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MY WORDS FLY UP, MY THOUGHTS REMAIN BELOW. WORDS WITHOUT THOUGHTS NEVER TO HEAVEN GO.

Why Chimpanzees Can't Learn Language and Only Humans Can

By Herbert S. Terrace. Leonard Hastings Schoff Lectures. New York, NY: Columbia University Press, 2019. 248 pp. Hardcover, $28.

The title of this review is from Claudius in Shakespeare's *Hamlet*, but it is not meant to awaken in the reader Claudius's unrepentant killing of Hamlet's father or Hamlet's revenge. It is meant to set the stage for the role of words in language and their two possible uses, with and without thoughts.

What do words have to do with language? The author, Herbert S. Terrace, claims that words are an early and necessary building block for language. You ask whether the famous chimps like Washoe, Sarah, and Kanzi; Alex the parrot; and Rico and Chaser the border collies have language. Replies Terrace, have language? They don't even have words or "the ability to refer with names" (Terrace, 1985, p. 1011). For Terrace, "the evolution of language depends on the evolution of the ability to converse nonverbally and verbally" (p. 5). Terrace documents his thesis in this book, following up on his research with Nim (Terrace, Petitto, Sanders, & Bever, 1979) and given in three Leonard Hastings William Schoff Lectures at Columbia University. Although the lectures were given in 2012, the book includes material not covered in the lectures, is current in its coverage, and deserves the 2019 imprint.

Terrace is professor of psychology and director of the Primate Cognition Lab at Columbia University. Under B. F. Skinner's mentorship at Harvard University, he succeeded in training pigeons to learn to discriminate various stimuli with a minimal number of errors. He demonstrated both errorless color and geometric shape discrimination in pigeons by starting with an easy discrimination (e.g., two highly discriminable colors or shapes) and progressively made the discriminations more difficult (Terrace, 1963). This research could be used to justify pedagogical techniques such as teaching machines that would initiate learning with relatively easy exercises and gradually increase their difficulty. As an undergraduate, Terrace's research inspired me to use this technique of errorless learning to train rats to count. But that is another story for another time.

Words as a Rubicon

Applying a variation of a language Rubicon between *Homo sapiens* and other species, Terrace claims that only humans (and not other species) are able to learn that things have names and that these names (words) can be used as declaratives in conversation. Later, he builds on Chomsky's distinction between mind-independent and mind-dependent concepts by distinguishing mind-dependent entities and mind-independent entities (see Bickerton, 2014, pp. 79–80). For Bickerton, the ability to perform offline thinking would qualify the organism for carrying out mind-dependent thoughts, whereas being limited to just online thinking would be mind-independent behavior. Readers are warned that these definitions are reversed on page 161 of Terrace's description of this distinction, which might derail its understanding. But luckily, he clarifies the distinction on the next page, stating that "Without names they are limited mind-independent thoughts." In mind-independent thoughts, words can be used as imperatives, whereas in mind-dependent thought, words necessarily have a declarative function and putatively can be used in conversation.

Science is grounded in distinctions, and it would have been valuable to describe the family of characteristics that distinguish these two types of using words. By definition, imperatives are mind-independent and declaratives mind-dependent, but the imperative/declarative distinction might be viewed as fuzzy. What other properties might be considered to solidify the distinction between mind-dependent entities from other types of behavior? We would not demand necessary and sufficient features, but coherent family resemblances would be helpful. Displacement might be one characteristic of mind-dependent thought in that words are used to name and communicate about things that are not present. But we know that animals request things not present. Alex the grey parrot

would reveal his displeasure and frustration if he was promised a reward and then did not receive it. Table 1 is my attempt to characterize mind-independent and mind-dependent entities. Most of these distinctions will be familiar to readers, but some could be embellished. For example, primary representation is a direct semantic relationship between what's in the head and what's in the world. Secondary representation involves separating a primary representation from its world reference for hypothetical purposes (pretense) (Boles, 2019).

Given his agenda, it is important that Terrace account for all previous claims of chimps, birds, or dogs producing or understanding sentences without prompting. His challenge to the community of advocates for nonhuman language is to provide an unaltered videotape indicating that, indeed, nonhuman conversation without prompting occurs. He claims that no one has come forward with such a demonstration. As artificial intelligence improves and videos are more easily modified, however, we will have to be skeptical of videos showing various animals conversing, similar to fake videos of celebrities (Vincent, 2019)

Mind-Dependent Thinking

Terrace, of course, is critical of ape language research that might be interpreted as the use of symbols by chimps in a mind-dependent fashion. We review these studies along with Terrace's alternative account of the findings putatively illustrating mind-dependent thoughts in non-hominins. Table 2 lists empirical findings that have been interpreted to support the thesis that non-hominins use language in a manner similar to humans. Two chimps, Sherman and Austin, had to categorize other lexigrams with superordinate lexigrams for food and tools. The basic level lexigrams such as *banana* and *wrench* had not been previously associated with the two superordinate categories. The chimps both performed nearly perfectly across 28 items with just one error between them. Terrace states the chimps were not necessarily thinking about food or tools to categorize the food and tools items correctly. Rather, he claims their "choice was simply a choice between a food and a nonfood or between a tool and a nontool" (p. 58). Although it is true that correct performance could be achieved with a coarser categorization than food versus tools, categorization was clearly occurring.

