

*Behaviourism and language acquisition*

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## Abstract

To what extent can human language learning be described, explained, and predicted from basic learning principles? Following the Skinner/Chomsky debate, many scholars avoided invoking basic learning principles, concentrating instead on cognitive approaches. We argue that these cognitive approaches have often ended up incorporating basic learning principles, either implicitly or explicitly. In the meantime, research on the communication among nonhuman animals and on language learning in clinical populations has shed light on how basic learning principles might contribute to learning communicative systems. We look forward to future research testing how far basic learning principles can go to explaining human language learning.

**Keywords:** basic learning principles; behavior analysis; behaviorism; nonhuman animals; shaping; Skinner/Chomsky debate; social reinforcement; vocal learning

### **Key points:**

- We review the Chomsky/Skinner debate and its impacts on research
- We show that cognitive approaches to language incorporate basic learning principles
- Research on nonhuman animal communication shows that learning can take place through modeling and shaping
- Successful interventions for clinical populations have been designed using basic learning principles

## Introduction

In his well-known book, *Verbal Behavior*, Skinner (1957) argued that human language processing, including children's language learning, could be explained through basic behaviorist principles of learning. The theory addressed how, at the conceptual level, a small set of domain-general behavior principles might suffice to account for verbal phenomena such as grammatical constructions, language productivity, and displacement in the verbal behavior of a mature speaker. Children's acquisition of the early building blocks of these phenomena was addressed mostly in passing. Nonetheless, Skinner's perspective was clear that language, including its acquisition, could be fully explained by the principles of operant conditioning and, to a lesser extent, Pavlovian principles. Language development as a product of operant and Pavlovian processes was explored in more detail by other early theorists (e.g., Staats, 1968). Chomsky (1959) challenged Skinner's arguments about language learning, maintaining that the grammar of human languages could not be learned through simple learning principles. Chomsky raised a number of theoretical objections, including that humans can process an infinite number of novel sentences and are not restricted to the set of sentences that they have previously encountered.

Following the Skinner/Chomsky debate, scholars diverged in their approaches to language learning. Many researchers, including some dedicated behaviorists, subsequently adopted the assumption that human language was distinct from other forms of animal communication (Wilson, 1972). Some scholars, from many disciplinary backgrounds, adopted Chomsky's arguments as assumptions guiding their theoretical work. These assumptions included that human language (at least the grammar) could not be learned via basic learning

principles and that the input to children was insufficient to allow them to learn grammar (Chomsky, 1965). We briefly discuss some major arguments from these cognitive approaches to language learning. In the meantime, behaviorists set to work to better understand how nonhuman animals learned their communicative systems, both nonvocal and vocal. In doing so, as we will show, these scholars identified many similarities between nonhuman animal communication and human language learning. More recently, scholars have started working on applying basic learning principles to human language learning, particularly in clinical populations.

### **Cognitive approaches to humans' language learning**

Starting in the 1960s and 1970s, many linguists studying children's language acquisition adopted Chomsky's Universal Grammar, assuming that humans are born knowing some grammatical knowledge that applies to all languages (e.g., Wexler, 1990). According to this approach, to learn the specifics of a particular language's grammar, children need some minimal exposure to that language. As research framed in a Universal Grammar has proceeded, many scholars have recognized that statistical properties of the input (such as frequency and co-occurrence) fundamentally change what children learn (Pearl, 2021; Zamuner, Gerken, & Hammond, 2005). Pearl (2021) argues that, in order for children to benefit from the statistical distributions in their input, they require reinforcement for correct interpretation. Pearl (2021) explicitly makes the connection between reinforcement and operant conditioning, arguing that Universal Grammar allows children to recognize what needs to be tracked in their input and statistical learning helps them do the tracking.

