a single expression by the child, they were counted as a single word. This applied to expressions that were expressly coded as single lexical items in the files (e.g., *bunny+rabbit*), but also to a handful that were not (e.g., *sit down*). All utterances coded in the CHILDES files as imitations (IMIT) were eliminated.

As can be seen from Table 4, the final count in utterance types is almost identical to that for the chimpanzees. The mean length of utterance (MLU) values for Eve and Sarah are clearly within the Stage I range, whose upper limit Brown (1973) set at 2.00 (p. 249). On the other hand, Adam's MLU places him within the Stage II range (2.00 to 2.50), but his performance on two key Stage I morphemes (the progressive *-ing* form, and the plural *-s*) suggests that he is barely entering that stage. Out of Adam's 1263 transcript lines, only two, arguably three, contain true instances of the "primitive progressive, with *-ing* but no auxiliary" described by Brown (p. 318), two of which could be interpreted as imitations, even though they are not coded as such in the file, namely:

> Mother: *do you hear a horn playing?*
> Adam: *horn playing .*

> Mother: *you didn't watch where you were going.*
> Adam: *watch going .*

The following exchange provides an interesting contrast:

> Mother: *he's going out.*
> Adam: *he go out.*

In the third progressive *-ing* occurrence, Adam seems to be commenting on a story his mother is reading to him, when he says, *like Adam Adam swimming.* There are twelve more uses of the *-ing* suffix in Adam's transcript, but these involve constructions other than the progressive, including nine instances of *camping trip* where the present participle functions as a modifier, a construction which Brown specifically excludes in his scoring criteria for this morpheme (p. 259). As for the plural *-s*, it only occurs three times in *play checkers*, *no pictures in here*, and *dirty my hands*. In short, despite his slightly elevated MLU, Adam can still be

considered a high Stage I speaker who is beginning his transition to Stage II and his two-word corpus should still provide a reasonable basis for comparison with the chimpanzee data, especially as it is combined with those of Eve and Sarah.

Table 4 Summary description of child corpus

Name	Age	MLU	Two word-utterances	
			Tokens	Types
Adam	2:3:4	2.215	484	251
Eve	2:3:5-2:3:19	1.714	269	176
Sarah	2:3:5-2:4:10	1.820	380	215
Total			1886	642

Note. All data are drawn from the CHILDES database (MacWhinney, 2000). MLU = mean length of utterance.

2. Procedure and results

2.1. Semantic relations

In their appendices Greenfield and Savage-Rumbaugh (1991) and Lyn, Greenfield, and Savage-Rumbaugh (2011) assign all the two-element combinations in the chimpanzee corpora to several categories of semantic relations, seven of which are drawn from Brown's (1973) set of eight prevalent Stage I semantic relations, specifically:

1. Agent + action: *Adam put, Eve read*
2. Action + object: *put book, hit ball*
3. Agent + object: *Mommy pumpkin* ("*Mommy is cutting the pumpkin*")
4. Action + locative: *walk street, go store*
5. Entity + locative: *sweater chair, book table*
6. Attribute + entity: *big train, other room*
7. Demonstrative + entity: *that doll*

The missing eighth category is possessor + possession (e.g., *Mommy pumpkin* meaning 'Mommy's pumpkin'). It should be noted that in the chimpanzee studies, the category action + locative appears to be labelled action + goal, where "goal coded deictic gestures and substantive lexigrams *always indicated a place or location* [emphasis added]" (Lyn, Greenfield, & Savage-Rumbaugh, 2011, Appendix, p. 2). The chimpanzee demonstrative + entity category comprises exclusively mixed lexigram/gesture utterances, as does the agent + object category, leaving only five categories for comparison with the child data.

