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Language Is Complex

Rick Dale*, Jennifer Roche, & Nicholas Duran

University of Memphis, USA

ABSTRACT

In this commentary, we consider three good ideas from *Verbal Behavior* that have become central to some recent cognitive theories of language learning and use: social contingencies, multiple causality, and piecemeal syntactic growth. Following this, we identify two weaknesses of the book that may still invite new avenues of application of a behavioral framework to language: comprehension precedes production, and the vast complexity of syntax in normal usage. We end by briefly considering how behavioral, cognitive, and other frameworks should seek ways to integrate in an attempt to tackle the daunting complexity of language behavior.
Keywords: language, complexity, learning, cognition, syntax, pluralism.

RESUMEN

En este comentario se toman en consideración tres buenas ideas de *Conducta Verbal* que se han convertido en puntos centrales de recientes teorías cognitivas del aprendizaje y uso del lenguaje: las contingencias sociales, la causalidad múltiple y el desarrollo sintáctico pieza a pieza. Posteriormente, identificamos dos debilidades del libro que pueden todavía fomentar nuevas vías de aplicación de una aproximación conductual al lenguaje: que la comprensión precede a la producción, y la enorme complejidad de la sintaxis en el uso normal del lenguaje. Finalizamos haciendo una breve consideración de cómo las distintas aproximaciones o marcos de trabajo, entre ellas las conductuales y las cognitivas, deberían buscar modos de integrarse en un intento común de abarcar la impresionante complejidad del comportamiento lingüístico.
Palabras clave: lenguaje, complejidad, aprendizaje, cognición, sintaxis, pluralismo.

Verbal Behavior is an impressive book, even when one considers it against the backdrop of decades of research on language that came after it. Only a small fraction of this later research is influenced by *Verbal Behavior* itself. The vagaries of history and human hubris can keep communities from sharing good ideas, even when these communities are composed of scientists, the supposed archetypal agents of objectivity (a sometimes challenged ideal: Brush, 1974). The emerging community of cognitive psychology, and the "behaviorist" community that preceded it, served to antagonize only for a short time until the communities in many ways diverged (Leahey, 2001). *Verbal Behavior* has many good ideas that have, in the decades after it, been reemerging. Cognitive psychological research on language, in which this reemergence is occurring,

* Correspondence concerning this article should be adressed to the first author: Department of Psychology, University of Memphis, Memphis, TN 38152, USA. Email: radale@memphis.edu

is now a literature apart from the book's intellectual progeny. Despite exciting and valuable work on applying the units of analysis identified by Skinner (e.g., Sundberg, 1991; Sundberg & Michael, 2001; see also Dymond, O'Hora, Whelan, & O'Donovan, 2006), Verbal Behavior's good ideas were not properly imported into broader interest in language learning and use. Discussing some of these reemerging good ideas is one goal of this commentary.

But after 50 years, it cannot be denied that *Verbal Behavior* was not and cannot be a complete answer. We seriously doubt anyone, even those whom the book inspires, would contest this. The book laid a scientific foundation by "building" and "strengthening" a new verbal repertoire (p. 455) that was nevertheless intended to be an "exercise in interpretation" (p. 11). New data and new ideas should effect change in interpretations. In the past two decades there has been a well-known movement in behavioral circles to do this (e.g., Hayes, Barnes-Holmes, & Roche, 2001). There still remain open questions about the applicability of this interpretation and its progeny to the vast database gathered by the sciences of language. It behooves the scientist whom Verbal Behavior inspires to consider these data in a way that moves beyond the promissory connotation that "interpretation" carries. Another goal of this commentary is to consider two avenues of research in psycholinguistics and developmental psycholinguistics that demand an explanation, and still generate debate.

A final goal of this commentary is to consider briefly how behavioral and cognitive communities could interact in a broader "plural" psychology (Slife, 2000). Already within cognitive science, there has been some suggestion to get beyond "paradigm debate" that has characterized so much of the history of our field to date (Dale, in press; Eliasmith, 2003; Looren de Jong, 2002; McCauley & Bechtel, 2001). According to this approach, the complexity of our subject matter -in structure, function, and history- requires a solution that embraces that complexity even in the solution itself.