Another line of reasoning that took the gist of Chomsky's arguments seriously was language socialization, a theory originating in linguistic anthropology (Ochs & Schieffelin, 2008). Language socialization assumes that community members respond to children in such a

way to encourage them to act as competent community members themselves, such as only responding to them socially when children articulate something meaningful in the language (Schieffelin & Ochs, 1986). When children act like competent members of their culture, they get treated communicatively. Children's behavior (including language behavior) is therefore shaped in the context of social interactions. For example, one study found that mothers treated nine-month-old infants as if they were attempting to communicate if the infants pointed (Nicoladis & Barbosa, 2024). Sturdy and Nicoladis (2017) argued that the learning principles assumed by language socialization are largely identical with basic learning principles.

Both Universal Grammar and language socialization theories have attempted to explain children's language learning without drawing on basic learning principles. However, they have ended up including these basic principles, either explicitly or implicitly (see discussion in Sturdy & Nicoladis, 2017). More recently, scholars have been working on a set of theories that could be compatible with behaviorism: usage-based theories (Tomasello, 2010). While differing in some minor details, all usage-based theories assume that language learning can be explained through domain-general processes (i.e., processes that are not specific to human language), including statistical learning and social reinforcement. When language learners receive repeated exposure to a particular linguistic form, they produce that form verbatim. Repeated exposure across different types leads to generalization. While usage-based theories could be compatible with basic learning principles, we have yet to see scholars attempt an assimilation of the two theoretical approaches.

### **Learning communication among nonhuman animals**

Following the Skinner/Chomsky debate, some scholars focused on how nonhuman animals learn to communicate. They showed that insight into human communication can be

gained, seemingly paradoxically, not only from studying humans, but by going further afield, or sometimes going into an actual field. Studying nonhuman animals and their communication systems allows researchers the opportunity to delve into the neuronal, behavioral, and developmental substrates of communication systems in a manner not possible to achieve by studying humans. We first describe some examples of animal communication that are often thought to be only possible by humans, then move to more mechanistic studies of vocal communication learning (in this case song learning), and finally end back with humans and human speech learning, to show how human communication follows similar Skinnerian rules thought to be only the stuff of nonhuman animals.

One aspect of communication that was once thought to be the sole purview of humans is referential communication. In human languages, words or signs (in sign languages) are arbitrarily associated with a referent (Watson et al., 2022). For example, the word *ball* refers to the entire class of balls (including beach balls, footballs, and baseballs) and yet there is nothing inherent in the word that indicates what it means (in Slovakian, for example, the word for ball is *loptu*). There are well-known examples of nonhuman animals, in these particular examples, vervet monkeys (*Chlorocebus pygerythrus*) and Japanese tits (*Parus minor*), using referential communication. In both of these examples, nonhuman animals pair acoustically distinct vocalizations with particular referents. Furthermore, when exposed to these vocalizations, animals respond with appropriate behavioral responses. For instance, Seyfarth et al. (1980) showed that vervet monkeys produced specific calls in response to particular predators, and playback of these calls produced particular predator-specific responses. In a similar fashion, Suzuki (2018) have shown similar patterns of referential vocalizing and behavioral responses to

predators. These examples of communication usage are intriguing, but do not address vocal learning, per se. We now turn to examples of nonhuman animal vocal learning.

Nonhuman animals have also increased our understanding of more fundamental, mechanistic details underlying the development of learned vocalizations, an ability that humans share with a few animal groups (see review Vernes et al., 2021). Songbirds (the *Oscine Passeriformes*; Mischler et al., 2017) are an order of birds that learn their vocalizations (songs, mainly) by interacting with tutors during critical periods in development (Catchpole and Slater, 2008). Marler and Thorpe, the former of whom made the observation that chaffinches (*Fringilla coelebs*) in different parts of the countryside sounded slightly different from one another, and the latter who experimentally deduced how this came to be (Marler, 1952; Thorpe, 1958) engaged in a detailed examination of birdsong development. During the course of later studies conducted on the white crowned sparrow (*Zonotrichia leucophrys*), Marler was instrumental in systematically demonstrating the developmental determinants of birdsong learning (Marler & Tamura, 1964; Marler 1970b) and reviewed in Marler (1970a). Many other researchers studying various songbird species followed with studies of other species leading to where we are today, essentially understanding song learning and production from a very detailed molecular and cellular level to the developmental determinants and every permutation of inquiry in between (for some recent advances see the volume by Sakata et al., 2020).