Nevertheless, once the child corpora of two-word utterances types were compiled as described in the preceding section, each utterance type was considered for assignment to one of all eight of Brown's semantic relations. Overall, it was possible to categorize 76.5% of the child utterance types, a proportion consistent with Brown's previously mentioned claim that his prevalent relations account for about 70% of most samples. An area of difficulty in the coding task involved locatives. As Brown describes them, "Stage I locatives are either the name of places or one of the pro forms" (1973, p. 194). However, as he further notes, the "pro forms" (the pro-adverbs *here* and *there*) often function as demonstratives. Thus one coding strategy might have been to classify N + pro-adverb sequences (e.g., *Cromer there*) under the entity + locative category, but to assign pro-adverb + N sequences (e.g., *there Cromer*) to the demonstrative + entity category. The problem is that the child's semantic intentions are not always made clear from the context. Such a structure-based strategy could then conveniently (from the perspective of the eventual word order analysis) assign N + (*here* or *there*) combinations to the semantic category whose expected syntactic frame would be N + locative, while equally conveniently assigning (*here* or *there*) + N combinations to the semantic category whose expected syntactic frame would be demonstrative + N (effectively, a DP), thus artificially inflating the children's word order scores. To avoid this unsatisfactory outcome, it was decided to treat all instances of *here* and *there* as locatives. The problem did not arise with respect to the action + locative category (expected syntactic frame: V + locative) as neither *here* nor *there* can properly function as demonstratives in two-word utterances that include a verb. Another "appropriate" way that *there* might appear in first position would be as an expletive. However, use of the expletive *there* does not occur in Stage I child language. Indeed, language acquisition studies concerning the use of expletive subjects (usually in the context of children's understanding of raising vs. control verbs) typically test subjects in the 3-5 year range (e.g., Becker, 2009).

The differences between the child and chimpanzee groups as a function of semantic relation were then tested by means of a two-tailed Mann-Whitney *U* test, using the probability tables for very small samples from Mann and Whitney (1947), reproduced in Popham and Sirotnik (1973, p. 394). The two-tailed test was applied because there were no a priori expectations as to the directionality that any differences might take. The results failed to reach significance for all five semantic categories.

As an examination of Table 5 shows, there is a great deal of variability in the proportional frequencies, both within and across the two groups. For example, within the child group, the proportion of total utterance types in the action + object category ranged from 0.079 to 0.283. Similarly, within the chimpanzee

group, proportions in the entity + locative category ranged from 0.092 to 0.181. Across the two groups, proportions in the action + locative category ranged from 0.028 to 0.173, with the higher proportions found in the chimpanzee group; meanwhile, results for the entity + attribute category went in the other direction, with a range from 0.046 to 0.167, with the higher proportions found in the child group. Such results are very much in line with Brown's (1973) own finding of considerable variation in frequency among the eight semantic relations (p. 179).

Table 5 Child and chimpanzee usage of different semantic relation categories: absolute and proportional type frequencies

	Agent + action	Action + object	Action + locative	Entity + entity + locative	Attribute
Human children:					
Adam	22	71	13	7	25
	0.088	0.283	0.052	0.028	0.100
Eve	17	23	5	9	10
	0.097	0.131	0.028	0.051	0.057
Sarah	4	17	7	33	36
	0.019	0.079	0.033	0.153	0.167
Chimpanzees:					
Kanzi	8	22	23	22	16
	0.047	0.129	0.135	0.129	0.094
Panpanzee	12	11	26	17	11
	0.065	0.060	0.141	0.092	0.060
Panbanisha	3	13	45	47	12
	0.012	0.050	0.173	0.181	0.046
Mann-Whitney	$U = 2.0$	$U = 1.0$	$U = 0$	$U = 2.0$	$U = 2.0$
U test (two-tailed)	ns	ns	ns	ns	ns

Note. ns = nonsignificant

It will be recalled that the first research question was: Do the two sets of utterances resemble one another in terms of the semantic relations they encode? The short answer is that this comparison uncovered no statistically significant differences; hence, with respect to this specific set of five semantic relations, the chimpanzees do seem to be functioning approximately at the level of a 2-year-old human child.

2.2. Word order

It is an accepted finding in the study of first language acquisition that children's two-word utterances in English almost always exhibit appropriate word order. Bloom (1970) and Brown (1973) remarked upon this phenomenon decades ago,

as did Tomasello (1992) about 20 years later, as do contemporary textbooks (e.g., O'Grady, Archibald, Aronoff, & Rees-Miller, 2009). Researchers such as Christophe, Nespor, Guasti, and Van Ooyen (2003) have even argued that 12-week-old infants can already discriminate between languages that differ in their word order. On the other hand, explanations for this phenomenon have varied over time, even just within the single tradition of generative grammar. For instance, in the context of early generative transformational theory, circa the "extended standard theory" period (Chomsky, 1965), Bowerman (1973) suggested that the "surface structures of most of children's utterances can be generated directly by the rules of the base component and do not require transformational modification" (p. 172). Later accounts took inspiration from transformational theory circa the "principles and parameters" period (Chomsky, 1981). For example, Gibson and Wexler (1994) proposed that the interplay between the settings of two parameters (specifier-head and complement-head) produces a language's basic word order, such as the English SVO order. Wexler (1998) further proposed his "Very Early Parameter-Setting" (VEPS) hypothesis according to which certain basic parameters (including the two just mentioned) are set by 18 months of age. More contemporary approaches in the generative grammar tradition draw from the minimalist program (Chomsky, 1995) and focus on the operation Merge to characterize the underlying architecture of children's early multi-word constructions. Thus, Yang and Roeper (n.d.) argue that the operations Asymmetric Merge and Label both directly capture the unique combinations found in early child language and predict word order invariance. At the same time, they consider that "minimalism has not supplemented the basic architecture of P & P for the task of language acquisition" (p. 2) and that the parameter-setting paradigm remains extremely useful in the language acquisition research context.