To begin, we consider some good ideas that Verbal Behavior emphasized. The book broadly emphasizes three fundamental notions that have become a centerpiece of some cognitive accounts of language learning and use: the richness of social contingencies, diverse multiple causes of language behavior, and piecemeal growth of language structure.

Social contingencies are complex

The control by other speakers of a linguistic community is definitive of verbal behavior according to Skinner (p. 14). While this broad definition is known to lead to some questionable identification of "verbal behavior" in experimental settings (e.g., Hayes *et al.*, 2001, pp. 10-11), it is a notion that is rich in its layers of causes and effects in the book. For example, the application of these social influences in ecological contexts may be piecemeal in nature, influencing ongoing child learning in subtle ways, perhaps at first just to encourage anything that "vaguely resembles the adult form" (p. 29) then when these forms appear more frequently a "closer approximation is insisted upon" (pp. 29-30). It is known that "insistence upon forms," in the literal sense of language training, is something only very rarely issued by caregivers as children learn language (as classically noted by Brown & Hanlon, 1970). But the system of control

suggested by *Verbal Behavior* is richer than that. A range of ideas is introduced in this book, from such processes as self-strengthening by speaker (pp. 64-65; Chapter 17), to mere apparent approval as having some impact on the growing language of a child (p. 54).

Some exciting recent research in language acquisition shows that this social influence can be richer and subtler than the simplest assumptions of "training" that many falsely attribute to Skinner. This influence from the social community spans many levels of language learning: From early vocalization, and perhaps even to the syntactic forms used by the child.

Goldstein, King, and West (2003) demonstrate that mere social stimulation can influence the quantity and quality of babbling. They had mothers interact with their young infants in a playroom, and through headphones, experimenters had mothers socially stimulate the infant at the point of babbling simply by leaning in and touching their child. A yoked group of mothers who pseudo-randomly interacted (in which contingent touching is lost) did not induce such changes in babbling. The mere social contingency of the environment served to change patterns of vocalization in these children, and these changes even carried into an extinction phase of the experiment, in which the experimenter-induced synchrony was removed. Even more recently, Goldstein and Schwade (2008) found that the sound structure of the contingent feedback can selectively modulate the subsequent babbling of children. This suggests that both the form and contingency of interaction leads to what the authors call "socially guided statistical learning." (Goldstein & Schwade, 2008, p. 521)

In the case of learning syntax, caregivers may elicit "contrastive" forms to the child who has erred in language usage: reusing a word in a grammatically appropriate way following a child error. This would serve as contingent evidence that the child needs to modify her language, even though the exact form of the caregiver response is not "corrective" in the sense of noting the error. By analyzing transcripts and child-caregiver interaction, Saxton (2000) found that children significantly modified their language following such a contrastive contribution by the caregiver. Chouinard and Clark (2003) offered similar evidence in both French- and English-speaking children. Their analysis showed, as in the Goldstein and Schwade (2008) results above, that contingent responses that contrast the correct/incorrect forms selectively modulate the child's language (e.g., a sound error vs. a syntactic error).

These more recent studies demonstrate that attention to subtler forms of "control" my unveil subtle but important influences on language. It should be emphasized, however, that these sources of information remain highly controversial and disputed in cognitive science. In the case of word learning, perhaps seemingly obviously requiring feedback to nail down "semantics," it is known that children have an extraordinarily robust ability to learn words without any obvious evidence of feedback (see Bloom, 2000). (An important counterpoint is that there is some evidence that rich exposure to a second language but without social interaction does not seem to be sufficient for acquisition: Sachs, Bard, & Johnson, 1981.)