Terrace's suggested modification to make the test definitive is to have three categories, for example, flowers, toys, and tools. In this case, the logic is that the chimp is forced to think in terms of the categories the experimenter intended. Even in this scenario,

TABLE 1. Fuzzy properties of mind-independent and mind-dependent entities. In mind-independent mapping, for example, the language user associates a name with a specific behavior of getting a reward. In naming, the language user knows the meaning of the symbol. These distinctions are fuzzy, not determinate. For example, imperatives are often mind-dependent but they can also be made in a mind-independent fashion

Mind-independent Entities	Mind-dependent Entities
Symbol to get Reward	Meaning of Symbols
Categorization	Naming
Specific Behavior	Category of Objects
Imperatives	Declaratives
Non-symbolic	Symbolic
Non-intentional	Intentional
Non-referential	Referential
Non-communicative	Communicative
Self-centered	Interlocutor-centered
Only to Get Things	Sharing Thoughts
Directed Instruction	Implicit Learning
Non-grammatical	Grammatical
Context-dependent	Context-independent
Individual Intentionality	Shared Intentionality
Non-Arbitrary Linkage	Arbitrary Linkage
Learning is Laborious	Learning to Learn
No Brain Plasticity Influence	Brain Plasticity Influence
Immediate Context	Displacement
Word as Object Specific	Word as Category
Self Recognition	Recognition of Outside World
No Pretense	Pretense
No Offline-Thinking	Offline-Thinking
Association	Symbolic Reference
Basic Requests	Information Transmission
Primary Representation	Secondary Representation
Imperative	Declarative-Expressive
Imperative	Declarative-Informative
Context-dependent Signals	Reference Independent of Context

however, the chimp would likely find a shortcut. First, the chimp could consider the flower category that has salient features that distinguish it from toys and tools. Then, if the object doesn't fit the flower category, the chimp could look for some set of properties that al-

low a perceptual distinction between toys and tools. This three-alternative task is not qualitatively different from the two-alternative task. Performance might always succeed without full-blown representations even with multiple categories. Using the criteria in Table 1, one might conclude that the chimps were exhibiting mind-dependent thoughts.

Another observation with chimps might inform the issue of mind-dependent thoughts. When shown two plates with different amounts of food, the task of a chimp named Sheba was to point to one of the plates. She learned, however, that the plate she chose with the larger number of food items always went to another chimp, Sarah, leaving Sheba with the smaller one remaining. The catch was that Sheba couldn't help but be attracted to and point to the plate with the larger amount of food. Given Sheba's unavoidable choice attraction to the larger amount of food, she had to be content with obtaining a smaller amount. An ingenious manipulation by Boysen, Berntson, Hannan, and Cacioppo (1996) involved covering the food on the plates and putting numerals representing the number of food items on the unseen plate. Having already learned the magnitude of the numerals, Sheba was able to point to the plate with the smaller numeral, so she would benefit from obtaining the larger plate of food. This demonstration would seem to be an instance in which Sheba was using names in a mind-dependent manner. She had to think that the numerical symbols referred to amounts of food, and that her choice referred to the plate of food that Sarah would receive, leaving the other plate for herself. Another interesting manipulation was to provide both the sight of the food and the labels simultaneously, which revealed that the label continued to overcome the tendency to point to the bigger plate of food (Boysen, Mukobi, & Berntson, 1999).

Sue Savage-Rumbaugh makes the argument that ape language researchers had an implicit belief that chimpanzees had the ability for symbolic reference (Dubreuil & Savage-Rumbaugh 2019, p. 123), but Terrace preempts their proposition since he claims that chimps do not name things. From Terrace's perspective, the chimp must necessarily carry out this task in a mind-independent fashion. Dubreuil and Savage-Rumbaugh (2019) discuss two important research findings that appear to run counter to Terrace's thesis that nonhumans do not use language to communicate. First, Lyn et al. (2011) consolidated a database of the 105,629 utterances for three apes (Kanzi, a bonobo [*Pan paniscus*]; Panbanisha, his half sister; and Panpanzee) and 4445 verbal utterances in archived data from two children who were

raised in a normal family and home environment. They evaluated how much spontaneity was present in both the ape and the child utterances. They included only social interactions and removed from the analysis imitations, answers to questions and tests, and undocumented utterances. About 74% of the remaining utterances in the ape database were spontaneous lexigram and gestural utterances. The children's corpus had a lower percentage of spontaneous utterances (54%). Tellingly, the apes generally had a much lower proportion of spontaneous declaratives (about 5%) than the children (about 40%). This large difference highlights that, although apes might have the biological capacity to declare, an early enriched environment might be necessary to increase the frequency of declaratives and to promote conversations. This enriched environment would encourage intersubjectivity and joint attention, to be described later, during the chimp's early experiences. The original authors emphasize, however, that both apes and children "used declaratives to name objects, to interact and negotiate, and to make comments about other individuals . . . comments about past and future events" (Lyn et al., 2011, p. 63). Although not documented in a video recording, this research offers evidence for declarative language in two bonobos and a chimpanzee.

Leavens, Bard, and Hopkins (2019) list several research findings of declarative-informative pointing from apes who had been nurtured in language-trained or in-home environments. For example, Chantek, an orangutan who learned sign language, could comprehend deictic pointing. Children don't follow a point gesture near them until about nine months and require yet another nine months of experience before they follow a pointing gesture to a location behind them. These authors also provide a compelling critique of negative findings, revealing that the studies had various confounds and the researchers had failed to sample their subjects appropriately. The confounds included different characteristics of the humans versus apes being compared—for example, their life histories—and procedural differences in the testing situation. They suggest that future research attend to cross-fostering of apes by humans, radical operationalism in terms of defining mental states in physical terms, training, and sampling of a wide range of species. As they point out, training of other species must be very extensive for comparisons with children.

Given the results in Table 2 and the limitations of previous negative findings, it might be premature to claim that only humans use words in a mind-depen-

TABLE 2. Compilation of evidence that might be taken to support mind-dependent naming in animals other than ourselves

Animal Skill	Accomplishment	Reference
Rico	Learned 200 words	Kaminski & Call (2004)
Rico, Chaser, Fast Mapping, Mutual Exclusivity	Learned new words by mutual exclusivity	Pilley (2014)
Chaser, Mutual Exclusivity	Learned new words by exclusivity	Pilley (2014)
Chaser, Learning to Learn	Learning new words became easier	Pilley (2014)
Chaser, 1200 Word Vocabulary	Acquired 1200 word vocabulary	Pilley (2014)
Alex, Turn Taking Conversations	Understood the turn-taking of communication	Pepperberg, I. M. (2009)
Kanzi, Implicit Learning	Learned Yerkish symbols and spoken words without direct instruction	Savage-Rumbaugh et al. (1993). Savage-Rumbaugh & Lewin (1994)
Kanzi, Following Spoken Commands	Could follow spoken commands	Savage-Rumbaugh et al. (1993). Savage-Rumbaugh & Lewin (1994)
Nim, Pretense	Used words to mislead interlocutor	Terrace (1979, 2019)
Nim, Communicative	Used words to replace behavior	Terrace (1979, 2019)
Nim, Context Independent	Used word out of context	Terrace (1979, 2019)
Sherman and Austin, Categorization	Categorizing foods and tools	Savage-Rumbaugh, Rumbaugh, & Boysen (1978)
Sheba, Productive Use of Word	Used word to control her behavior	Boysen, Berntson, Hannan, & Cacioppo (1996)
Database of utterances of 3 Apes, 5% spontaneous declaratives	Declaratives to name objects, to interact and negotiate, and to make comments about other individuals . . . comments about past and future events	Lyn, Greenfield, Savage-Rumbaugh, Gillespie-Lynch, & Hopkins (2011)
Chantek, an orangutan who learned sign language	Could comprehend deictic pointing	Leavens, Bard, & Hopkins (2019)