For the purposes of this paper it is the well-established fact of word order invariance in very early child language that matters most. That invariance is best tested in three of the five semantic relation categories presented in Table 5: agent + action, action + object, and action + locative. In terms of Gibson and Wexler's proposals, setting the specifier-head parameter will yield the SV order of agent + action, while setting the head-complement parameter will result in the VO order of action + object. The positioning of locatives (particularly adverbial locatives) is a controversial issue in linguistics, but if we limit ourselves to the Stage I locatives at hand, under an analysis such as Larson's (1988) which places the locative in complement position of the lexical verb within a vP shell, setting the head-complement parameter would also account for the V-locative sequence in the action + locative category. This is not to suggest that the child is generating an entire vP shell structure with several empty nodes but rather, along the lines of Yang and Roeper's argumentation, that the child is merging a V and a locative (either a noun or one of the two pro forms) with the latter in complement position.

As discussed above, the entity + locative category presents certain problems and will be disregarded in the word order analysis. Similarly, the entity + attribute semantic relation can fit equally well into two syntactic frames that yield opposite word orders: an adjective-noun sequence (e.g., *big truck*) and noun-adjective or noun-adjectival participle sequences (e.g., *dog happy, truck broken*). As Brown commented, "either order is likely to be heard, since the model language includes both the prenominal adjective (*Yellow block*) and the predicate adjective (*The block is yellow*)" (p. 197). To reiterate, then, the three semantic relation categories that offer the most straightforward material for comparing the word order strategies of children and chimpanzees are agent + action, action + object, and action + locative. The results of the comparison are presented in Table 6. The Mann-Whitney U test employed here was one-tailed as there was a strong expectation of directionality in the findings since, as already discussed, children's "violations of normal word order are triflingly few" (Brown, 1973, p. 156).

Table 6 Child and chimpanzee performance on word order in three semantic relation categories: proportion of utterance types in normal word order

	Agent + action	Action + object	Action + location
Human children:			
Adam	0.864	0.944	1.000
Eve	0.941	1.000	1.000
Sarah	1.000	1.000	1.000
Chimpanzees:			
Kanzi	0.750	0.818	0.435
Panpanzee	0.500	0.455	0.739
Panbanisha	0.667	0.615	0.667
Mann-Whitney U test	$U = 0$	$U = 0$	$U = 0$
(one-tailed)	exact $p = .050$	exact $p = .050$	exact $p = .050$

As can be seen, all three comparisons came in at the .05 level of significance; the contrast to the results in Table 5 is evident. The answer to the second research question, whether the two sets of utterances resemble one another with respect to the major syntactic mechanism that is present at Stage I, namely word order, is that they are not. Chimpanzees may be capable of cognitive operations involving certain semantic relations that also feature in the cognition of human children, but these results yield no evidence of a capacity for syntax on a par with that of 2-year-old human children at Stage I of their language development.

3. Concluding discussion

So far, the data examined in this study have led to two conclusions: (a) no statistically significant differences were found in the frequency with which three

chimpanzees and three 2-year-old children expressed five types of semantic relations in their two-word utterances, (b) significant differences in word ordering were found in the three patterns that were tested. The general conclusion, it was suggested, is that while human and nonhuman primates may share certain cognitive capacities, the ability to process language syntactically is not one of them.

That general conclusion may be further elaborated by examining qualitative data that were not included in any of the tables presented above. To start with, the complete absence of the possessor + possession category in the chimpanzee corpus stands out, especially when one notes, as Roeper (2009) does, that the first two semantic relationships to appear in child language are usually location and possession. In fact, Roeper even argues that possession can be demonstrated to be a part of the 1-year-old child's one-word grammar (p. 49).