Many simply remember Verbal Behavior for its behavioral approach to language learning, but Skinner's emphasis on "community control" included fascinating observations

of influences of the audience on language behavior (Chapter 7). This detailed chapter offers numerous examples of how audiences may encourage or discourage verbal behavior, modify it in particular ways, or induce the speaker to choose particular forms or topics over others. The functional role of an audience is one that much linguistic theory to this day completely lacks, but new avenues of discourse and sociolinguistics have instead taken the audience, or speaker-listener in combination (a mutual audience), as central to any accounts of language use (e.g., Clark, 1996). In fact, changes to the audience can have direct influences on selection of syntactic form. Balcetis and Dale (2005) had experimental participants interact with a pseudo-confederate that either behaved boastfully and rudely towards the participant, or with charismatic respect. The extent to which syntactic mimicry occurred in a subsequent exchange was modulated by this audience effect: Change the nature of the audience (though the task is entirely the same), and it will influence the probability of certain kinds of language use.

Language is multiply caused and constrained

Skinner recognized that any given episode of language behavior is likely brought about by a constellation of causes. In the first among three chapters devoted to this idea (Chapter 9), it is recognized that "any sample of verbal behavior will be a function of many variables operating at the same time," (p. 228) and he supplies a variety of examples of everyday and literary uses. This idea has formed the core of a number of approaches to language in later research.

In somewhat less related work, the question of how a particular word obtains its syntactic function can be helped by a convergence of information sources (for a review see Christiansen, Dale, & Reali, in press). In this work, the format of a word, from its phonological to distributional characteristics, may help the early language learner acquire grammatical function for particular words. While this is more relevant to very early comprehension skills in the language learner, it is nevertheless an example of multiple variables converging to help language learning. Christiansen *et al.* (in press) note that this "multiple-cue" approach to syntax learning is a demonstration of the presence of various biases converging to help a learner in a way that may help overcome the "poverty of the stimulus" that continues to pose challenges to learning-based approaches to language learning (e.g., challenges presented recently by Lidz, Waxman, & Freedman, 2003).

In more relevant work, research on language comprehension and production in adults has been influenced substantially by a "multiple constraint satisfaction" approach (e.g., MacDonald, 1994; Seidenberg & MacDonald, 1999). In this framework, which has already accumulated extensive empirical support, the specific language comprehended or produced is guided by multiple probabilistic constraints. For example, in hearing The cop saw the burglar with the... the resulting syntactic interpretation of... with the... will depend on the semantic relations of the completing material. Complete the sentence with merchandise, and a listener will likely see the prepositional phrase as describing the burglar; complete it instead with binoculars, and the phrase will describe the cop. In such contexts, the modifying material (analogous to the autoclitic processes of Chapter

12) depends not just on the ordering or the potential syntactic relations, but also the plausibility and other semantic constraints. Such constraints in a developed language, and the multiple constraints imposed by characteristics of the learner, together shape this constraint-satisfaction account which sees acquisition and use as two inherent parts of one explanation for our language abilities. In broad strokes, this is consistent with the original proposal of multiple causality in Verbal Behavior.

Syntax grows in pieces

There has been considerable debate recently challenging the notion that child language emerges in whole as an abstract rule-based system. Alternative accounts of language structure see the regularities emerge in concrete, probabilistic ways (e.g., Tomasello, 2003; Goldberg, 2006), rather than an abstract and innate system of behavior (Chomsky, 1966, 2000). This predicts that, early in development, children should treat individual words as concrete "objects" with their own function and distribution, to some extent independent of other gradually learned words. Only with extensive experience does grammatical behavior form in full-fledged fashion. Verbal Behavior embraces such "concrete" growth by identifying the function of units of language as children become more skilled. More recent behavioral approaches to language do so as well by identifying the growth of complexity and generalization in behavior carried through "multiple-exemplar" learning (Hayes *et al.*, 2001, pp. 147-148).