dent manner. Word use does not appear to be the language Rubicon that Terrace proposes. Remembering Elizabeth Bates, "The Berlin Wall is down, and so is the wall that separates man from chimpanzee. We are going to have to learn to live with relative differences and permeable borders. It will be hard, but I believe that the world will be the better for it" (Bates, 1993, p. 240).

Excursion Through the Chapters

After a short Prologue, Terrace's book has chapters entitled "Numberless Gradations"; "Ape Language, Recent Ancestors and the Possible Origin of Words"; "Before an Infant Learns to Speak"; "The Origin of Language, Words in Particular"; ending with a short Epilogue describing a documentary on Project Nim.

Numberless Gradations

Terrace begins by setting the Darwinian stage for his treatise on language evolution and its learning by any hominin in a language environment. He gives Skinner credit for extending his behavioristic approach to account for language behavior. This set the stage for Chomsky's renowned critique, of course. His two disagreements with Chomsky concern whether language appeared because of some mutation in our ancestors' evolutionary history, and Chomsky's concentration on grammar and neglect of the evolution and acquisition of words.

In his short review of comparative psychology, perhaps paving the path for skepticism concerning the chimp language research, he cautions us in overinterpreting results. For example, Kohler's famous chimpanzee Sultan supposedly showed insight in stacking boxes to reach a banana hanging overhead. Follow-up studies revealed that this behavior only occurred when a chimpanzee had experience playing with the boxes. This experience, however, should not preclude the possibility of offline thinking. For the cognitive scientist, there's no magic bullet like Time

on Task, when the task is relevant to the problem to be solved.

Terrace introduces his primary thesis that words must necessarily precede any facility in multiword utterances. We will delay the discussion of this thesis and its supporting evidence because he develops them more fully in chapter 4.

Ape Language

In chapter 2 on "Ape Language," Terrace reviews the ape language research and aims to convince the reader that apes and other animals such as border collies have not succeeded in learning and using language. In his Project Nim, a chimpanzee, named Nim Chimpsky, was tutored in American Sign Langue (ASL) by his caregivers and during his interactions with his many teachers. Terrace's goal was to create a corpus (an early idea of big data) of Nim's signing combinations, which included 20,000 combinations of two or more signs. Although Terrace claims that most of the signs in ASL are arbitrary, it should be noted that ASL, like British Sign Language, is highly iconic. Iconicity refers to a word symbol that resembles its meaning; for example, the spoken word *teeny* sounds small and means small. Even though many of the signs no longer have their original intended iconicity, there remains a good deal of iconicity (Perlman, Little, Thompson, & Thompson, 2018). Most importantly, iconicity facilitates word learning in children (Massaro & Perlman, 2017). Some of Nim's first words were highly iconic, including those for *drink*, *more*, and *up*, but Terrace claims he did not learn them as names. Perhaps children's first words are not immediately learned as names either. Helen Keller didn't realize words existed until age six after having experienced words spelled into her hand. Analogous to Terrace's claim that chimps do not use words in a mind-dependent manner, perhaps children don't either until they reach some developmental milestone.

Initially, Terrace's impressions of the Nim-Teacher interactions were that Nim was capable of creating sentences. One can easily empathize with Terrace's thrill of successfully proving that a chimp can indeed learn and use language. Luckily, for Terrace, he also stumbled on observing the teachers in these interactions and not just the chimp. We know we can easily miss a gorilla in our midst when we're counting ball tosses by others (Simons, 2010). Once Terrace focused in on the teachers, he saw that the words in Nim's combinatorial sentences were actually being cued by the teachers. Nim's utterances were often initiated by the teachers' preceding utterances and were often full or partial imitations of the signs of the teachers. We should applaud Terrace for not being blinded by confirmation bias and finding that gorilla in his midst.

This type of cueing for Nim was not a Clever Hans type of cueing, however, but was more subtle. From what I could discern, these cues were not always signs that Nim could imitate directly but rather could have provided an informative context for Nim to create his next sign in the dialog. In one illustration in which Nim putatively signed a request "me hug cat," the teacher signed YOU, and Nim signed ME; the teacher signed NIM and Nim signed HUG; and finally, the teacher signed WHO? and Nim signed CAT. From these contingencies, Terrace concluded that "me hug cat" was "a sequence of prompted signs, not a spontaneous sentence" (p. 44). Given that the prompting was not a Clever Hans type of prompting, we can perhaps interpret this exchange as a single-word conversation (see below).

Given the large variety of different unstructured combinations of signs, Terrace et al. (1979) concluded that Nim was not expressing semantic propositions in a rule-governed sequence of signs. Further, Nim's three-sign combinations were not informative elaborations of his two-sign combinations. Terrace et al. (1979) observed that the mean length of Nim's utterances was stuck below two signs and did not increase across a 19-month period. This result contrasts with children learning sign language whose mean length of utterance increases during a similar period by a factor of two or three.

It is interesting that none of Nim's teachers or other observers were aware of Nim's dependency on his teachers' signing and how often he imitated or interrupted his teacher. As the authors correctly point out, this analysis could have only resulted from scrutiny of videotapes of the interactions, and for other research to be credible requires the same type of analysis. The authors revealed similar prompting in a filmed dialogue between the chimp Washoe and Beatrice Gardner. In addition to the confounding of prompting, Terrace et al. (1979) propose that other demonstrations of multiword utterances do not necessarily show that the chimp understood all of the words in the utterance. For example, Sarah and Lana learned to produce specific sequences of words such as "Mary give chocolate Sarah," but this could reflect rote learning, which through Terrace's critical lens would not be mind-dependent thoughts. Terrace et al. make the important point that observing a chimp producing a sequence of symbols might seem mean-

ingful to us, but it might not be meaningful in the same manner to the chimp.