Another marked contrast involves the sheer level of linguistic production: It only took child transcripts representing from 1 to 3.5 hours of conversation to yield a two-word corpus comparable in size to the chimpanzee corpus which, it will be recalled, was gathered over 5 months. Question making in general, and *wh*-interrogation in particular, also provide stark contrasts. As would be expected at Stage I, Adam's, Eve's, and Sarah's transcripts contain numerous instances of declarative utterances followed by question marks that indicate the rising intonation of a *yes/no* question (e.g., *Neil sit?*). As for the chimpanzees, they were regularly exposed to both *yes/no* and *wh*-interrogation by their experimenters, and had access to a "question mark" of their own, the lexigram rendered as QUESTION. However, only Panbanisha ever made use of this lexigram, and then only twice: "QUESTION YES" classified as a "Performative-Affirmative" (no gloss given), and "QUESTION REFRIGERATOR" classified as a "Performative-Entity," where Panbanisha is asking to go to the refrigerator (Lyn, Greenfield, & Savage-Rumbaugh, 2011, p. 309, and Appendix, pp. 14 and 18). The children all produced *wh*-questions. Eve used *where*; Sarah used *where* and *what*; Adam used *where*, *what, who,* and *why*. Even though lexigrams were provided for *where*, *what* and *how*, the chimpanzee corpus does not contain a single instance of their use.

Two more areas of the chimpanzees' "linguistic" production deserve particular scrutiny: the extensive use of conjunction in two-element combinations, and the very limited production of lexigram-only, three-element combinations, which also appear to rely on conjunction. Starting with the former, 144 or 23.5% of the total chimpanzee corpus of 614 two-word, lexigram-only utterance types presented in Table 3 above consisted of "conjoined actions" (e.g., GRAB PLAY), "conjoined attributes" (e.g., QUIET SCARE), "conjoined entities" (e.g., BANANA RAISIN), and "conjoined locatives" (e.g., GROUPROOM BEDROOM). While a handful of utterances in the child corpus that were designated as "unclassifiable" do seem to resemble such conjoined expressions (e.g., *coffee grape-juice*

or *pull ride*), these accounted for a tiny proportion of Adam's, Eve's, and Sarah's overall production; in fact, they accounted for a very small proportion of the unclassifiable category itself. Roeper (2009) specifically discusses the almost complete absence of conjunction at the two-word stage of child language, arguing that while conjunction might look like the simplest way to assemble two-word strings, the problem is that conjunction fails to make a structural distinction between those two words. That is, children are driven "to always 'merge' – to always build phrases where one element dominates" (p. 56), in short to display the basic structure of language in their earliest utterances. Children do this by performing the Asymmetric Merge and Label operations, but chimpanzees appear not to, as attested to by their word order performance and their extensive use of (symmetric) conjunction. Furthermore, their three-element combinations seem consistent with such an analysis.

Unfortunately, an extensive review of the chimpanzee research uncovered very few three-element, lexigram-only utterances that also came with glosses to help illuminate their possible meanings. A table supplied by Savage-Rumbaugh, McDonald, Sevcik, Hopkins, and Rubert (1986, p. 225) lists 25 three-element combinations (without glosses), only one of which consists solely of lexigrams, which suggests that three-lexigram utterances are very rare indeed. The four that were found are listed below, with their glosses:

1. T-ROOM SCARE NOISE (Brakke & Savage-Rumbaugh, 1995, p. 147).
   Gloss: Panbanisha and the experimenter are looking in the toy room when Panbanisha notices the noise made by the toilet in the bathroom.
2. SLEEP HUG MILK (Gillespie-Lynch et al., 2011, p. 450).
   Gloss: Panbanisha is vocalizing happily as the caregiver prepares milk for her nap.
3. CHASE BITE GRAB (Gillespie-Lynch et al., 2011, p.453).
   Gloss: Both Kanzi and Panpanzee produced this sequence to ask their caregiver to play with them by chasing, biting and grabbing them.
4. SHIRT ON BAD (Lyn, Greenfield, Savage-Rumbaugh, Gillespie-Lynch, & Hopkins, 2011, p. 68).
   Gloss: Panbanisha doesn't want to put her shirt on, and feels bad about it.