Another species, the zebra finch (*Taeniopygia guttata*), has become the main species used for song learning studies beginning around the same time as Marler's work in the middle of the 1960s. Starting with pioneering work of Immelmann (e.g. Immelmann, 1969). Zebra finches are small songbirds from Australia who thrive in captivity, making them ideal subjects for studies of vocal learning. Work with zebra finches has elucidated the developmental determinants of song,



including groundbreaking work by Nottebohm and Tchernicofski who showed that although zebra finches will generally not learn songs from a recording, they will do so if the song playback is requested by the birds by pecking a key and the song is played from a model of a zebra finch (Tchernicofski et al., 1999). Moreover, Nottebohm's group was able to determine, employing the same method, that zebra finches needed only brief exposure to song in order to produce complete good song copies. Paradoxically, they also found that more is not better when it comes to the amount of examples provided to young birds learning to sing. To determine precisely the minimal optimal dose of song exposure needed to accurately copy a tutor, Nottebohm's group employed an automated tutoring system whereby they could precisely deliver tutor songs in different amounts and assess the consequences with respect to song copying accuracy. What they showed was that 30 seconds of total song exposure led to accurate imitation of the tutor song, while more exposure actually resulted in less accurate song imitation (for similar results in human infants, see Goldstein et al., 2003)

Male brown-headed cowbird (*Molothrus ater*) vocal output has also been shown to be shaped in a Skinnerian manner (West & King, 1988) and shaped in particular by females, the ultimate target of male singing behavior. In a clever experiment, West and King first observed cowbird male female pairs and their subsequent behavior. In particular, they noted male songs that females responded to with a conspicuous display termed the wing stroke. In the second part of their study, they presented songs to females, both those that led to a wing stroke as well as other songs, with the idea to assess female song preference. What they found was striking; females performed significantly more copulatory solicitation displays following the playback of wing stroke songs. In essence, females were shaping males to sing the songs they most preferred.

In sum, research on communication among nonhuman animals has shown that nonhuman animals are capable of using referential communication in many ways similar to humans (see Watson et al., 2022, for discussion). Moreover, nonhuman animals can learn vocal communicative systems based on models and shaping. Could these insights inform behaviorist approaches to human language learning?

### **Behaviorist approaches to human language learning**

The 21<sup>st</sup> century has seen an exponential increase in empirical research influenced by Skinner (1957), particularly in applied research with clinical populations (Petursdottir & Devine, 2017). These developments can be traced in part to the growth of the profession of behavior analysis (Behavior Analysis Certification Board, 2024), and the involvement of this profession in early intervention services for children diagnosed with autism spectrum disorder (ASD), in which an emphasis is placed on fostering the development of language and communication.

Behavior analysis has a long history of applying techniques grounded in operant reinforcement and stimulus control to teaching language skills to children with disabilities (e.g., Lutzker & Sherman, 1974; Risley & Wolf, 1967). As demand for behavior analysis services increased, attention was drawn to the potential advantages of using concepts derived from Skinner (1957) to conceptualize, assess, and teach early language skills (Sundberg & Michael, 2001). Assessment and curriculum guides have been developed that are grounded in Skinner's theory (e.g., Sundberg, 2008) and its basic concepts have been disseminated to parents (Barbera, 2007). The research related to these developments has had a largely practical focus on evaluating teaching procedures, rather than on evaluating theory or investigating the operation of behavioral principles in typical language development (Petursdottir, 2018). However, it certainly provides

indirect support for a behavioral perspective on language development, insofar as it demonstrates that language skills can be established through deliberate programming of the experiences hypothesized (e.g., by Skinner) to be responsible for natural language acquisition. Researchers have investigated, to name but a few examples, the induction of early canonical speech sounds in nonverbal children (e.g., Esch et al., 2009), verbal responding to novel combinations of stimuli (e.g., Degli Espinosa et al., 2021; Rodriguez et al., 2022), rapid vocabulary expansion (e.g., Pistoljevic & Greer, 2006), utterance length and grammatical complexity (e.g., Fischer et al., 2010), and labeling of private events (e.g., Rajagopal et al., 2021).