Consider the following study by Akhtar (1999), in which children, some at about 2 years of age, were exposed to novel, unfamiliar words in an experimental setting. Children were shown an action meant to reflect the meaning of a new word gopping, but were presented these words in syntactic contexts that violated the English language. For example, one such expression might be Big bird the car gopping in which the object of the sentence precedes the verb, violating English's subject-verb-object patterning. When learning the nonce words in non-English patterns, the 2-year-old children had a surprisingly high probability of using that ungrammatical pattern when prompted later in the experiment. Older children, from about 3 years onward, more frequently "regularized" this uncommon word ordering, indicating that by this age they had in place firmer expectations regarding word order. These "item-based" (Tomasello, 2003) patterns also seem to hold in naturalistic usage. Lieven, Pine and Baldwin (1997) found that just 25 fixed initial patterns of language usage can account for as much as 60% of the language produced by 11 children. Theakston, Lieven, Pine and Rowland (2001) found that a good account of verb development was not so much syntactic complexity as the extent to which children were mastering differing lexical frames for different types of verbs. These "frames," starting piecemeal and growing in gradual fashion over the early years of learning, are not entirely unlike the concrete, functional frames described in *Verbal Behavior* (Chapter 12).

Finally, the assortment of autoclitic elements described in Chapter 12 are also reminiscent of construction grammars that emphasize the relation among pieces of language that have pockets of productivity (Goldberg, 2006). The very notion that functional relations hold between elements of a language is a core characteristic of

these theories which see a language's grammar as composed of an assortment of context-specific, quasi-general structures.

Summary: Two complexities

Skinner's "good ideas" certainly did not take the exact form that these later proposals have. Nevertheless, their broader consistent characteristics are foundational elements in very successful cognitive approaches to language acquisition. To many, they may seem obvious, but they can be clouded by constraining assumptions. For example, in language learning, social contingencies probably matter (at the very least, in a strongly facilitative manner). But many simplistic assumptions regarding "evidence" from caregivers have neglected the other possible contingencies at play that are subtler, and multifarious in their effects (Moerk, 1980, 2000).

The foregoing core characteristics of the behavioral account also suggest another interesting comparison with the Chomskyan approach that came after. Chomsky (1959) argued, among other points, that the explanation offered by *Verbal Behavior* was insufficient to help us understand the complexities of language structure. In this sense, the behavioral account is "simplistic." Curiously, notwithstanding purported limitations in capturing rich grammatical patterns, the account in Verbal Behavior is anything but simplistic. The constraints on language are judged to be multiple, subtle, and piecemeal. This is a distinct complexity in comparison to the functional simplicities of traditional linguistic accounts. The two complexities form a curious complementarity. Complexity of structure in later Chomskyan accounts is matched with the complexity of function in Skinner's.

Challenge 1: Skinner got it backwards

Despite the consistencies described in previous sections, there are distinct challenges for any account drawing on the tradition of *Verbal Behavior*. We consider two in the next two sections. In the first case, *Verbal Behavior* starts in a way that would seem odd to a developmental psycholinguist these days. Skinner considers potential units of verbal behavior for the speaker, with the listener mostly assumed to be an attentive linguistic community member. The problem with this is that language seems to get started first with listening rather than speaking. Language comprehension by children with only a modicum of productive abilities can be very sophisticated. A classic study by Golinkoff, Hirsh-Pasek, Cauley, and Gordon (1987) presented infants with two videos, one to the left and another to the right, showing an action performed by one thing on another. For example, a video on the left might be a boy kissing a girl, and a video on the right a girl kissing a boy. By noting the infant's looking preferences when hearing the sentence The boy is kissing the girl, one can assess whether the child has some capacity for detecting the significance of word order. Children systematically showed these semantic word order preferences at a very young age. 17-month-olds, only at the one-word stage of language production, appeared to show looking preferences to the consistent video. Even more complex syntactic patterns, such as transitive versus

intransitive verb constructions, seem to be interpreted correctly by children at about 2 years of age, well before they show the syntactic complexity in production themselves.