Terrace also critiques other language studies using apes. One of the most famous is Savage-Rumbaugh's prize student Kanzi. The bonobo infant Kanzi at nine months was being cared for by his adopted mother Matata, who was being explicitly taught a linguistic visual symbol system (Yerkish lexigrams; see Savage-Rumbaugh & Lewin, 1994; Savage-Rumbaugh et al., 1993). Kanzi learned this Yerkish language, but his adopted mother did not even with explicit instruction. This serendipitous result suggests that the greater plasticity of the brain is dispersed on youth and Kanzi's mother was at a disadvantage relative to her son. Kanzi learned the symbolic system implicitly and learned comprehension without having been directly schooled in production. Additional evidence followed soon after when Panbanisha, Kanzi's younger sister, began learning at birth, acquiring a more extensive vocabulary than Kanzi's.

Although Kanzi putatively could use lexigram symbols to make various requests without prompting, Terrace doesn't seem to address this skill directly but focuses on Kanzi's ability to follow spoken commands. This tack seems inconsistent because he does not consider comprehension as a valid measure of mind-dependent thoughts. For Terrace, production is the gold standard of language competence. In critiquing nonhuman language studies, Terrace observes that "It is misleading to evaluate linguistic knowledge with tests of comprehension" (p. 65). However, it seems somewhat unfair to discard comprehension as a measure of language ability, particularly because we have not settled on the best linguistic modality for other species. Eric Lenneberg (1962) documented an 8-year-old boy who did not develop an ability to speak but had normal comprehension of spoken language. In addition, there are children with dysarthria who have good receptive speech understanding without any speech production ability. Thus, maybe it is unfair to not consider comprehension as a measure of linguistic ability.

Kanzi's trainers had spoken to him in ordinary English as he was being taught and tested on the Yerkish symbols (Savage-Rumbaugh et al., 1993). Terrace challenges the claim that Kanzi indeed could understand spoken commands such as "Now go get your ball." One reason he gives is that the relations between an object and the required action were constrained. For example, Kanzi only had to understand the two words *milk* and *vacuum* to respond correctly to the command "Pour the milk on the vacuum." For Terrace, it was not necessary to understand the other words, *pour*, *the*, *on*. Although Terrace is critical of giving partial credit for pouring the milk on the floor, for example, there are plenty of completely correct cases, even in situations in which the instructions were given by a disembodied voice behind a one-way mirror (Savage-Rumbaugh et al., 1993). Also, Kanzi performed about as accurately as a control subject, a 1.5- to 2-year-old child of an experimenter. This child had been exposed to lexigram symbols beginning at around three months and participated in many of the training exercises for Kanzi.

Interlude: Are Single-Word Conversations Possible?

If words are the foundation for language, then someone with words should be able to carry out adumbrated single-word conversations. When Sue Savage-Rumbaugh was giving a tour of her Yerkes research institute, Panbanisha, a bonobo chimp, abruptly and repeatedly pressed three symbols on her portable keyboard. The symbols had been learned to correspond to *Mad*, *Fight*, *Austin*. Panbanisha pressed the symbols in different orders precluding a definite grammatical interpretation. Of course, I didn't learn much from just reading about this scenario. I predicted that Panbanisha was mad at Austin and that she had had a fight with him (or perhaps wanted to fight him). As an informed group member, however, Savage-Rumbaugh confidently interpreted this communication to mean that there had been a fight at Austin's. Indeed, later she learned that Panbanisha must have overheard a fight between two chimpanzees over the use of computer equipment. Could Panbanisha have believed that Sue was ignorant of this fight and that her symbol presses would inform Sue about this event?

Single word utterances would challenge the perceiver in a similar way to multiword utterances and, similar to multiword utterances, multiple bottom-up and top-down sources of disambiguating information would be used (Massaro, 1998). Savage-Rumbaugh had significantly more prior information than I did in interpreting Panbanisha's three words. She also had bottom-up information about Panbanisha's emotional and cognitive state when she was repeatedly pressing the symbol buttons. As Everett observes, "Language . . . is by itself insufficient for full communication and understanding without knowledge of an enveloping culture" (2009, p. 202). Within the framework of predictive coding, single-word utterances would be understood by a process that discriminates information to predict the most likely

event. As described by Ramscar & Port (2015, pp. 89–90), "uncertainty reduction lies at the heart of communication: Virtually every linguistic act—even saying, 'Hello!' – is intended to reduce a listener's uncertainty, whether about the world, about the thoughts and feelings of a speaker, or a speaker's sincerity, etc."

Although we might expect that single-word utterances quickly encounter a barrier in terms of what can be communicated (Hinzen, 2012), Daniel Everett (2017) proposes that even the most complex grammar can be expressed in a linear order. If we consider the exchange of single-word utterances as a linear order of words and gestures, then we could view a conversation taking place with only single-word utterances. But as language evolved, one can speculate that deixis was an important source of information if one-word conversations were taking place. We don't have to claim that these exchanges were "the most intricate achievement of language: the making of a claim of truth, which depends on configuring a full proposition and assigning it a truth value" (Hinzen, 2012, p. 258). We have reviewed evidence that both Nim and his teacher had the impression of conversing. Nim could mislead the teacher by lying, pretending he had to go to the potty. He also invented and used a clapping sign for CHASE ME, and when caught signed TICKLE. Although adumbrated, such interactions accomplish at least a proto-conversation: Nim claps, the teacher chases and catches Nim, and Nim signs TICKLE, and the teacher tickles Nim.

Herr-Israel and McCune (2011) studied five children who were using "successive single-word utterances" (SSWUs) before using multiword utterances. The children (age 1;3 to 2;0) were observed in play with their mothers. These one-word utterances occur for a short period before infants are able to produce multiword utterances. The results indicate that single words were functional in conversations with their mothers. Table 3 illustrates an example conversation from each of the five children. In one observation, Alice (1,5) pretends to feed a doll and her mother asks her, "Does she want a drink or something?" Alice replies "drink" and then after a pause adds the word "milk." It should be noted that successive single-word utterances are not simply unrelated words uttered in close temporal proximity (Branigan, 1979). Deictic gestures can also be used in single-word conversations. My 12-month-old grandson communicated a declarative-informative gesture by successively using a gesture and a spoken word. As a guest was intending to leave but was in no hurry while still talking, he pointed to the guest and then pointed to the open front door and uttered "out."