With such limited evidence, one can do little more than offer an impressionistic interpretation. However, impressionistically speaking, all four utterances strike this observer as displaying no more underlying structure than would result from simple, symmetric conjunction, certainly when compared with "typical" three-word sentences constructed by Adam, Eve, and Sarah, three of which are presented below

(each being the first three-word utterance, not counting potential unanalyzed "chunks" such as *I don't know*, taken from the child's first CHILDES file):

1. *alright look tv.* (Adam)
2. *read the puzzle.* (Eve)
3. *I broke dat.* (Sarah)

In a study to which this one bears some similarity, Rivas (2005) examined 3448 videotaped instances of signing by five chimpanzees who had been using signs in their communications with humans for several decades, including Washoe and others who had been studied extensively in earlier research (e.g., Fouts, 1975; Gardner & Gardner, 1969). It is important to note that these chimpanzees were exclusively taught to use signs based on American Sign Language and did not have access to other modes of communication such as the lexigrams employed by Kanzi, Panpanzee, and Panbanisha. A total of 2,366 utterances that did not contain imitations, or unclear or unidentifiable signs, were selected for analysis. Of these 474 were two-sign combinations, and another 307 involved three or more signs. The study addressed three research questions, the third of which is of particular relevance to the present paper: "What combinations of signs do the chimpanzees make and is there a semantic or grammatical structure in these sequences? Are semantic relations present and do order preferences exist?" (p. 405).

The basic conclusions reached by Rivas were: that there is no clear evidence of semantic relations in the two-sign combinations of the five chimpanzees; that utterances involving three or more signs are essentially repetitive concatenations of signs; and that no syntactic pattern is evident in the signing order of multi-sign utterances. Rivas summarized as follows: "The chimpanzees' combinations of signs show no internal structure, whereas humans combine words or signs in a semantically and grammatically structured way" (2005, p. 413). Rivas's second and third conclusions are fully in accord with this study's findings. The first conclusion, however, renders a more severe judgment on the chimpanzees' semantic capacities than does this study. The difference appears to be in the willingness to accept the coding schemes employed in categorizing the chimpanzees' utterances.

In carrying out the present study, some of the categorizing listed in the appendix by Lyn, Greenfield, and Savage-Rumbaugh (2011) did seem somewhat puzzling, as the two following examples may illustrate:

SLOW STRING: categorized as attribute + entity, with the explanation that SLOW is a way of asking permission due to caregivers' requests to go more slowly

OPEN DOG: categorized as action + goal (where "goal" actually refers to "place or location"), with no explanation offered.

Nevertheless, the overall coding seems reasonably appropriate and was not contested. Rivas, on the other hand, finds little correspondence between the sign combinations (and the semantic relations they embody) in his study and those reported earlier by the Gardners. To take just one example, the Gardners had reported action + object utterances such as EAT APPLE, but Rivas found that over half of the candidates for this relation type consisted of strings such as DRINK GUM or CLOTHES EAT, which he judged to be unrelated combinations.

Be that as it may, both studies essentially conclude that the two-word stage of language development in children and apes is different, and lend support to the contention by Hauser et al. (2014) that "animal communication systems have thus far failed to demonstrate anything remotely like our systems of phonology, semantics, and syntax, and the capacity to process even artificially created stimuli is highly limited" (pp. 8-9).

To place this conclusion in the broader context of the "animal rights" debate which has arisen in recent years, it is useful to turn to the *Cambridge Declaration on Consciousness* (2012) which was signed by a prominent group of cognitive neuroscientists and which states in part that:

> Convergent evidence indicates that non-human animals have the neuroanatomical, neurochemical, and neurophysiological substrates of conscious states along with the capacity to exhibit intentional behaviors. Consequently, the weight of evidence indicates that humans are not unique in possessing the neurological substrates that generate consciousness. Nonhuman animals, including all mammals and birds, and many other creatures, including octopuses, also possess these neurological substrates.

To argue, as Lenneberg did, that the faculty of language is a species-specific characteristic available only to humans, or to argue more narrowly, as Hauser, Chomsky, and Fitch (2002) do, that it is only the computational mechanism for recursion (effectively, the ability to perform multiple Merge operations) that is unique to our species is not equivalent to endorsing the classical Cartesian position on animals as unfeeling automatons undeserving of recognition as fellow creatures on this planet. It is entirely possible, indeed fully justifiable in this writer's opinion, to simultaneously accept the position articulated in the *Cambridge Declaration on Consciousness* and that presented in the writings of Lenneberg and his successors. Language is unique to humans, but human and nonhuman animals do share many other fundamental biological characteristics.

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