In fact, subtle forms of perceptual learning seem to occur even earlier on in language. Other fascinating work has shown that perceptual sensitivities exist in very young infants who've just left the womb -indicating that they have acquired sensitivity to certain sound patterns in the womb (Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, & Amiel-Tison, 1988). One explanation for these capacities is that humans have an ability to become sensitive to regularities in sequential sensory streams. They may thus be capable of learning the probabilistic structure of these sequences, and identifying significant units of organization.

An impressive demonstration of such probabilistic learning is the segmentation of speech into words. Language users are confronted early on with the problem of identifying word boundaries from a speech signal that inconsistently provides acoustic cues. Despite this potential setback, children prior to the age of 12 months are able to distinguish sequences of syllables that form word units from sequences that bridge word boundaries. Research by Saffran, Aslin, and Newport (1996) suggests that children are highly attuned to and learn from the sequential dependencies between syllables, such that words are understood by noticing consistent dependencies. To assess such learning, 8-month old infants were exposed to just 2 minutes of a continuous speech stream consisting of four three-syllable nonsense words. The only available source of information for segmentation was the transitional probabilities of syllable sequences. The probability for a word sequence is greater because of a fixed order structure, compared to the between word sequence that exhibits more ordering flexibility. After the children listened to the continuous speech patterns, they then listened to one of the previous words or a three-syllable sequence that bridged two of the words. The researchers found that the infants listened longer to the bridged-word sequence, possibly indicating that these sequences were more novel than the single word sequences.

This process of segmentation thus seems to be an important part of early language learning. If social contingencies apply to word units, then a significant problem is how a child identifies and responds to these stimulus units. Naturalistic speech is an incredibly complex and continuous signal, with non-existent word boundaries in much fluent speech, including stimulus variability introduced by coarticulation. It is a highly nontrivial problem how a child, with no knowledge of, for example English, is capable of identifying such relevant units in continuous speech. Some rapid and early perceptual learning involves categorical phonetic contrasts at the level of the auditory signal (Jusczyck, Pisoni, Walley, & Murray, 1980; Werker & Tees, 1984), with infants eventually becoming more sensitive to how these and other acoustic cues relate to the boundaries between words (Werker & Tees, 1984). One possible solution to finding word boundaries is to identify multiple acoustic correlates of those boundaries. The rich and probabilistic acoustic cues available to the listener could be used to discern the markers of word boundaries (Christiansen, Allen, & Seidenberg, 1999; Fernandes, Ventura, & Kolinsky, 2007; Mattys, White, & Melhorn, 2005).

This behavior of "early listening" may very well precede any type of language production. It could eventually flow into the onset of influence from social contingencies,

such as a mother's touch, a subtle contingency among others that may induce "socially guided statistically learning" early on (Goldstein & Schwade, 2008).

Challenge 2: Complexity of form

From a behavioral perspective, the problem of language learning is the problem of discovering the contingencies and establishing operations for complex linguistic skills that culminate in syntactic and high-level semantic patterns. Sundberg (1991) identified this in his list of research endeavors that could have emerged from *Verbal Behavior*: "experimental research on establishing operations lags far behind," (Sundberg, 1991, p. 82) and in the case of accounting for grammar using such frames as the autoclitic, it is a foundational open question that still needs answering. The issues of syntax and semantics have been given some experimental attention, both from the Verbal Behavior's framework and modern behavioral approaches (e.g., sequence classes: Lazar, 1977; Wulfert & Hayes, 1988; Green, Stromer, & Mackay, 1993). Unfortunately, it remains the case that these demonstrations of establishing "syntactic" and "semantic" behaviors are as yet quite simple and only promissory in how they might address a fully blossomed linguistic skill of impressive complexity. Despite the inevitable and very important application of these simple but successful processes in clinical contexts, they are taxed when applied to normal usage. There is promise in identifying functional constraints on syntactic forms, and using those constraints to account for their development. However, the challenge is to scale up the functional accounts to capture the richness of normal language functioning.