For Nim, single-word utterances might be particularly productive in sign language since this language usually embellishes single signs with facial and gestural features. Nim's mean length of utterance was only slightly more than one, which would be appropriate for a single-word dialog. In the scenario shown in Table 3, both the teacher and Nim are exchanging words in which Nim conveys the message request to hug the cat. Thus, single-word utterances might bridge minds of familiar conversants. To play devil's advocate, maybe Nim was having a conversation with his teacher with nothing more than single-word utterances. Thus, Terrace could be right that Nim could not compose a sentence but wrong that Nim could not use words in a mind-dependent fashion.

In order to obtain food, chimps were taught to request a tool from each other by touching the appropriate lexigram on their computer consoles, and were also taught to share the food they obtained. Sherman could request a tool from Austin, who was in a different room, to retrieve the food reward. However, when Austin selected the wrong tool, Sherman would agitatedly bang on the window and point to the toolbox in Austin's room. Terrace shrugs this result off because the chimps were motivated to obtain rewards. Perhaps the concept of reward should be broadened to include an adult's positive actions when an infant offers a toy or points to an object. These contingencies probably remain influential as full-blown conversations occur. Should we deny the participants language?

I would expect Terrace to agree that productive conversations between humans could occur with single-word utterances, perhaps with accompanying prosody and gestures. Given Terrace's thesis that chimps don't use words to declare, however, this form of conversation could not occur in other species. This possible distinction makes Terrace's grounding of language in words all the more exciting and perhaps testable. If indeed word order (syntactic constituency) is not a defining characteristic of language (Evans & Levinson, 2008), we could imagine single-word conversations embellished by gesture and prosody serving to fuse the social groups of our ancestors. Another reanalysis of Nim's big data might address the question of whether productive single-word conversations were occurring between Nim and his teachers. Nim, after all, did successfully achieve his request to hug the cat.

Following Frank (2016), we might interpret mind-dependent thoughts as words represented as associations between linguistic forms and concepts. Words would then be naturally used to make references to situational characteristics and to converse about the here and now and perhaps how even other things not present might be of interest. The word forms would have various tangible characteristics, which could include iconicity, in which the form of the word resembles its meaning. Given this framework, we might conclude that we are not alone in using words to engage in social communication. Kanzi, Alex, and Chaser are impressive positive examples of exchanging thoughts and feelings with another individual. Given that they could understand speech, it should also be noted that these three students provide a damning falsification of Berwick and Chomsky's claim that "but apes hear nothing but noise" (2016, p. 143). As pointed out by Frank, there is a potential for additional research to determine how closely other animals use words like human children. For example, will the child's or chimp's learning and use of words be influenced by the speaker's intention (Baldwin, 1991)?

As described by de Waal (2019), animals appear to experience and communicate emotions we usually believe to be unique to ourselves. De Waal touches on the increasingly popular relative theory of Happiness (Heck & Krueger, 2016; Parducci, 1965), which pinpoints inequity among members of a group as a major source of unhappiness. A dog will shake its paws at our request without any tangible reward. If this dog sees another dog rewarded with a tasty morsel for this same action, however, the unrewarded dog will refuse to play the game. Similarly, two brown capuchin monkeys placed side by side will perform a simple task for a small cucumber reward. But when one of the monkeys sees the other monkey rewarded with a grape (preferred by these monkeys), she will refuse to perform and even toss the cucumber back to the tester. Tomasello (2020), however, has claimed that the monkey is upset at the experimenter, a more understandable emotion. Not surprisingly, these results are more controversial than most and a cottage enterprise has blossomed on the question of aversion to inequality culturally and across species ("Inequity," 2020).

This adventure down the path of conversation with single-word utterances brings to mind two thoughts. First, Tarzan with his limited language was a credible character and could even marry Jane who spoke in complete sentences. Their relation-

TABLE 3. Example conversations from each of the five children with their mothers studied by Herr-Israel and McCune (2011) and anecdotal instances of a child and two chimpanzees.

Note that # means a pause

Alice (1;5) Context: the child pretends to feed a doll
Mother: does she want a drink or something?
Child: drink #
Child: milk

Aurie (1;8) Context: The child has a book and is sitting with her mother
Child: book, book
Mother: do you want me to read?
Child: read

Jase (1;11) Context: the child is playing with a toy hammer
Mother: can you hammer the wood?
Child: hammer #
Child: wood

Rick (1;10) Context: The child successfully opens a toy toolbox
Mother: there you did it
Child: did #
Child: box

Shanti (1;6) Context: the child forms a proposition through response to a question and clarification
Child: more, more
Mother. more juice, are you thirsty?
Child: cookie

Domi (1;0) Context: Guest leaving
Guest: talking at door
Domi: points to guest #
Domi: points to door
Domi: out

Nim Context (Terrace, p. 45): Teacher, Cat, Nim requests to hug a cat,
Teacher: you
Nim: me
Teacher: Nim
Nim: hug
Teacher: who
Nim: cat

Panbanisha Context (Dubreuil & Savage-Rumbaugh, 2019): was told Sue had necessary vaccines
Panbanisha: SHOT HURT?
Sue: No
Panbanisha: SEE, pointing to Sue shoulder

ship should not have been jeopardized if Jane was also constrained by uttering only single words. Second, and more importantly, perhaps we have been accepting the well-rehearsed language Rubicon too categorically. As a long-time critic of categorical perception and a promoter of the Fuzzy Logical Model of Perception (FLMP) grounded in fuzzy logic, an obvious interpretation is to assess the Rubicon fuzzily, as is the case for so many other concepts. After all, there is a river to cross and the different stages of embarking, sailing, and landing might succeed or fail. Perhaps single-word conversations or conversations with chimpanzees don't always land at the appropriate port of call but do embark even if they sometimes remain somewhat lost at sea. But all conversation is a continuing game of tag to reduce uncertainty (Ramscar & Port, 2015, 2016). Imposing a categorical boundary can only sharpen acrimonious debates about what qualifies as evidence and what doesn't. Perhaps we have to happily settle for an empirical inquiry in which we answer what linguistic feats occur and do not occur under what conditions (Greenwald, Pratkanis, Leippe, & Baumgardner, 1986).