Concurrently with, but independently of these developments in the applied arena, new theories of language have emerged that are philosophically grounded in radical behaviorism (Skinner, 1974) or its offshoots, and can be seen as building up on or extending Skinner's (1957) *Verbal Behavior*. Relational frame theory (Hayes et al., 2001), which aimed to address what were seen as limitations in the scope and influence of Skinner's work, arose from basic research on derived symbolic relations among stimuli (e.g., equivalence relations; Sidman & Tailby, 1982). Similar to Skinner (1957), relational frame theory is not particularly a theory of children's language learning, but more of a theory of the essence of language (i.e., it consists of arbitrarily applicable relational responding, which is proposed to be acquired through early social interactions) and its operation in the human experience. Nevertheless, it has generated and continues to generate a fair amount of basic empirical research on children's learning of arbitrarily applicable relational responding (e.g., Kirsten & Stewart, 2022; Lipkens et al., 1993; Luciano et al., 2007; Sivaraman et al., 2021). It has also been applied in the realm of language intervention (e.g., McKeel et al., 2015).

Other behavioral theories have emerged with a more developmental focus. Naming theory (Horne & Lowe, 1996) was ultimately a theory of derived stimulus relations, but its exposition necessitated a theoretical extension of Skinner's (1957) account as it pertained to language development. A key concept in this theory is bidirectional naming, which is introduced as the basic unit of verbal behavior, and conceptualized as a higher-order behavioral relation consisting of several components. Essentially, the bidirectional naming concept addresses how it is that we can learn new relations between words and their referents without the apparent involvement of operant reinforcement contingencies (a point acknowledged but not fully explicated by Skinner). The theory outlines the development of bidirectional naming in early childhood, and its involvement in more complex behavior. The bidirectional naming concept was later incorporated into verbal behavior development theory (VBDT; Greer & Speckman, 2009); an evolving account that provides a more comprehensive look at language development in the context of evolutionary processes (Pohl et al., 2020). VBDT characterizes bidirectional naming as a significant milestone or cusp that expands a child's capacity to learn from their environment. Naming theory and VBDT have generated a body of research on bidirectional naming in childhood and beyond, including research on interventions to induce bidirectional naming when absent (for a review, see Sivaraman & Barnes-Holmes, 2023). Other behavioral theories with a developmental focus include a behavioral systems theory of language development (Pelaez & Novak, 2024) and an ecobehavioral model (Ford et al., 2020).

## **Conclusion**

The novelty and one of the major strengths of Skinner's (1957) theory lay in the continuity it provided between human language and cognition and other behavioral aspects of living systems. Language, in Skinner's view was simply behavior; like all other behavior a

product of organism-environment interactions that were lawful and biologically grounded.

However, until the 21st century, *Verbal Behavior* had little to no influence on empirical research on language learning (McPherson et al., 1984; Sturdy & Nicoladis, 2017). And the strongest influence to date has been on research in clinical populations (Petursdottir & Devine, 2017).

We anticipate a future in which there will be more theoretical and empirical attempts to explain language learning from a behaviorist perspective (e.g., VBDT; Greer & Speckman, 2009). As Sturdy and Nicoladis (2017) pointed out, it may well be the case that behaviorist approaches are insufficient to describe, explain, and predict human language learning. Indeed, theoretical approaches that include insights from both learning theory and from cognitive approaches (see, for example, Pearl, 2021) may provide particularly powerful explanations.

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