Consider the case of center embedding. Skinner would identify many instances of center embedding of relative clauses as "qualifying" autoclitics: The gentleman [that the bartender served] drinks Murphy's. Such center-embedded clauses are rich syntactic tools that humans have for describing the world. They can also multiply: The gentleman [that the bartender [who likes tips] served] drinks Murphy's. The productivity of these structures can still appear astonishing to behavioral scientists, as they may have to Lashley (1951). Identifying these qualifying structures, and describing their hypothesized functional role, does not explain them, however. Showing how they emerge, in either experimental or observational contexts, is required for a satisfying account. One mode of accomplishing such a demonstration is in computational "existence proofs," pursued extensively in some corners of cognitive science. For example, Christiansen and Chater (1999) demonstrate that a simple sequential learner (a simple-recurrent network) can learn these center-embedding structures, while also demonstrating a human-like breakdown of comprehension when these center embeddings multiply.

Placing the behavioral processes of equivalence and sequence classes in a computational existence proof is surprisingly easy, and extensive resources exist to accomplish this. The framework in *Verbal Behavior*, and the potential theoretical extensions offered in newer approaches (Hayes *et al.*, 2001), make very specific claims about the operation of social and other contingencies. An explicit mathematical or computational model that instantiates these processes could offer researchers a chance to explore simulated contexts that are very difficult to establish in real human experiments. In the

case of generating syntax-like sequence classes, Dale and Spivey (2005) created a generalized simple-recurrent network model to demonstrate sequence classes that could also be extended to center-embedding-like response sequences. Embracing such research contexts may mean embracing computational considerations that take the behavior analytic approach beyond the theoretical considerations with which it is comfortable (but this is not always the case; e.g., Barnes & Hampson, 1993; Burgos, 2007; Lyddy, Barnes-Holmes, & Hampson, 2001; Palmer, 1997). Simulating the establishment of more complex syntactic sequences may not only have explanatory benefits, but also potential insights into clinical contexts in which these syntactic behaviors would be crucial to everyday functioning by someone who does not have these behaviors in place. By simulating basic contexts, more complex ones can be explored much more cheaply on a personal computer than through human subjects review boards.

Conclusion: Uncover the conspiracy

The two challenges identified in the previous sections involved extending the behavioral approach to early emerging comprehension skills, and fleshing out the origin of the very complex syntactic skill exhibited by language users. Elman (1999) seeks an explanation of these skills through what he dubbed an emergent "conspiracy" of genetic and environmental constraints that slowly "tweaked" our species towards language, across evolution and during development. Conspiracies are often "complex," in that no single individual or mechanism drives events. Instead, events unfold according to a conglomeration of causal factors. As Elman (1999) acknowledged, the conspiracy view has promise but is as yet unfulfilled: The evolution and development of human language is still veiled by the complexity of brain structure, and the subtle forces tucked into an individual's (and our species') history, difficult to access by scientific analysis.

Perhaps due to the complexity of this scientific problem, there has been a proliferation of solutions whose advocates often prefer to see them as being fundamentally distinct, and mutually exclusive. With a few exceptions (e.g., Spencer, Thomas, & McClelland, in press), cognitive science has grown its own disputes, and already forgotten the potential insight that the basic behavioral approach in *Verbal Behavior* might supply. But the agenda should go both ways (O'Hora & Dale, 2008). Perhaps the ultimate lesson from Chomsky and Skinner is just that. Chomsky's formalisms kick-started vast improvements to our understanding of language structure. The behavior analyst's approach through functional analysis can allow an integration of this structure in the interaction with our environment.

In this new century, there has been a move to address such complex problems by complex, interdisciplinary scientific solutions. Such interdisciplinarity also applies to the divergent approaches inside our own diverse field of psychology (Slife, 2000). This may mean exiting our own "research silos" (Jilk, O'Reilly, Lebiere, & Anderson, in press) more readily and frequently. In Skinner's own terms, that may require a "strengthening" of not one but multiple and multifarious scientific verbal repertoires (and encouraging our students to do so as well).

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