Remembering Nim

Reviewing this book encouraged me to read Terrace's book *Nim*, which he described as "a personal account of a scientific project whose main goal was to teach an infant chimpanzee to use language" (Terrace, 1979, p. 4). Nim was adopted at two weeks of age by a woman with a large family and had cared for another chimp previously. She knew sign language and taught everyone in the family the initial signs for Nim to learn and other signs deemed basic to human communication. We are not given many details about Nim's first months with his adopted family, but their experience with the previous chimp indicated that the chimp's basic needs were no different from feeding, burping, and diapering a human infant. The goal for the project was to socialize Nim in order to have a well-disciplined chimp.

Nim was first instructed in the signs DRINK, UP, and GIVE, which are reasonably iconic signs. Bootstrapping Nim in these iconic signs may have facilitated his learning of sign language. At two months Nim was taught to sign by molding his hands into the configuration of the sign of interest. Nim mastered these signs as well as the signs for MORE and SWEET. Unfortunately for Nim, the adopted mother limited her role on the project and at ten months of age Nim was primarily tutored by a sign language teacher. This teacher believed that signs should be introduced in three stages: reception, production, and expression (making the sign in the appropriate context).

Terrace observes that "Nim was curious and expressive in an almost human way" (1979, p. 37). Terrace (1979) observed that "Nim had become well socialized, and his use of sign language had developed in many directions" (1979, p. 68). His signing seemed to increase interactions with others in the household. Nim loved doing the dishes, for example. An important milestone appeared when Nim learned the sign for YOU after having learned the sign for ME. Nim was now able to point to another person rather than touching the other person's chest. In one vignette, Nim saw several children in a nearby crowd (it was New York City), turned to them, signed YOU, and threw one of them a ball.

As Terrace (1979) remarked, Nim "appeared to have finally recognized the existence of an outside world, separate from himself" (p. 74). Nim's signing also became more sophisticated. Nim had learned the signs for SLEEP, to want to go to sleep, and DIRTY, to signify that he had to go to the potty. He then creatively extended these signs to change the situation he was in. If he was bored with a task, he could sign DIRTY, the teacher would rush to get him to the potty, and Nim would escape to do something more interesting. Nim also invented a clapping sign for chase me. He observed a group of people clapping, started clapping himself, and then ran off looking back at the group, with the intention of having teacher chase him. When caught, he rolled over and asked her to tickle him. Nim then used this sign with other teachers and in other situations.

Notwithstanding the anecdotal nature of this evidence, these examples should at least challenge us to understand the differences between mind-independent and mind-dependent thoughts. By some criteria, Nim seems to have acquired the skill to name mind-dependently. Unfortunately, over four decades later, we have yet to convincingly counter Terrace's conjecture that "Nim's impressive achievements will not prove to be the last word."

Recent Human Ancestors and the Possible Origin of Words

Chapter 3 provides a tutorial on the study of our recent ancestors and how language may have come to be. Terrace describes how bipedalism preceded the increase in brain size by millions of years (Boles, 2019). Following Bickerton (2014), he claims that the advent of words emerged when our ancestors, having evolved large brains, had to scavenge meat from kills

of other animals. A scout would require some semblance of words and perhaps grammar to alert and guide his tribe to the kill and feast. Following Darwin, vocabulary would be passed on only if it increased the likelihood of survival (relative to near relatives who lacked words). However, it seems that language would have survival consequences long before and after this desperate need for meat. Bickerton (2014, p. 54) is critical of explanations of "unspecified 'social pressures,' since these are never spelled out in sufficient detail to enable discussion." However, we can envision words contributing to survival more generally by contributing to group cohesiveness and productivity. Individuals in a linguistic group would necessarily have an advantage over non-linguistic ones. For example, it is more efficient for a village to raise a child when language can mediate their shared care and survival. Respect for parental investment in offspring can be more easily negotiated with language than without it.

Hrdy (2011) makes a strong evolutionary case for alloparenting, which putatively came along well before other attributes like a big brain. The occurrence of alloparenting—caring for the young of others—might be interpreted as reciprocal altruism, a concept initially developed by Robert Trivers (1971) to explain the evolution of cooperation as instances of mutually altruistic acts. This type of behavior could easily generalize to caring for the young even if the young do not reciprocate at some later time. In addition, intersubjectivity is related to cradling, in which the mother must spend extended time with her child who is not yet capable of fending for herself. In the parent self-help book *The Happiest Baby on the Block*, the pediatrician Harvey Karp (2003) describes what he calls the fourth trimester, in which the infant is dependent on her mother's care because birth had to occur early before the infant's brain grew any larger, the size of the mother's pelvis providing the major constraint. According to Hrdy (2011), Beebe and colleagues (1985), and Terrace (2019), cradling and related mother-infant interactions bootstrap the infant into communication, establishing a firm foundation for language learning.

Before an Infant Learns to Speak

As early as 1979 and certainly in 1985, Terrace was convinced that only children and not chimpanzees learn words. But there wasn't an obvious explanation. Now there is, and Terrace now has an answer. Why do children learn words but not chimps? At the time of Nim's enculturation, developmental psychologists hadn't yet incorporated the seminal studies of Condon (1979) and others. Following studies that videotaped conversations between two adults, recordings were made between a mother and her young infant. Beebe et al. (1985) found that mother and child negotiated phasic engagement with one another. One of the most significant findings, however, was a correlation between coordinated interpersonal timing at four months of age and cognitive development and attachment. Given these more recent findings, Terrace claims two specialized attributes that provide the infant a foundation for language learning. The first is what Terrace dubs intersubjectivity. Like other nonhuman primates, human infants establish a strong attachment to caregivers, but they also uniquely "develop a reciprocal communicative bond, in which they take turns sharing gaze and emotion" (p. 113). As Susan Hrdy claims, "Brains require care more than caring requires brains" (Hrdy, 2011, p. 176). Given that Terrace (2019) believes that both intersubjectivity and joint attention "are uniquely human" (p. 113), it would have been informative for Terrace to now reflect on how Nim's almost four years in a signing environment were missing these processes. An even more exciting scenario would have been whether Nim could have been enculturated with human-directed intersubjectivity and joint attention.

Approaching their first birthday, infants learn to share their attention with caregivers to external objects. That stage is called joint attention. Joint attention is a reciprocal communicative bond of an infant with a caregiver that involves the mother and child jointly viewing an object such as a toy. The couple then shares this experience with each other by smiling or some other acknowledgement such as pointing. Now when the mother labels the toy, the child more easily knows that the name necessarily refers to the toy. Although we can expect various differences across cultures in terms of how joint attention is negotiated, it seems to be pervasive in all of the studies that have been completed (Kinard & Watson, 2015; Morgenstern, 2015). Although eye gaze and eye gaze following are usually highlighted as engagement techniques, infants and caregivers use a variety of modalities including touch, vocal, and postural interactions (Akhtar & Gernsbacher, 2008; Akhtar & Jaswal, 2019). Yu and Smith (2013) showed that 1-year-old children also attend to manual engagement of objects by either or both the caregiver and the child.

Children become highly sophisticated with utilizing various situational cues for interpreting linguistic

intent of their interlocutors. At about 18 months, a typical child might comprehend a few hundred words and produce a few dozen (Massaro & Rowe, 2015). In a creative study, Baldwin (1991) presented novel labels to children focused on a particular object. In one case, the adult looked at the object the child was focused on and uttered a novel label. In the other case, the adult looked at and named another object. The child learned the names for objects within the child's focus of attention but did not get misled by the adult's label when the adult was looking at another object. This research shows that infants of roughly 18 months with a fairly limited vocabulary can navigate the conversational interaction to understand whether a label is relevant to the object they are focused on. We expect that they are influenced by multiple sources or cues in the conversational environment to understand and to learn vocabulary. This is consistent with other research that shows that children can learn words when they overhear them in others' conversations (Ahktar, Jipson, & Callanan, 2001).

Considering intersubjectivity and joint attention, Terrace believes that intersubjectivity develops sooner and necessarily precedes joint attention. Terrace believes, however, that "Both stages are uniquely human" (p. 113). Given this conjecture, it would have been illuminating for Terrace to reflect on how much these stages were missing in Nim's interactions with his caregivers and teachers. Even if the stages are uniquely human, perhaps they can be described in behavioristic terms. Learning theory has advanced dramatically since Chomsky's critique of Skinner's empiricist description of language learning. Prediction and surprise are inherent components of association learning. The infant could be rewarded by stimulation contingent on the child's action. These associations would be learned and remembered robustly (Heyes, 2018, p. 71; Rowe, 2020).

As most of us are prone to do as long-term members of WEIRD (Western, Educated, Industrial, Rich, and Democratic) societies, Terrace fails to acknowledge that intersubjectivity and joint attention might not generalize to the preponderance of non-WEIRD cultures. David Lancy (2015) has made this argument most convincingly (see Bjorklund, 2016). He distinguishes between gerontocracies and neontocracies. Gerontocracies, such as agrarian societies, view infants as a cost to society, and parents expect their children to be in their debt. Our children in a neontocracy society, in contrast, are valued and must be protected and nurtured regardless of cost. Heyes (2018) describes this commitment as our extreme

tolerance for children relative to other primate species. Given observations of non-WEIRD societies, we can ask how pervasive intersubjectivity is when Pashtu (nomadic pastoralists in Afghanistan) mothers seldom make eye contact with their infants when nursing unless a problematic event occurs. Their custom is that a mother should not be overly fond of her child (Lancy, 2015). To what extent would joint attention be compromised when Tahitians find their children less amusing and even annoying (Lancy, 2015, p. 135)? East African Gusii mothers ignore their infant's vocalizations, and rarely look at or speak to them even during breastfeeding (Lancy, 2015, p. 1). Given the variety of infants' experience in different societies, we should remain open to the question of whether intersubjectivity and joint attention are necessary conditions for language learning (Akhtar & Gernsbacher, 2007).

In addition to huge cultural differences, there is also the puzzle of language learning in various unique conditions. Autistic children have particular difficulty in participating in the triadic situation of caregiver, intended object, and the child. A recent study found that children later diagnosed as being on the spectrum showed normal receptive joint attention but initiated joint attention much less often (Nyström, Thorup, Bölt, & Falck-Ytter, 2019). Even so, many children on this spectrum acquire both understanding and production of language. Children with Down Syndrome, a genetic condition, have significant delays in cognitive and motor development as well as language. Supposedly, however, they appear to engage in joint attention. Thus it might be puzzling that some children on the spectrum will advance in language skill more easily than children with Down Syndrome. Children with Williams Syndrome, another genetic condition, display strong social motivation accompanied by impressive language skills. However, they fail at joint attention situations that pose no problem for children with Down Syndrome. We don't yet have an understandable link between joint attention and language acquisition. Behavioral science has traditionally been saddled with the inadequacy of models of "normal" outcomes for understanding special cases.

Helen Keller, becoming blind and deaf at 19 months, remarked that deafness was a much more challenging burden than blindness. Deafness poses a barrier to spoken language acquisition, whereas blind children acquire language with relative ease. Joint attention is somewhat challenging given no visual cues, but the children learn to exploit other cues

from sound, touch, and memory of typical encounters. Non-sighted children might have some difficulty with difficult phonetic distinctions that are more easily seen on the face and therefore serve as an aid to sighted children. Deaf children raised in a signing environment acquire language normally even though joint attention is more challenging given that the triadic relationship must be primarily visual. If a Deaf child points to an object, her caregiver might sign the name of the object while having the child look at her and then at the object. The Deaf child must share visual attention across the symbol, the caregiver, and the object, whereas the hearing child benefits from having the caregiver articulate the sound of the symbol during the presence of the visual object.

The Origin of Language, Words in Particular

Much of the content of this review has already addressed much of the material in this chapter, so these few remarks are meant to offer a retrospective about the controversial issues of language and human uniqueness. Terrace in this chapter gives a detailed hearing of Chomsky's position and criticizes it primarily because grammar without words would be impossible. Terrace describes Chomsky's distinction between internal and external language. Internal language is an innate function that supports thinking with discrete units of meaning, "atoms of computation" (Berwick & Chomsky, 2016, p. 66). External language occurs via a sensorimotor system that generates expressions that provide a semantic/pragmatic interface. The atoms of computation become words with phonological and morphological structure during this externalization process. Terrace's major criticism is that Chomsky has not accounted for the origin of words and how they are acquired by children. Of course, Chomsky hasn't given a convincing account of the origins of grammar or how it is acquired. Judging Chomsky, however, is a lost cause because he embodies an interminable moving target. Terrace's distinction between mind-dependent versus mind-independent entities seems analogous to Berwick and Chomsky's distinction between uniquely human lexical items/concepts and forms of communication by other animals. The tenet that Terrace, along with the overwhelming majority of linguists, seems to embrace most is a central role for grammar once words are acquired.

Advocates of the human uniqueness of language use remind me of my earlier experiences in speech perception (Massaro, 2015). They would reason that quail perceive speech categories, but they are doing it differently from humans. Analogously, they could reason that Kanzi, Alex, and Chaser appear to understand sentences but they are short-circuiting the process by perhaps not understanding each of the words in the sentence, or that the relations between an object and the required action was constrained. Similarly, Terrace remarks that although an ape's signing might be meaningful to us, it's not meaningful in the same way to the ape. However, more extant views of language processing (e.g., Ramscar & Port, 2015) would highlight more commonality between humans and other animals. For example, Anderson (2016) observes that "Language works by presenting and manipulating cultural affordances that will cause one's dialog partner(s) to see and do what the speaker intends to be seen and done."

Not to cast aside our English teachers, but perhaps it is apropos to rethink grammar as a fundamental framework for understanding language use. As illustrated by our examples of single-word conversations, multiple sources of influence are endemic to language use, not only proximal factors but the nature (child, adult, or chimp) of the interlocutors, their culture, and the situational environment. Of course, languages and cultures have evolved various formalisms in language use that facilitate linguistic exchanges. As noted by David Barash (2019) in his review of Terrace's book, Nim's relatives might be given more credit if we observed what they do in their natural environments. For example, although perhaps only a proto joint attention, chimps in the wild will watch and soon imitate their mothers gainfully using a stick to attract termites from inside their nest (e.g., Musgrave, Morgan, Lonsdorf, Mundry, & Sanz, 2016).

As convincingly argued by Edelman (in press), "Language has emerged, and continues to evolve, under evolutionary pressure to serve as a set of tools for dynamically and occasionally strategically influencing the behavior of others." Following this logic, it is also necessary to revisit the imperative/declarative distinction. Why delegate imperative uses of language to the dustbin? Having already identified the imperative/declarative distinction as fuzzy, it seems necessary to bring imperatives into the fold of language use. For both so-called declaratives and imperatives, adults, children, and chimps are not simply declaring but attempting to change the behavior of their interlocutor partner(s) in crime. Imperatives continue to flourish even when the interlocuters converse with shared intentionality and theory of mind. This reawakening to language use perhaps might begin to

dissolve a Rubicon between human and non-human communication. Frans de Waal (2019), a noted primatologist who captivated a wide audience with his video of Mama's Last Hug (Van Hooff, 2019), is also critical of scientists seeking a Rubicon that distinguishes us from other animals.

On the other hand, Terrace appears to have the odds in his favor, at least in our lifetimes. He observes the sheer delight a child has in naming things in their shared world. Originally, language might have provided an *experimentum crucis* for nativist empiricist debate. Language could very well be unique to hominins, but that doesn't make it innate. We expect that the social environment would influence declarative communication. We reviewed some evidence chimps reared in a human social environment make and understand declaratives. Single-word conversations might have been sufficient for a long period in the lower Paleolithic, but with increased urbanization and aquiculture, more communication and conversation were advantageous, and Darwinian principles led to various behaviors. This might have given prominence to intersubjectivity and joint attention. These behaviors might be well-explained by behavioristic principles and could bootstrap full-blown language communities.

Epilogue: A Personal Touch

In an epilogue, Terrace describes how a well-known filmmaker made a documentary about Project Nim in 2010. Although Terrace discussed the science motivating the research and its results with him, "the documentary ignored the science that motivated Project Nim and the implications of its negative results" (p. 175). Even more sobering, the released film "was mainly an ad hominem attack on me that consisted of interviews with Nim's teachers" (p. 178). The film implied that Nim was returned to the primate colony because he failed to learn sign language. One can easily empathize with Terrace's distress having his innovative research from over three decades ago being used in this negative way and situating him in a bad light; he even received hate mail. I recommend the documentary because it reveals a change in our mindset about how we engage with other species and it alerts scientists to be more cognizant of how others will view their research.

Terrace concludes his book by acknowledging Nim: "He deserves a place in history for sharing himself and his abilities in the pursuit of what it means to be human and for helping us to understand what he and his descendants are and are not" (p. 178).

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THE FADING OF A BAD IDEA

The Mismeasure of Minds: Debating Race and Intelligence between Brown and *The Bell Curve*
By Michael E. Staub. Chapel Hill, NC: The University of North Carolina Press, 2018. 232 pp. Hardcover, $29.95.

The members of each animal species vary in biological and psychological properties. The students of non-human species managed to arrive at the consensual criterion of fitness, or reproductive success, to rank the relative importance of each property. They also agreed that a blending of local ecology with the animal's genome made the major contribution to fitness. It is difficult, however, to assess the relative contribution of each in a non-experimental, natural setting.

Fitness does not work as a criterion for ranking human traits because our species cares more about their own and others' status in a community than about number of offspring. Historical events regularly alter the traits that are awarded higher status depending on place and time. The properties have included strength, endurance, courage, ability to dominate others, land owned, leadership, piety, membership in a priestly group, family pedigree, oratorical or writing skills, wisdom, wealth, and, after industrialization, a technical talent that most of the time required outside schooling.

The twentieth century brought increasing numbers of youths pursuing careers requiring at least 12 years of schooling or a college degree in order to learn a marketable technical talent. This new social setting made families more concerned with the quality of the schools their children attended. Because more afflu-